

INVESTIGATION ON VARIOUS PARAMETERS OF SOAPS AND DETERGENTS

Gunavathy N.,* T. Amalorpavathavitha, J.J. Anthoniammal, J. Gowri, P. Nithya, K. Radhamani,
K. Suganthi and K. Dhanalakshmi

Department of Chemistry, Nirmala College for Women, Coimbatore.

*Email: gunavathykrishnaprakash@yahoo.co.in

ABSTRACT

Soap is a substance that dissolves in water to remove dirt from surfaces such as skin, textiles and other solids. Soaps are mainly used as surfactants for washing, bathing and cleaning. They are also used in textiles spinning and are important components of lubricants. The present study was carried out to assess the various properties of different soaps, in terms of pH, basicity, emulsification, content of fat, washing property, moisture content, foaming capacity and hard water reaction. A cursory look at the obtained results reveals similarities in parameters in the selected soaps. It can be concluded that the values determined are within the limits set by standards.

Keywords : Soaps, Detergents, pH, TFM, hard water reactions, foam capacity.

1. INTRODUCTION

The name of soap, after an ancient Roman legend, comes apparently from Mount Sapo, where animals were slaughtered. The rain had mixed fat, tallow and ashes on the Tiber. The women found that this mixture enhanced the work, and started to use the slity soil, moistened with a mixture of fat. Soap, in fact, is the oldest active substances, and has been used about 4500 years. For centuries, soap was the only one cleaning substance available. Historically, it has been claimed that the esteem of a country's civilization is based on consumption of soap. In the 18th century, because of the shortage of some raw materials, soap was a highly priced luxury, and only wealthy people could afford it. It became handy to other people only after the manufacture of sodium carbonate was developed (Schulze, 1968). At the end of the 19th century, the first soap powder for laundry was made using sodium silicate as a builder. Whereas the use of sodium or potassium carbonate leads to a hard or soft soap, respectively. The chemical nature of the lipophilic part of the soap plays by far the largest role in determining the performance of the finished soap (Viorica Popescu *et al.*, 2011).

The first written record of soap can be seen in the writings of the Roman Pliny the Elder. He described the Phoenicians' synthesis of soap by using goat tallow and ashes. By the second century A. D, sodium carbonate was heated with lime (from limestone) to produce sodium hydroxide (lye). The sodium hydroxide was heated with animal fats or vegetable oils to produce soap (Bahl, 1991). Other societies made soap in much the same manner.

Soap (sodium salt of fatty acid) the oldest known surfactant has been used since the Egyptian era (Saad Moulay, 2011). It is now used mostly as toiletry soap bars for body cleansers and sometimes for fabric detergents and today for cleaning utensils. In detergents, soap is sometimes formulated as foam control agent. Direct saponification from fats was used initially to make soap but, today, soap is obtained by neutralizing fatty acids with NaOH. As the salt of a weak acid (fatty acid) and strong base (NaOH), soap is alkaline (pH 10) in aqueous solution, the alkalinity favours detergency but can cause skin irritation and hair damage. In addition, soap is not tolerant of hard water and forms scum with calcium and magnesium ions (Roila Awang *et al.*, 2001). In the present study the various properties of soap like pH, basicity, emulsification, content of fat, washing property, moisture content, foaming capacity and hard water reaction were evaluated.

2. MATERIALS AND METHODS

2.1. Preparation of Samples

The soaps analyzed were purchased from the departmental store. The bathing soap - Nature Power Herbal soap and Fair Beat, dish washing soap - Vim bar and Exo bar, fabric cleansing soap - Power detergent and Sundari detergent (Figure 1), were made into small bits using a steel scrapper and stored in different air tight container.

Figure. 1. Soap samples scrapped into bits



2.2. Determination of pH

10g of the powdered soap was weighed and dissolved in distilled water in a 100ml volumetric flask. This was made up to prepare 10% soap solution (Jahagirdar 1994, Dalen, 2009). The pH of the soap solution was determined using Model ELICO pH meter.

2.3. Determination of basicity

0.1g of soap samples was dissolved in 5ml of ethanol. A few drops of the phenolphthalein were added (Blackburn *et al.*, 1996). The appearance of the solution was noted.

2.4. Determination of Emulsification

100ml of coconut oil was taken in the test tube and 10ml of distilled water was added and shaken well. 0.1 gm of soap was added the above mixture. The appearance of the solution was noted.

2.5. Determination of Total Fatty Matter (TFM)

The soap samples were made into small slices. 5g of thoroughly mixed soap sample was weighed, using an electronic balance, the weight was noted. The weighed soap samples were taken into a separating funnel and 30 ml of hot water was added from a beaker and mixed well. Excess of 1:1 HCl was added to decompose the soap till acids floated as a clear layer on the top. 50ml of ether was added in the cold condition, mixed well and separated (Kundu *et al.*, 1977).

The aqueous layer was taken in another separating funnel and extracted with ether. The combined ether extracts were washed thrice with water to remove mineral acids and the contents were collected in a previously weighed 100ml conical flask. The ether was allowed to evaporate (with the contents) in a hot air oven to constant weight.

From the difference in weight, the % of fatty matter in the analyzed soap samples was calculated using the relation (Viorica Popescu *et al.*, 2011).

$$\text{Fatty matter (\%)} = (B-A)/C \times 100$$

Where,

A - Weight of the empty conical flask

B - Weight of the conical flask + Soap after drying

C - Weight of initial sample of soap.

2.5.1. Determination of Washing Property

Each of the soap samples were used to wash the hands. The observations were noted.

2.5.2. Determination of Moisture Content

5g of the scrapped soap samples were weighed in an electronic balance into a pre weighed petri dish and placed in a hot oven at 105°C. It was then placed in the crucible in the desiccator and its content was weighed after cooling. The moisture content was found from the weight difference (Mak-Mensa, 2011). The moisture content of the samples was calculated using the following equation.

$$\% W = A - B / B \times 100$$

Where, % W = Percentage of moisture in the sample,

A = Weight of wet sample (grams) and

B = Weight of dry sample (grams)

2.5.3. Determination of Foaming Capacity

6 conical flasks (100ml) were taken and numbered 1 to 6. In each of these flasks equal amounts (5g) of the samples of soap shavings were taken and 50ml of distilled water was added. Each conical flask was heated for few minutes to dissolve all the soap. In a test tube stand, six big clean and dry test tubes were taken and numbered them 1 to 6. One ml of the soap solution was then poured in to the test tubes of corresponding number. 10ml of distilled water was then added to each test tube. Test tube no. 1 was then shaken vigorously (5 times). The foam was found to be formed in the empty space above the container. Stop watch was started immediately and the time taken for the disappearance of foam was noted

Similarly the other test tubes were shaken vigorously for equal number of times (i.e., 5 times) with approximately with the same force and the time taken for the disappearance of foam in each case was recorded.

The lesser the time taken for the disappearance of foam, the lower is the foaming capacity. The soap for which the time taken for disappearance of foam is highest has maximum foaming capacity and is the best quality soap among the soaps tested.

2.5.4. Determination of Hard Water Reaction

1g of the powdered soap sample was taken and warmed with 50ml of water in a 100ml beaker. When the clear solution was obtained, it was poured in to each of three test tubes. One of the three test tube with 10 drops of 5% CaCl₂ solution, one with 10 drops of 5% of MgCl₂ solution and one with 10 drops of 5% FeSO₄ solution (Blackburn, 1996). These solutions stand until the other tests have finished. The observations were noted.

3. RESULTS AND DISCUSSIONS

Most soaps and cleaners usually remove dirt adequately, but their use is not devoid of adverse side-effects (Beetseh, 2013). These adverse effects include damage to the barrier function of the skin, increased susceptibility to environmental irritants and antigens, skin irritation with erythema and edema, and reduction of the cosmetic qualities of the skin, such as moisture and smoothness. These changes are usually subtle, occurring slowly over time, and are most important in elderly and atopic patients. Often, the association of these problems with the use of a particular type of soap is overlooked. Skin dryness can be exacerbated by dry climate and the influence of hard water, which increases the irritant effect of soaps or detergents (Lourdes Baranda *et al.*, 2002). Although it is important that the general population are aware of the potential of products used for body cleansing, fabric cleansing and dish washing, this information is not usually available therefore, it was decided to analyze the pH, foaming capacity, moisture content, basicity, hard water reaction, emulsification, content of fat and washing property.

3.1. pH of Soaps

Soap is a base and exact pH would be different depending on the soap. The pH level of soap can vary with the brand and with the function of the soap. However soap makers measure the acidity or alkalinity of soap by its pH level on a scale of 0 to 14. The average pH levels in bath soaps range from 3.61 to 12.38. For a general soap pH is from 5 to 8 and for hand soaps the pH is anywhere from 10 to 12. A 2002 International Journal of Dermatology study found pH levels in bath soap ranging 3.61 to 12.38. High pH soaps caused the most irritation. In liquid dish washing liquids, a pH in the range of about 7-8 (Dalen, 2009; Beetseh, 2013).

The pH of the soap samples were determined using ELICO pH meter and it was found to be 7.3, 7.2, 8.1, 7.6, 7.8 and 7.7 for Nature power, Fair beat, Vim, Exo, Power and Sundari soap respectively. As soaps are more frequently used by general population, soaps with high irritation index should not used by individuals. The test samples had pH ranging from 7.3 to 8.1 which were well within the recommended levels.

3.2. Basicity of soaps

Soaps undergo a hydrolysis reaction in water. As a result, soap solutions tend to be alkaline. Detergents solutions on the other hand tend to be more neutral. Phenolphthalein indicator when in contact or presence of acid it will turn colorless and

with base, it will turn into a pinkish violet color (Blackburn, 1996). When the solution of soap is treated with 2-3 drops of phenolphthalein, it is found to show no change, indicating that the selected soaps are found to be neutral.

3.3. Emulsification of soaps

Soap is an excellent cleanser because of its ability to act as an emulsify agent. An emulsifier is capable of dispersing one liquid into another immiscible liquid. This means that while oil (which attracts dirt) does not naturally mix with water, soap can suspend oil/dirt in such a way that it can be removed.

For a soap to perform its cleaning activity it should be able to form emulsion in presence of oil. As a result of their molecular structures, soaps and detergents are both capable of emulsifying or dispersing oils and similar water-insoluble substances. Results showed that all the selected soap samples were found to have good cleansing action as they formed emulsion when shaken with oil.

3.4. Total Fatty Matter (TFM) of soaps

Total Fatty Matter (TFM) is one of the most important characteristics describing the quality of soap and it is always specified in commercial transaction. It is defined as the total amount of fatty matter, mostly fatty acids, that can be separated from a sample after splitting with mineral, usually hydrochloric acid. The fatty acids most commonly present in soap are oleic, stearic and palmitic acids and pure, dry, sodium oelate has TFM 92.8%, while top quality soap noodles now increasingly used for making soap tables in small and medium size factories, are typically traded with a specification TFM 78% minimum, moisture 14% maximum. But besides moisture, finished commercial soap, especially laundry soap, also contains fillers used to lower its cost or confer special properties, plus emollients, preservatives.etc. and then the TFM can be as low as 50%. Fillers which are usually dry powders, also make the soap harder, harsher on the skin and with greater tendency to become 'mushy' in water and so low TFM is usually associated with hardness and lower quality. In older days in Europe and in some countries, soap with TFM 75% minimum was referred to as Grade I and 65% minimum as Grade2 and less 60% Grade 3.

However according to the norms laid down by Bureau of Indian Standards (BIS) soaps are graded into three categories. Soaps containing TFM of 76% and above are Grade 1. Soaps with TFM content of 70% and above but less than 76% are considered to be Grade 2 soaps and soaps having

formed scum with $MgCl_2$. The results (Table. 3) show that Vim, Exo, Power and Sundari soap can be used even in hard water for cleaning purpose.

In the present study the effect of the soaps on the hands were determined by washing the hands with the selected soaps. All the soap samples were found to be soft on hand. It can be concluded these soaps are safe for use by public.

The results were sufficiently promising to warrant further investigation.

4. CONCLUSION

All the samples were observed to be good cleansers.

- pH of soap samples were found to be in the neutral range 7.2 – 8.1.
- All samples were found to have neutral basicity.
- All the soap samples formed emulsion when shaken with oil.
- The TFM values ranged from 63 to 80 which were well within the standard values
- All the soap samples were found to be soft on hand while washing.
- Moisture content was in the range 6.50% to 22.90%.
- Fair beat soap showed high foaming capacity of 3 40' minutes. Power detergent soap showed the lowest foaming capacity with 1 minute as the time taken for disappearance of 2mm of soap froth.
- In hard water reaction all the soap samples formed scum when treated with $CaCl_2$ and $FeSO_4$ while only Nature power and Fair beat formed scum with $MgCl_2$.

The results further indicate that good soaps are not characterized by their fragrance or appearance, nor by the place in which they are sold, but by their properties the exhibit.

REFERENCES

A report from Consumer Voice. (2014). Toilet soaps. 13-20.

Bahl, B.S. and Arun Bahl, (1991). Advanced Organic Chemistry, S. Chand and Company, NewDelhi. 644-698.

Beetseh, C.I. and M.K. Anza, (2013). Chemical characterization of local black soap (Chahul Mtse) made by using cassava peels ashes (alkali base) and palm oil in North Central zone of Nigeria. *Civil Environl. Res.* 3(4): 82-93.

Blackburn *et al.*, (1996). Preparation and properties of a soap. Austin Peay State University Department of Chemistry CHEM 1021. Revision

SP11 Page 1 of 7. Adapted from Blackburn *et al.*, Laboratory Manual to Accompany World of Chemistry, 2nd ed. (Saunders College Publishing: Fort Worth).

Dalen, M.B. and P.A. Mamza, (2009). Some physico-chemical properties of prepared metallic soap-driers of Aluminum, Copper and Zinc. *Science World Journal.* 4(3): 7-9.

Jahagirdar, D.V, (1994). Experimental in Chemistry. Himalaya Publishing House, 237 - 239.

Kundu, M.K. A.T. Deb and S.P. Gupta, (1977). A simple rapid method for direct determination of Total Fatty Matter in Soaps. *Fette, Seifen, Anstrichmittel.* 79(7): 285-288.

Lourdes Baranda, Roberto Gonzalez-Amaro, Bertha Torres-Alvarez, Carmen Alvarez and Victoria Ramirez, (2010). Correlation between pH and irritant effect of cleansers marketed for dry skin. Paper presented at the 6th edition of Colloque Franco-Roumain de Chimie Appliquee, COFrRoCA.

Mak-Mensa, E.E. and C.K. Firempong, (2011). Chemical characteristics of toilet soap prepared from neem (*Azadirachta indica* A.Juss) seed oil. *Asian J. Plant Sci. Res.* 1(4): 1-7.

Mirela Moldovan and Alina Nanu, (2010). Influence of cleaning product type on several skin parameters after single use. *Farmacia.* 58(1):29-37.

Roila Awang, Salmiah Ahmad and Razmah Ghazali, (2001). Properties of sodium soap derived from palm-based dihydroxy stearic acid. *J. oil palm Res.* 13(2): 33-38.

Saad Moulay, Ahmed Chalane and Zahia Ouad-Feul, (2011). Palm stearin in the soap process. *Natura Montenegrina* (Podgorica). 10(3): 335-346.

Schulze, E.L., (1968). Literature of soaps and synthetic detergents. *Lit. Cheml. Technol.* Chapter 12: 231-248.

Simmons, W.H and H.A. Appleton, (2007). The Handbook of soap manufacture. [EBook # 217241].

Viorica Popescu, Alina Soceanu, Simona Dobrinas, Gabriela Stanciu and Danut Tiberiu Epure. (2011). Quality control and evaluation of certain properties for soaps made in Romania. *Scientific Study Res.* 12(3): 257-261.

Warra, A.A, (2013). A report on soap making in Nigeria using indigenous technology and raw materials. *Afr. J. Pure Appl. Chem.* 7(4): 139-145.

Table 1. Different Parameters of soap samples

Soap sample	pH	Basicity	Emulsification	TFM	Washing property	Moisture content (%)
Nature Power	7.3	Neutral	Emulsion formed	77	Soft	9.60
Fair beat	7.2	Neutral	Emulsion formed	80	Soft	12.40
Vim	8.1	Neutral	Emulsion formed	78	Soft	22.90
Exo	7.6	Neutral	Emulsion formed	79	Soft	6.50
Power	7.8	Neutral	Emulsion formed	75	Soft	21.78
Sundari	7.7	Neutral	Emulsion formed	63	Soft	18.74

Table 2. Foaming capacity of soap samples

Name of the soap sample	Volume of soap solution (ml)	Volume of water added (ml)	Time taken for disappearance of 2mm of soap froth	
			Minutes	Seconds
Nature power	1	3	3	2
Fair beat	1	3	3	40
Vim	1	3	2	00
Exo	1	3	2	10
Power	1	3	1	00
Sundari	1	3	1	20

Table 3 Hard water reaction of Soap samples

S.No.	Name of the soap sample	Hard water reaction		
		CaCl ₂	MgCl ₂	FeSO ₄
1	Nature Power	Scum formed in plenty	Scum formed very slowly and scanty	Scum formed immediately and plenty
2	Fair Beat	Scum formed slowly and plenty	Scum formed very slowly and scanty	Scum formed immediately and plenty
3	Vim	Scum formed and Scanty	No scum formed	Scum formed immediately and plenty
4	Exo	Scum formed and Scanty	No scum formed	Scum formed immediately and plenty
5	Power	Scum formed and Scanty	No scum formed	Scum formed slowly and scanty
6	Sundari	Scum formed slowly and plenty	No scum formed	Scum formed slowly and scanty