CHAPTER IV
RESULTS AND DISCUSSION

4.1 Critical Micelle Concentration (CMC) of Supernatant Solution of SDS and Calcium Soap

Table 4.1 shows the CMC of supernatant solution of SDS and calcium soap. The results show that CMC of supernatant solution was lower than pure SDS. This is due to the decrease in electrostatic repulsion between the charged head groups in the presence of calcium soap in supernatant solution. CMC was also found to increased with increase in the alkyl chain length of calcium soap. This is due to the lower solubility of the longer chain calcium soaps

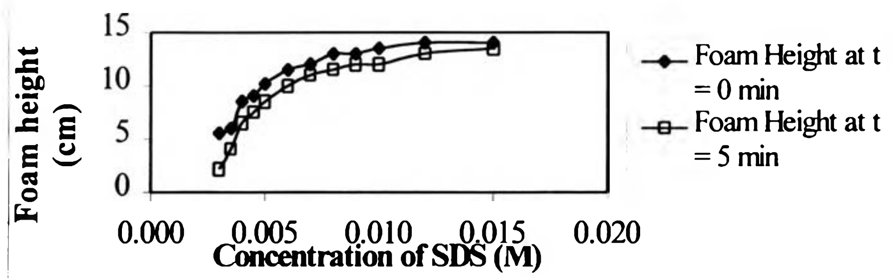
Table 4.1 CMC of supernatant solution of SDS and calcium soap

Type of calcium soap	CMC (M)
Pure SDS	0.0008
C_8	0.0005
C_{12}	0.0006
C_{14}	0.0007
C_{18}	0.0007

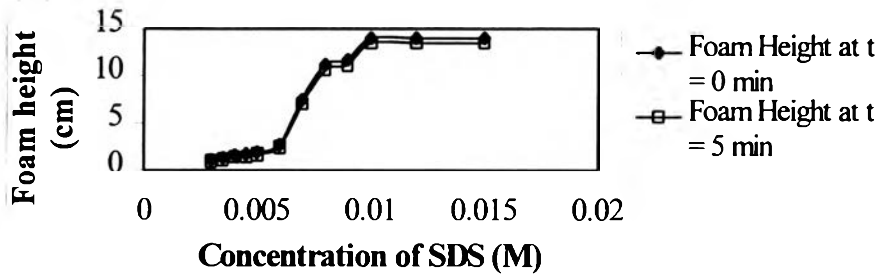
4.2 Foaming Test by Shake Method

4.2.1 Foaming of SDS and Calcium Soap Mixture

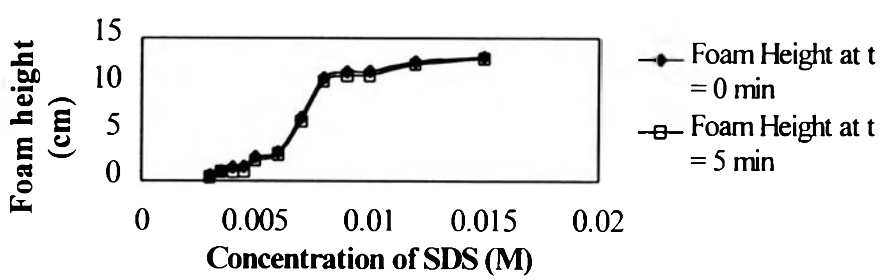
Figure. 4.1 shows the foam height of the mixtures between SDS and $C_8 - C_{18}$ calcium soaps by the shake method. The results show that at low SDS concentrations (0.003-0.006M) which is below the CMC, foam height of



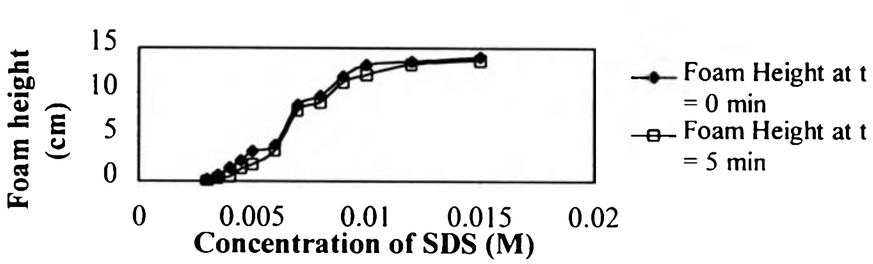
a) Pure SDS



b) SDS with 0.0005 M C12 calcium soap



c) SDS with 0.0005 M C14 calcium soap



d) SDS with 0.0005 M C18 calcium soap

Figure 4.1 Relationship between foam height and concentration of SDS by the shake method in the presence of 0.0005 M calcium soap

SDS solution in the presence of 0.0005M calcium salt is lower than that of pure SDS. However, when SDS concentration is over 0.007M, which is above the CMC foam heights of SDS solutions with or without calcium soap are at the same high value of around 14 cm. Foam stability after 5 minutes was high in all cases and over the entire concentration range under study. These results are agreement with Peper (1958) who also studied the effect of long chain calcium salt of fatty acid to on the foaming of SDS. The results show that calcium soap reduced the foamability of SDS solution only in the concentration below the CMC.

4.2.2 Foaming of SDS with Supernatant Solution of Calcium Soap

Figure 4.2 shows foam height of supernatant solution of C_{12} to C_{18} calcium soap in varying concentration of SDS. It can be seen that foam height is comparable to that of pure SDS over the entire concentration in all cases. The results show that calcium soap in solution does not have an antifoam effect on SDS solution.

4.2.3 Comparison of the foaming of supernatant solution and solution with Calcium soap precipitates

Figure 4.3 and 4.4 compare foam height at t = 0 and t = 5 min of supernatant solution and SDS solution with calcium soap precipitates. It can be seen that foam height of supernatant solution is higher than the solution with calcium soap precipitates in all cases. From these results we can conclude that the calcium soap particles act as an antifoam in SDS solution at low concentration below CMC, but at high SDS concentration above the CMC the antifoam ability of the soap precipitates decrease. This is because the foam film in the presence of micelle at above the CMC is thicker than the solution without micelle (Pugh, 1996) so the precipitates cannot penetrate into the film easily and thus the film is more stable.

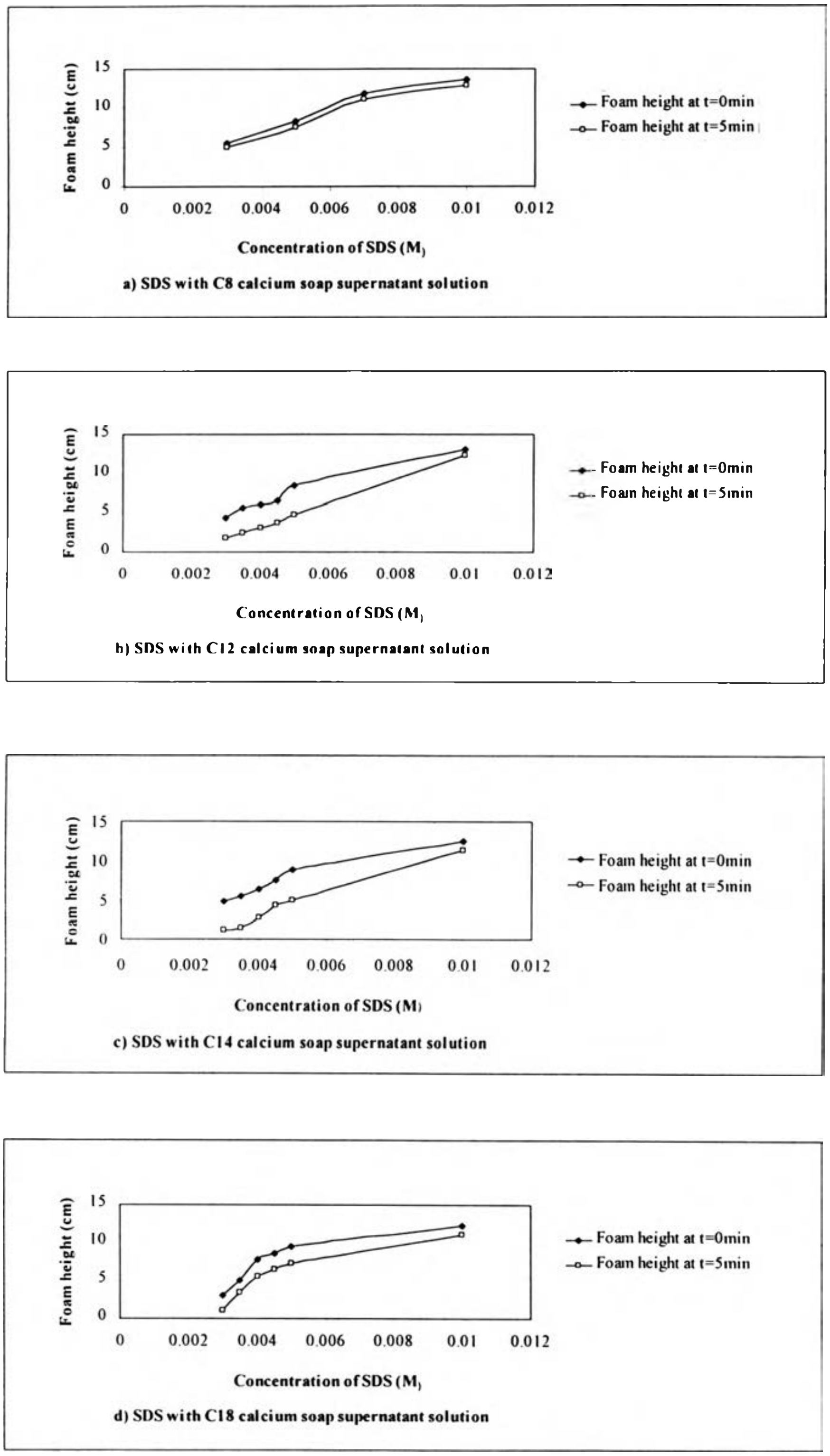


Figure 4.2 Relationship between foam height and concentration of SDS in SDS-calcium soap supernatant solution by the shake method

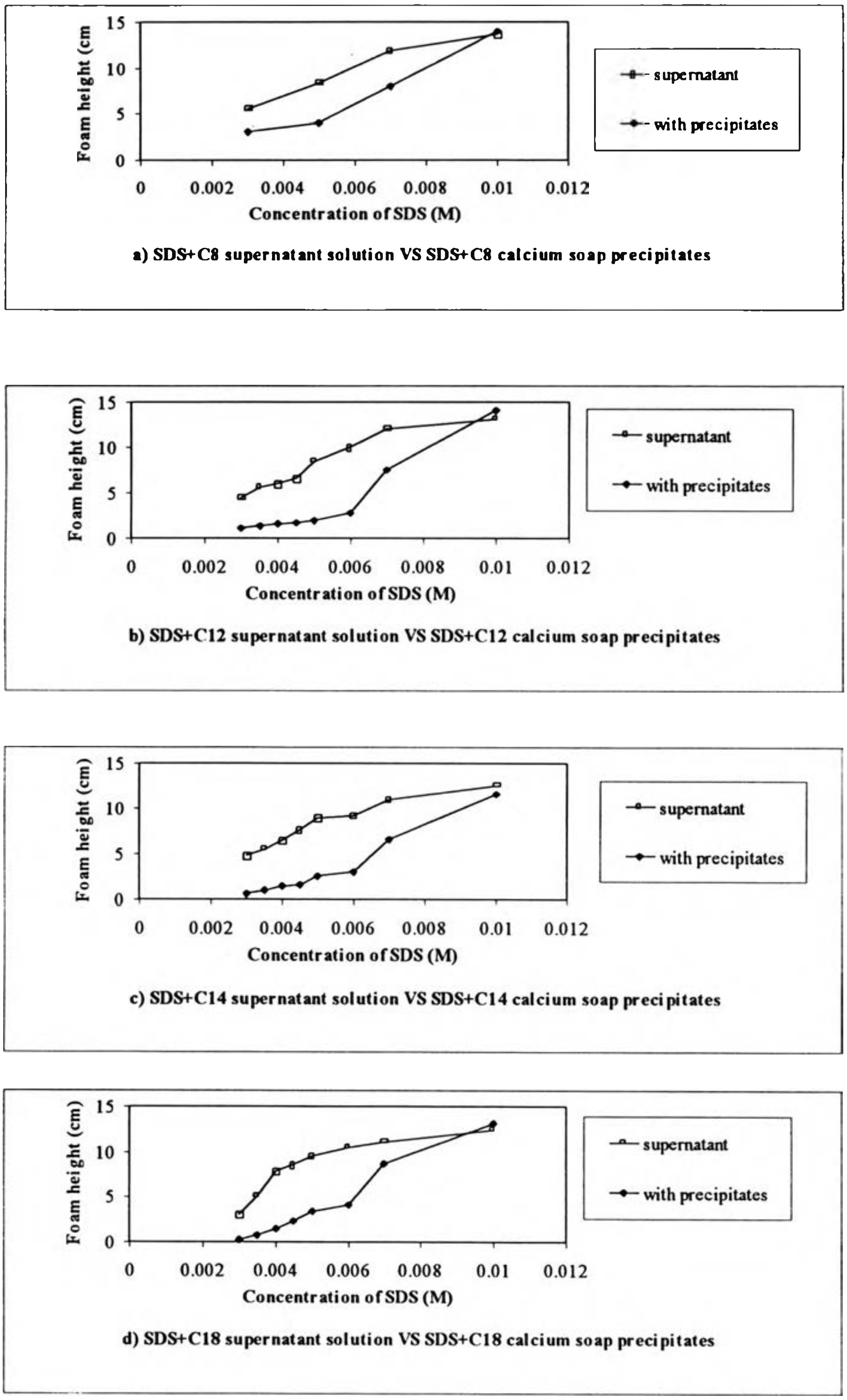
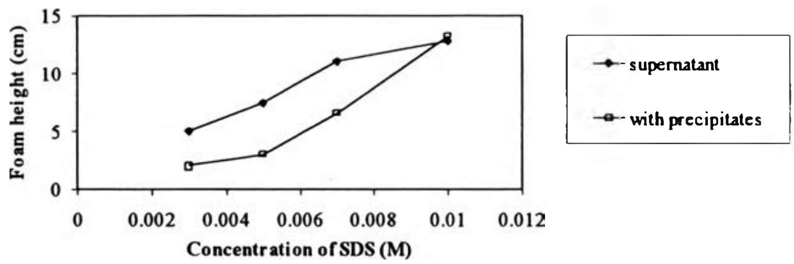
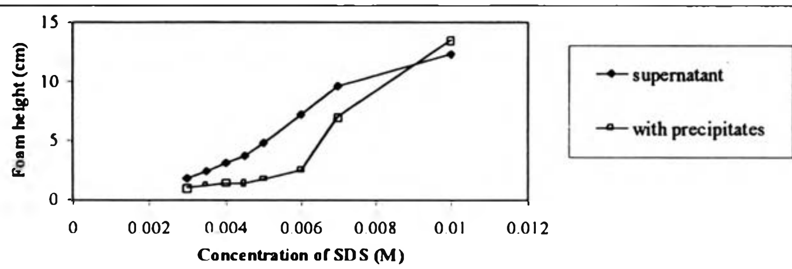


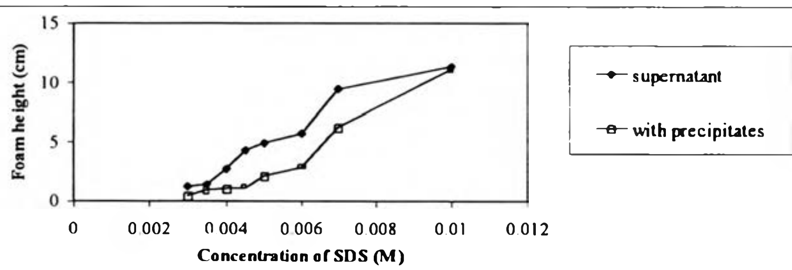
Figure 4.3 Comparison of the foamability of SDS supernatant solution with SDS with calcium soap precipitates by the shake method



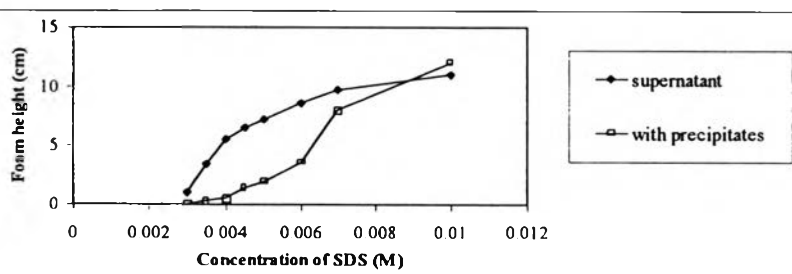
a) SDS+C8 supernatant solution VS SDS+C8 calcium soap precipitates



b) SDS+C12 supernatant solution VS SDS+C12 calcium soap precipitates



c) SDS+C14 supernatant solution VS SDS+C14 calcium soap precipitates



d) SDS+C18 supernatant solution VS SDS+C18 calcium soap precipitates

Figure 4.4 Comparison of the effect of calcium soap particles on foamability of SDS solution at time = 5 min by the shake test method.

4.3 Foaming Test by Ross-Miles Method

4.3.1 Foaming of SDS and Calcium Soap Mixtures

Figures 4.5 and 4.6 show foam height of SDS in the presence of 0.00025M and 0.0005M calcium soap by the Ross-Miles method. It can be seen that below CMC, foam height of SDS solution in the presence of calcium soap is lower than that of pure SDS. But above CMC, the foam heights in both cases are about the same. The results further confirm that calcium soap acts as an antifoam in SDS solution below CMC.

4.3.2 Effect of Calcium Soap Chain Length on Foamability of SDS

Figures 4.7 to 4.8 show the effect of calcium soap chain length on the foamability of SDS. For low SDS concentration below CMC (0.003-0.005 M SDS), foamability was found to decrease with increase in the chain length of calcium soap. But at SDS concentration above CMC (higher than 0.007 M), there was not much difference in foamability with change in the calcium soap chain length. The results show that the antifoam effect of calcium soap below CMC depends on the hydrophobicity of the calcium soap.

4.3.3 Effect of Amount of Calcium Soap on SDS Foamability

Figures 4.9 shows the effect of amount of calcium soap on the foamability of SDS. For low SDS concentration (0.003-0.005 M SDS), foam ability of SDS decreased with increase in the amount of calcium soap particles. At high SDS concentration above 0.007M, foamability of SDS remains high regardless of the amount of calcium soap in the system.

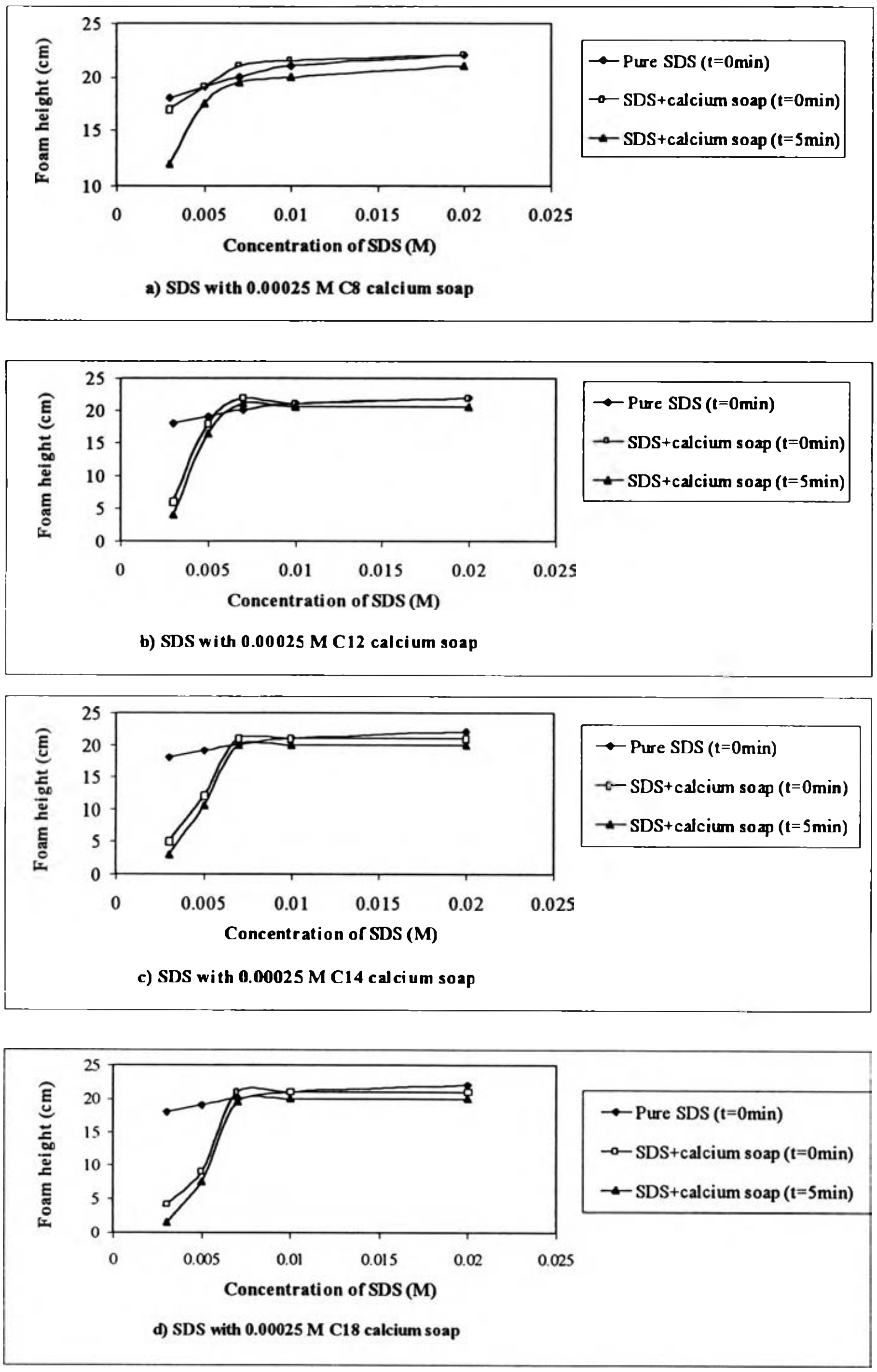


Figure 4.5 Relationship between foam height and concentration of SDS by the Ross-Miles method at 0.00025 M calcium soap

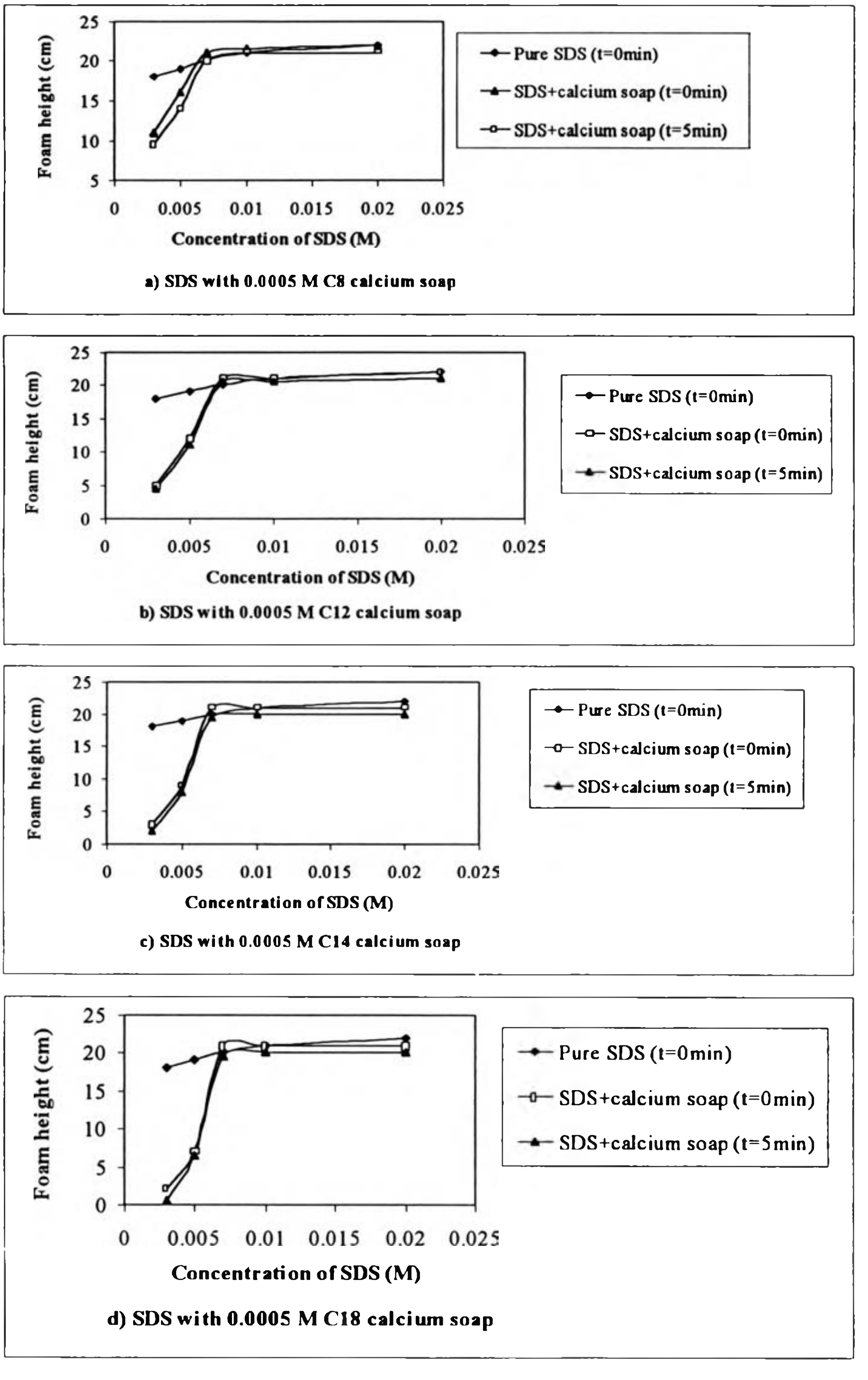


Figure 4.6 Relationship between foam height and concentration of SDS by the Ross-Miles method at 0.0005 M calcium soap

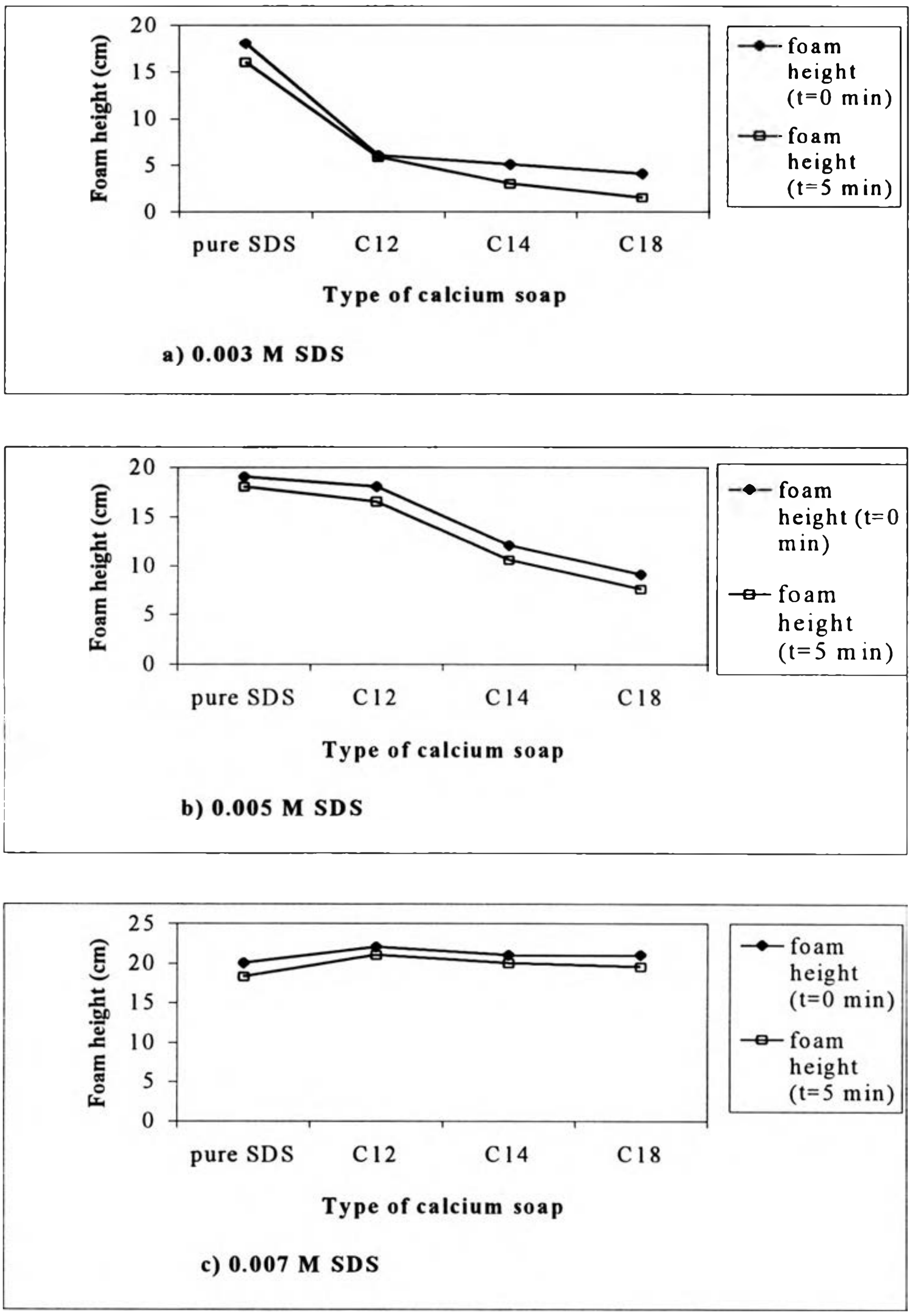


Figure 4.7 Relationship between chain length of calcium soap and foamability of SDS at 0.00025 M calcium soap by the Ross-Miles method

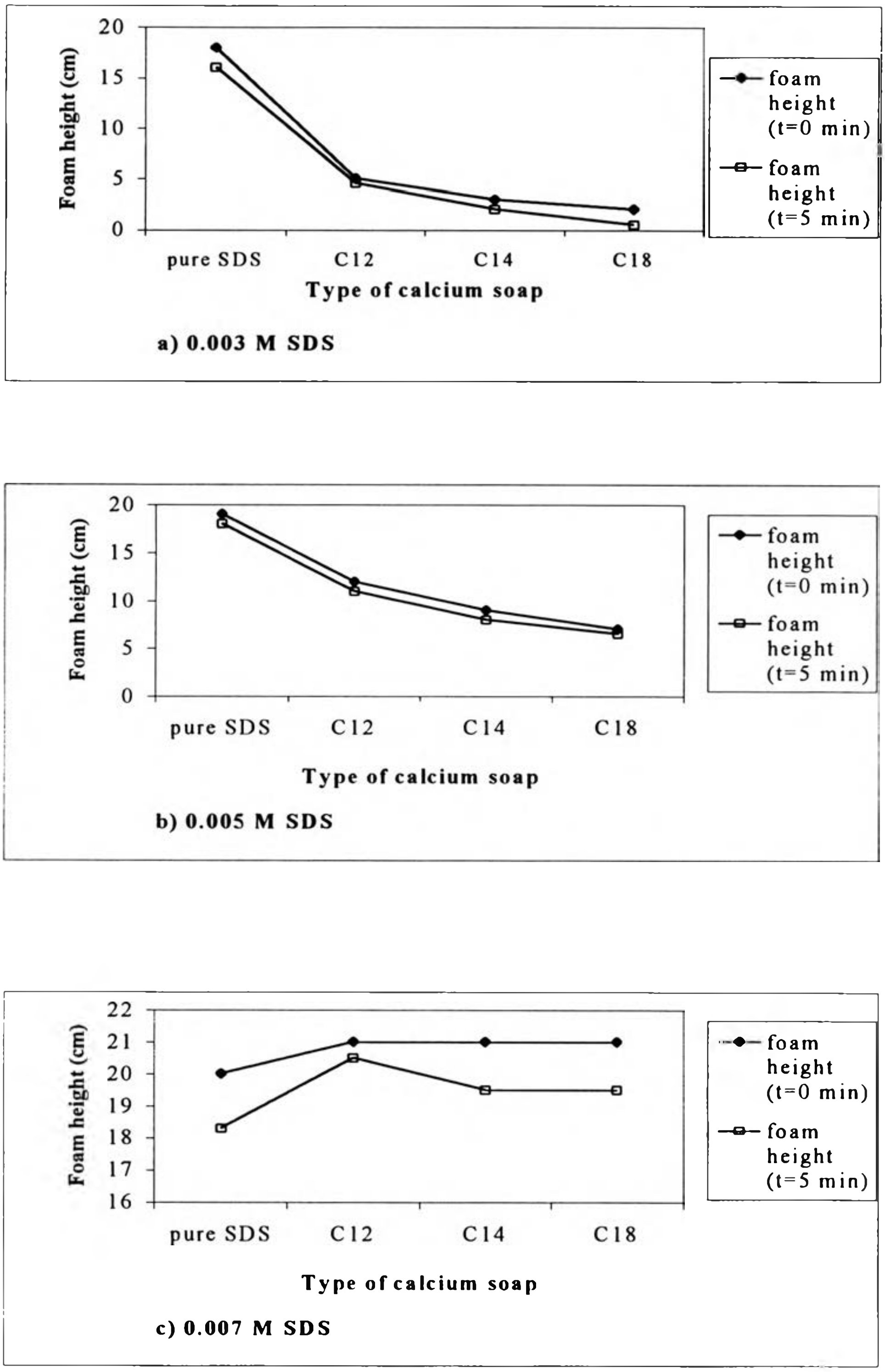


Figure 4.8 Relationship between chain length of calcium soap and foam ability of SDS at 0.0005 M calcium soap by the Ross-Miles method

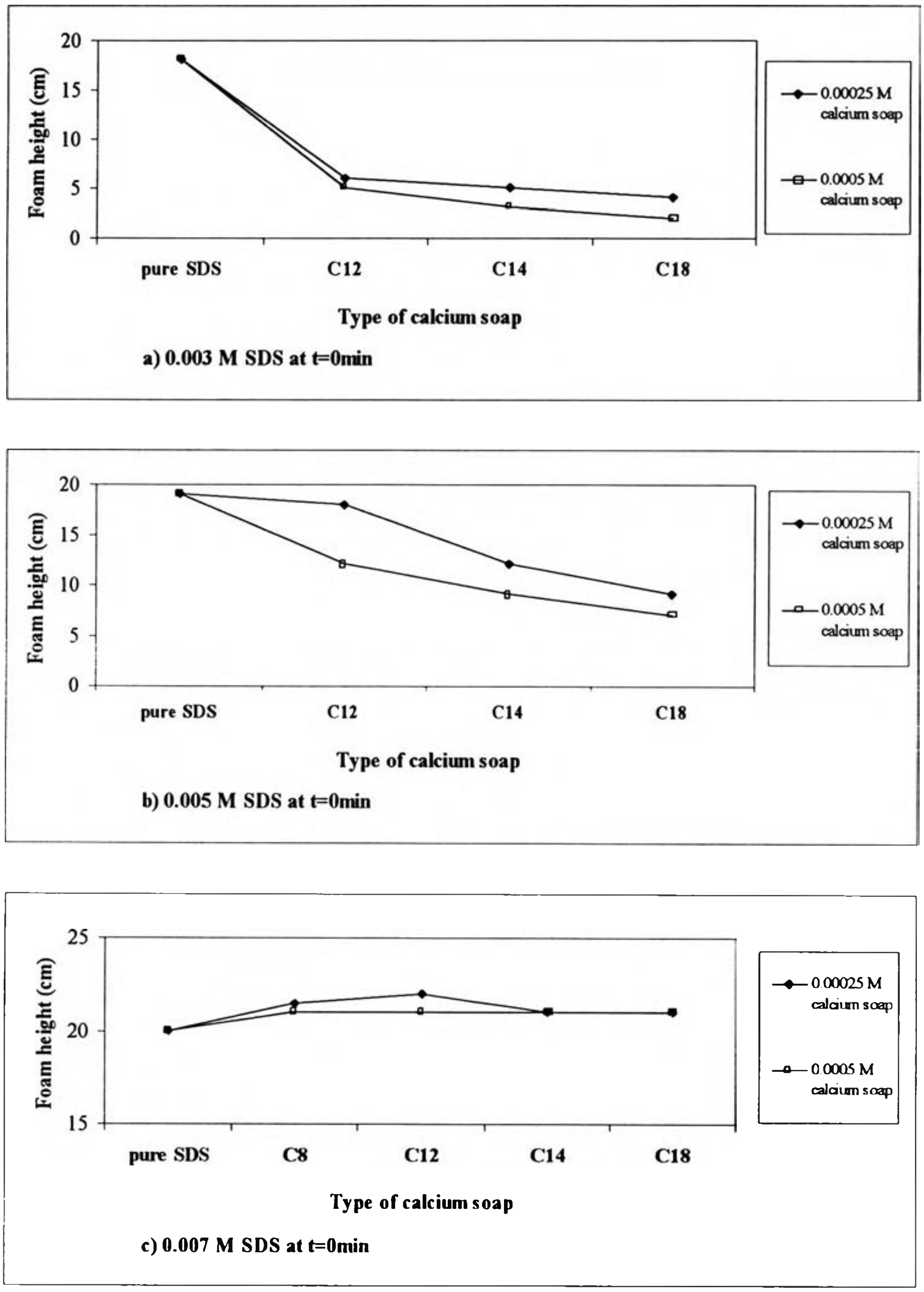


Figure 4.9 Relationship between amount of calcium soap and foamability of SDS at t = 0 min by the Ross-Miles method

4.4 Comparison of the Effect of Calcium and Sodium Soap of the Same Fatty Acids

Figure 4.10 shows the foam ability of SDS solution in the presence of the calcium salt and sodium salt of the same fatty acid, which in this case is C_8. The results show that foamability of SDS is increased slightly in the presence of sodium salt but it decreased sharply below the CMC in the presence of calcium soap. The results further confirmed that only the calcium soap have an antifoam effect on SDS solution at concentration below CMC.

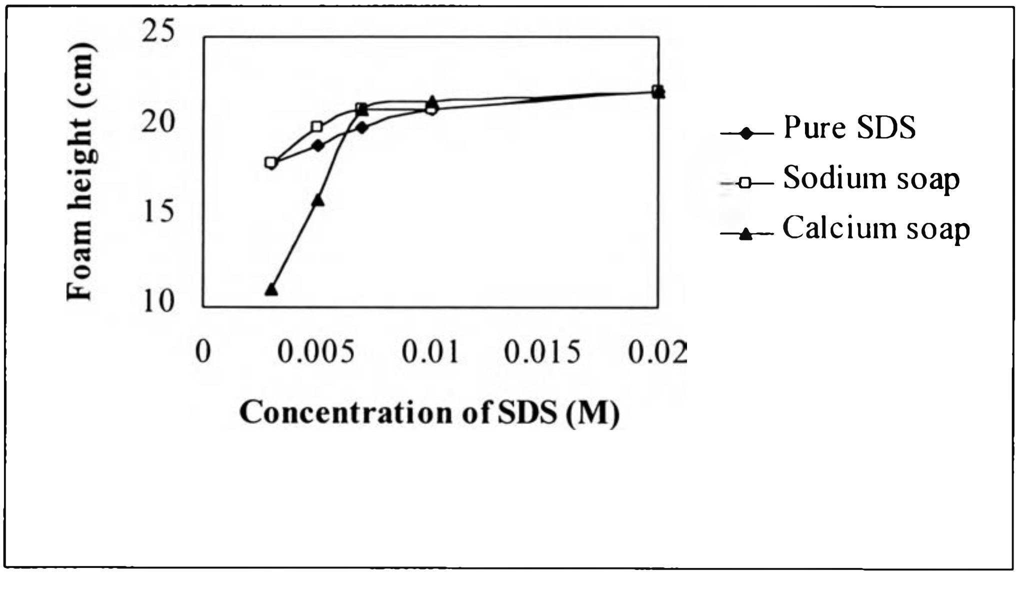
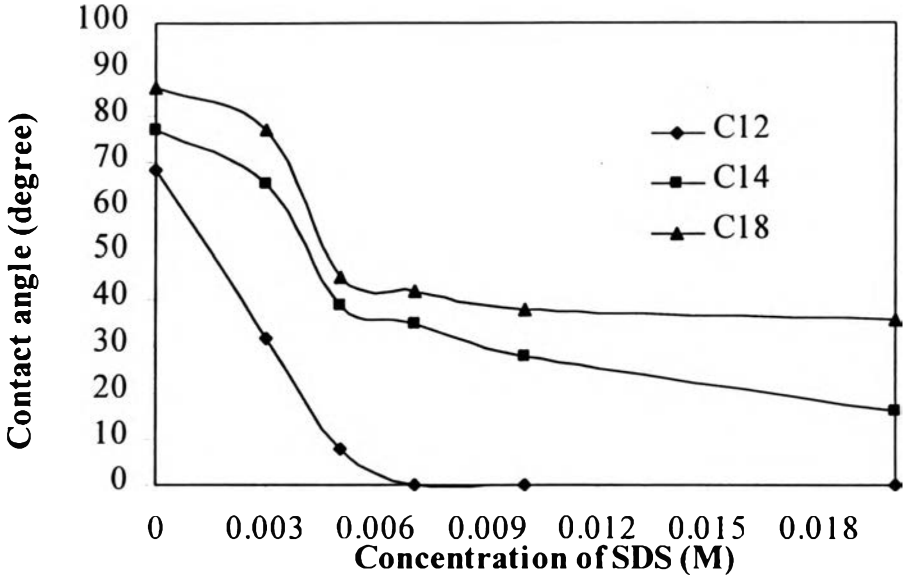


Figure 4.10 Comparison of foamability of SDS solution in the presence of calcium and sodium salt of C8

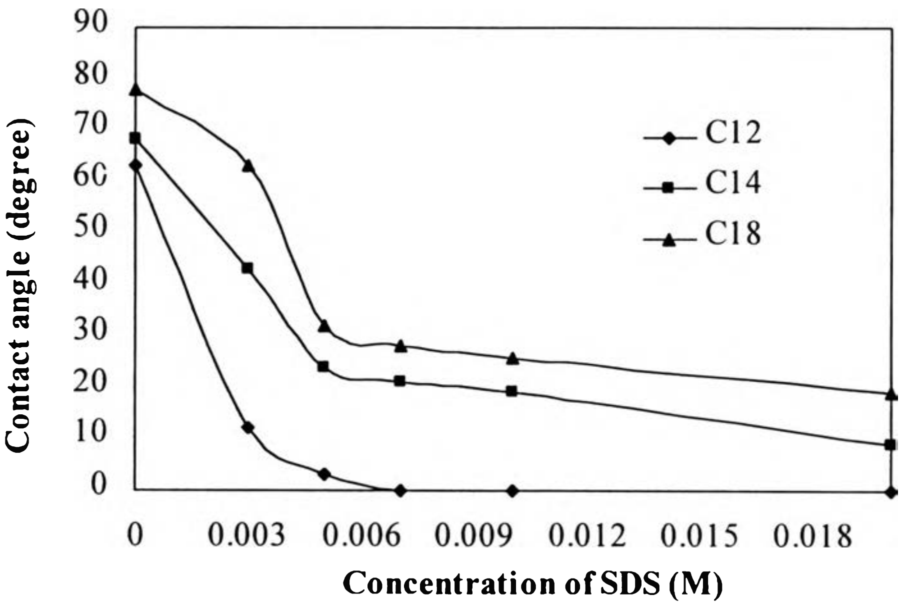
4.5 Contact Angle Measurements

Figure 4.11 shows the contact angle SDS solutions on the calcium soap surface. The concentration range of SDS is the same as in the foam test by the Ross-Miles method. It was found that, at the same concentration of SDS contact angle increased when chain length of calcium soap increased and for the same type of calcium soap contact angle decreased when the concentration of SDS increased. The contact angle was found to reach a constant value when the concentration of SDS was higher than 0.005 M, i.e. when it was above the CMC. The same results were obtained at the contact times of 15 sec and 10 mins.

From the above results, it can be seen that the contact angle was found to correlate directly with the antifoam ability of the calcium soap. Calcium soap with higher contact angle was found to have better antifoam ability. The results support the proposition that calcium soap precipitates acts as an antifoam by the dewetting mechanism. In this mechanism, the precipitates first enter the air/liquid interfaces at the foam film surface. The liquid at the three-phase air/liquid/solid interface recedes from the solid surface forming a convex-shape film due to the hydrophobicity of the solid. This gives rise to a capillary pressure that eventually detach the liquid film foam the solid particle leading to foam rupture.



a) Contact angle at time = 15 sec



b) Contact angle at time = 10 mins

Figure 4.11 Contact angle of SDS on calcium soap surface at different SDS concentrations