Technical News Features

Lather Stability of Soap Solutions

MARIA A. GROMPONE, Compañia BAO S.A., Laureles 573, Montevideo, Uruguay

ABSTRACT

The stability of soap foams in the presence of calcium ions was studied. Laundry and toilet soap bars available at the local market were used. The soap equivalent/calcium equivalent ratio is proposed as an objective quality criterion.

INTRODUCTION

Various articles have been published which describe the properties of soap bars in relation to the different tallow/coconut oil ratios used in their manufacture (1-5). Some refer to the behavior of the soap bar as such, as it is in this usage that the consumer will judge its performance. Others study the foaming capacity of the soap solutions and the stability of this foam (6,7).

An important effect on the formation of foam appears when hard water is used, and a certain percentage of a soap bar will be uselessly spent in order to soften the water. Kundu et al. (8) have proposed a method by which the resistance of soap solutions to the calcium salts can be established. This measurement is used by them as a parameter for the evaluation of soap quality.

The present report correlates the resistance of the soap foams to water hardness. We have used soap bars that could be purchased in the local market and/or that were prepared with the usual raw materials, additives and methods.

EXPERIMENTAL PROCEDURES

Reagents and apparatus used are those described in the publication by Kundu et al. (8).

Titration

Fifty mL of 0.5% soap solution were titrated with calcium chloride solution (1 mL of the solution = 1 mg of $CaCO_3$). The percentage of soap solution is taken in regard of the total sample and not on the basis of the anhydrous soap present. All determinations were made in duplicate and the averages are reported. The end-point was indicated by total disappearance of foam.

Gas Liquid Chromatography (GLC)

The coconut oil content in the fat base and the average molecular weight of the soap ($\overline{MW}_{soap}$) were determined by GLC analysis of the methyl esters of the fatty acids (9).

AOCS Methods

Glycerine and anhydrous soap contents were determined by the official AOCS methods (10).

ω-Phase Soap

Soap in ω-phase was prepared, starting from a translucent bar of milled soap that was in the β-phase, by heating it ca. 88 C in a closed container and allowing it afterwards to cool slowly to room temperature (11,12). The change from the microcrystalline β-phase to the opaque ω-phase was observed.

RESULTS

Laundry and toilet soaps made from different blends of tallow and coconut oil were studied. Results are summarized in Table I. Soap bars containing rosin or sunflower oil are so indicated in Table I.

Soap bars containing additives can be found on the market. These special types of soap may be superfatted, contain anionic surfactants, glycerine, sugar or alcohol (transparent soap). Results of the tests made with these three types are summarized in Table II.

The data indicated in Tables I and II are plotted in Figure 1.

DISCUSSION

Soaps made exclusively from tallow/coconut oil blends show a soap equivalent/calcium equivalent ratio of 1.5. Their resistance to water hardness depends on the number of moles of anhydrous soap contained in the bars—something which is only indirectly related to soap quality.

Soaps in ω-phase behave like β-phase soaps. This result is obvious as the solid crystalline form cannot change the properties of a soap solution. This is not in agreement with the conclusion of Kundu et al. (8).

The presence of unsaturated oils (i.e., rich in unsaturated fatty acids) in the fat base destabilizes the foam. Their ratio increases to 1.7. Soaps made with pure coconut oil show similar behavior.

The soap foam resistance to water hardness is affected by special additives. If the additives have foaming properties and are not precipitated by calcium ions (i.e., anionic surfactant-like alkylaryl-sulfonates) the foam will present great stability. If the additives are foam depressors (alcohol, free fatty acids, etc.), the resistance decreases (13).

This method makes possible the use of the soap equivalent/calcium equivalent ratio to establish an order of foam stabilities. The higher the value, the lower the ability of a soap to form a lather in the presence of hard water. It can have valuable applications in the soap industry as it makes possible comparisons between different kinds of

TABLE I

Stability of Laundry and Toilet Soap Foams to Water Hardness

Soap	Type of soap	% Coconut oil in fat base	% Anhydrous soap	% Glycerine	$\overline{MW}_{soap}$	Soap moles × 10^4	Consumed volume of $CaCl_2$ solution (mL)	Ca^{2+} equiv × 10^4	Soap equiv/Ca^{2+} equiv ratio
A	Translucent laundry	11	77.5	4	289	6.70	21.9	4.38	1.5
B	Translucent laundry	10	78.0	4	289	6.74	22.2	4.44	1.5
C	Laundry	0	81.5	1	298	6.84	22.4	4.48	1.5
D	Translucent laundry	6	76.5	4	292	6.54	21.7	4.34	1.5
E	Laundry	10	78.0	1	289	6.74	22.0	4.40	1.5
F	Toilet	15	84.0	2	288	7.30	23.9	4.78	1.5
G	Toilet	5	90.5	1	292	7.74	26.1	5.22	1.5
H	Toilet	15	88.0	1	288	7.64	25.2	5.04	1.5
I	Toilet	11	85.0	1	289	7.36	24.1	4.82	1.5
J	Toilet	100	67.7	2	250	6.78	19.5	3.90	1.7
K	Translucent laundry[a]	10	87.4	3	301	7.26	23.8	4.76	1.5
L	ω-phase laundry	7	79.0	4	292	6.76	22.7	4.54	1.5
M	Laundry[b]	0	79.5	1	301	6.62	19.9	3.98	1.7

[a]This soap contains also 6.5% of rosin.
[b]This soap contains also 15% of sunflower oil soap.

TABLE II

Stability of Additive-Containing Soap Foams to Water Hardness

Soap	Type of soap	% Coconut in fat base	% Free fatty acids in fat base	Soap and free fatty acids moles × 10^4	Consumed volume of $CaCl_2$ sol (mL)	Ca^{2+} equiv × 10^4	Soap equiv/Ca^{2+} equiv ratio
O	Superfatted	48	6	8.14	23.4	4.68	1.7
P	Superfatted	17	5	7.98	20.4	4.08	2.0
Q	With anionic surfactant	56	–	5.80	>100	>10	<0.6
R	Transparent with glycerine, sugar and alcohol	49	–	6.02	15.2	3.04	2.0

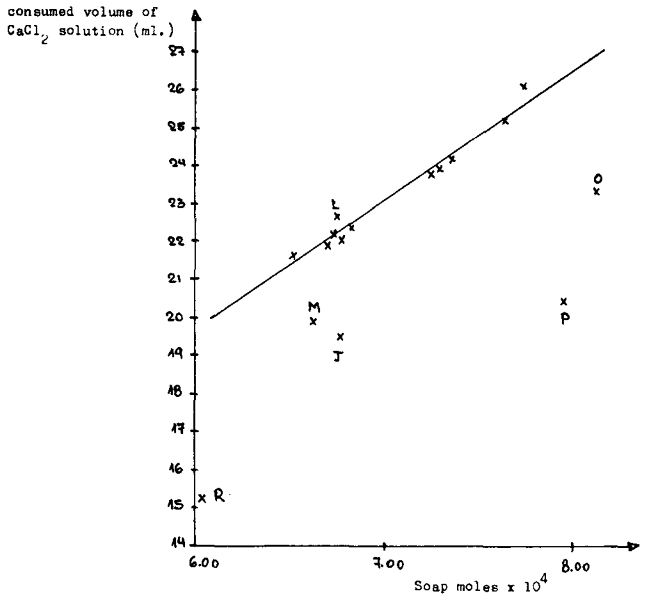

FIG. 1. Consumed volumes of $CaCl_2$ solution as a function of soap moles.

soap. This is of interest to manufacturers, allowing the selection of the best fat base and additives.

REFERENCES

1. Osteroth, D., Soap Cosmet. Chem. Spec. 53:29 (1977).
2. Becher, P., and R.E. Compa, JAOCS 34:53 (1957).
3. Ginn, M.E., R.C. Steinhauer, I. Liebman and E. Jungermann, JAOCS 45:666 (1968).
4. Pickin, J.H., JAOCS 51:670A (1974).
5. Sonntag, N., JAOCS 58:155A (1981).
6. Ross, J., and G.D. Miles, Oil Soap 18:99 (1941).
7. Ogino, K., and F. Takigami, JAOCS 56:880 (1979).
8. Kundu, M.K., A.T. Deb and S.P. Gupta, Fette, Seifen, Anstrichm. 82:131 (1980).
9. Official Methods of Analysis of the Association of Official Analytical Chemists, 13th edn., AOAC, Washington, DC, 1980.
10. Official and Tentative Methods of the American Oil Chemists' Society, 3rd edn., AOCS, Champaign, IL, 1973.
11. Swern, D. (ed.), Bailey's Industrial Oil and Fat Products, 4th edn., John Wiley and Sons, New York, 1979.
12. Ferguson, R.H.; F.B. Rosevear and R.C. Stillman, Ind. Eng. Chem. 35:1005 (1943).
13. Tomlinson, K., Rev. Fr. Corps Gras 20:697 (1973).

[Received August 2, 1982]