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Determination of Alkali Content & Total Fatty Matter in Cleansing Agents

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Abstract – **Cleaning products play an essential role in our daily lives. By safely and effectively removing soil, germs and other contaminants, they help us to stay healthy, care for our homes and possessions, and make our surrounding more pleasant. Soap is a mixture of sodium salt of various naturally occurring fatty acids. Total alkali and fatty matter contents are the most important characteristics describing the quality of soap and it is always specified in commercial transactions. The main objective of the study is to determine the total alkali content and total fatty matter content of some commonly used toilet and washing soaps.**

Keywords: **Soap, Free Alkali Content, Total Fatty Matter, Saponification, Toilet Soap, Washing Soap**

I. Introduction

Soap is a sodium or potassium salts of various naturally occurring fatty acids. It is produced by saponification or basic hydrolysis reaction of a fat or oil. Sodium carbonate or sodium hydroxide is used to neutralize the fatty acid and convert it to the salt [1, 2]. The fatty acids, stearic, palmitic, myristic, lauric and oleic acids, contribute to lathering and washing properties of the soaps [3, 4]. The chemical characteristics of soap depend on several factors: the strength and purity of alkali, the kind of oil used, completeness of saponification and age of the soap [5]. Such chemical characteristics include moisture content, total fatty acids (TFM), pH, free alkali, and percent chloride [6].

A. General Overall Hydrolysis Reaction

Fat + NaOH → glycerol + sodium salt of fatty acid

Soap is an anionic surfactant used in conjunction with water for washing and cleaning. Although the reaction is shown as one step reaction, it is in fact two steps. The net effect as that the ester bonds are broken. The glycerol turns back into an alcohol. The fatty acid portion is turned in to a salt because of the presence of a basic solution of the NaOH. In the carbonyl group, one oxygen now has a negative charge that attracts the positive sodium ion [7].

The fats and oils used in soap making come from animals or plant sources. Each fat or oil is made up of a distinctive mixture of several different triglycerides. In a triglyceride molecule, three fatty acid molecules are attached to one molecule of glycerin. There are many types of triglycerides; each type consists of its own particular combination of fatty acid. Fatty acids are the components of fats and oils that are used in soap making.

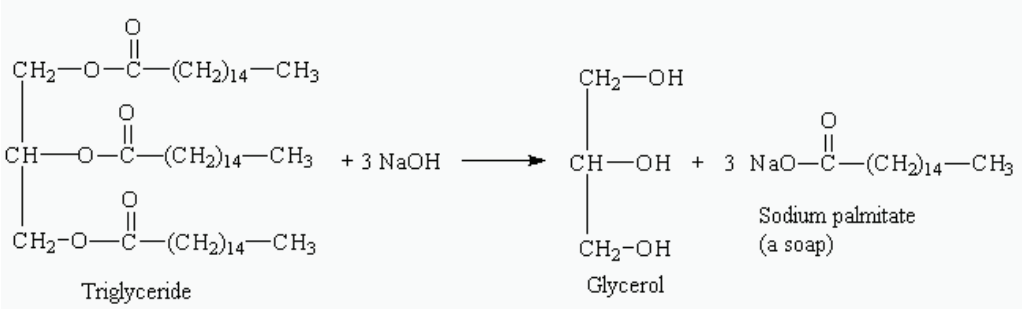

Fig.1 Hydrolysis of a Triglyceride (fat)

B. Alkali Content

The alkali used in soap making was obtained from ashes of plants, but they are now made commercially. The alkali mainly used is a soluble salt of an alkali metal like sodium or potassium. The alkalis used in soap making are NaOH (sodium hydroxide) and KOH (potassium hydroxide). Sodium carboxylates are the common toilet soaps. Potassium carboxylates or potassium soaps are obtained when saponification of a fat or oil is carried with potassium hydroxide. Potassium soaps are softer than sodium soaps and they are used for special purposes when rapid solution is desired eg: in making shaving creams or liquid soaps. The composition of sodium or potassium carboxylates constituting soap depends on the percentage of fatty acids bonded to glycerol in the original triglycerides. Solid fats give mixture with higher proportion of sodium or potassium salts of higher fatty acids (palmitic acid, stearic acid) and give hard soaps [8]. The vegetable oils give mixtures with a greater proportion of unsaturated fatty acids (oleic acid and linoleic acid) and give soft soaps [9]. According to Bureau of Indian Standards (BIS), good quality soaps must have less than 5% of alkali content whereas according to ISO specification, soaps should have only below 2% of alkali content [10,11].

C. Total Fatty Matter

The total fatty matter (TFM) is one of the most important characteristics describing the quality of soap and it is always specified in commercial transactions. It is defined as total amount of fatty matter, mostly fatty acids, that can be separated from a sample after splitting with mineral acid, usually HCl. This is the method and idea that we used here to determine the total fatty matter in soaps. Soaps are graded in terms of total fatty matter. TFM is usually associated with hardness and lower quality of soaps. The fatty acids most commonly present in soaps are oleic, stearic and palmitic and pure, dry, sodium oleate has TFM 92.8%, while top quality soap noodles now increasingly used for making soap tablets in small and medium size factories, are typically traded with a specification TFM 78% min., moisture 14% max. 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% [12]. 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 matter is usually associated with hardness and lower quality. In older days in Europe and in some countries now, soap with TFM 75% minimum was referred to as Grade 1 and 65% minimum as Grade 2. The soap with the higher TFM gives more lather, lasts longer and, more importantly, cleans your skin better and more gently. The least quality soap (Grade 3) has to have at least 60% TFM.

TFM is a measure of identifying the amount of fatty matter present in soap. Bureau of Indian Standards (BIS) has categorized bath or toilet soaps as 'normal', 'baby, transparent, and antibacterial soaps. The last three are called specialty soaps targeted to specific users. A toilet soap is a cosmetic by law and it must fulfill the requirements of the relevant Indian standard. BIS categorized toilet soaps in to three grades based on the total fatty matter present in them. If TFM is above 76%, grade I, which is having good quality. TFM above 60%, belongs to grade II and TFM above 50% belongs to grade III. According to International Standards (ISO), good quality soaps must have TFM above 76% [9,10].

In the present study, the total alkali content and total fatty matter content of different soap samples were determined and compared with standard values. These values are important in determining the quality of a soap and suitability in the cleansing applications.

II. Experimental

A. Materials

Soap samples, Chloroform ($CHCl_3$), Sodium Hydroxide (NaOH), Methyl Orange, Nitric acid (HNO_3) and Sodium Carbonate (Na_2CO_3) were purchased from Spectrum chemicals. 0.5N NaOH and 0.5N HNO_3 were prepared using standard procedures. NaOH was standardized using standard oxalic acid and standardized NaOH was used to prepare standard HNO_3.

B. Procedure

1. Determination of Total Alkali Content in the Soap Samples

5gm of soap sample is dissolved in 100ml hot water. About 40ml of 0.5N HNO_3 is added to make it acidic. The mixture is heated until fatty acids are floating as a layer above the solution. It is cooled in ice water to solidify the fatty acids. The fatty acids were separated and the aqueous solution was treated with 50ml chloroform to remove the remaining fatty acids. The aqueous solution was measured and 10ml of it was titrated against 0.5N NaOH using methyl orange as indicator and from the titer value the total alkali content was calculated using the following method [13].

Calculation:

Total volume of the aqueous solution =V=_____ml

10 ml of aqueous solution required t ml of NaOH

V ml of aqueous solution requires = Vxt /10 = A ml.

Amount of NaOH required by acid in aqueous solution =A ml

Volume of HNO_3 required, B ml =A x Normality of NaOH / Normality of HNO_3

Volume of HNO_3 required for neutralizing NaOH = C=40 – B

Amount of NaOH in 1000 cc of soap solution (E) = (C x 40 x Normality of HNO_3 g) /1000

250 cc of soap solution contains (F) = (E x 250) / 1000 g

2 NaOH ------- $Na_2O + H_2O$

80 gram of NaOH 62 g of Na_2O

F g of NaOH requires (Y) = (62 x F) / (80) g of Na_2O

Weight of soap taken = 5 g

% of alkalinity = (Y x 100) / w = _____.

2. Determination of the Total Fatty Matter in Soaps

Procedure

5gm of soap sample is dissolved in 100ml hot water. About 40ml of 0.5N HNO_3 is added to make it acidic. The mixture is heated until fatty acids are floating as a layer above the solution. It is cooled in ice water to solidify the fatty acids. The fatty acids were separated and the aqueous solution was treated with 50ml chloroform to remove the remaining fatty acids. The separated fatty matter was mixed together, solvent was evaporated and the yield is noted. The total fatty matter can be calculated using the following method [14].

Calculation

Weight of the china dish (x) = _____

Weight of china dish + Soap after drying (y) = _____

Weight of soap sample = 5 g

$$\% \text{ of fatty mater} = \frac{(y - x) \times 100}{\text{Weight of soap sample}} = \_\_\_\_\_$$

III. Results

Table I Total Alkali Content in The Soap Samples

Sl. No.	Name of soap	Volume of soap sample (ml)	Burette reading (ml) (NaOH)		Volume of NaOH (ml)	Total vol. of Aqueous Solution (ml)	% of alkalinity
			Initial	final			
1.	Breeze	10	0	0.5	0.5	140	2.52
2.	Radhas	10	0	0.6	0.6	140	2.42
3.	Lux	10	0	0.7	0.7	130	2.36
4.	Johnson Baby soap	10	0	1.0	1.0	128	2.08
5.	Pears	10	0	1.4	1.4	135	1.61
6.	Fiama di wills	10	0	0.7	0.7	138	2.3
7.	Lifebuoy	10	0	0.6	0.6	130	2.44
8.	Sunlight	10	0	0.4	0.4	120	2.68
9.	Surf excel	10	0	0.1	0.1	125	2.96
10	Dr.Wash	10	0	0.5	0.5	110	2.62

Standard NaOH x soap sample (methyl orange indicator)

TABLE II TOTAL FATTY MATTER CONTENT ON SOAP SAMPLES

Sl. No.	Name of soaps	weight of china dish (g)	Weight of china dish+ soap after drying (g)	% of fatty matter
1.	Lux	27.67	31.08	68.2
2.	Sunlight	27.67	29.76	41.8
3.	Breeze	27.67	31.63	79.2
4.	Johnson baby Soap	27.67	31.55	77.6
5.	Pears	27.67	31.25	71.6
6.	Fiama di wills	27.67	31.15	69.6
7.	Dr. Wash	27.67	29.51	36.8
8.	Surf excel	27.67	29.15	29.6

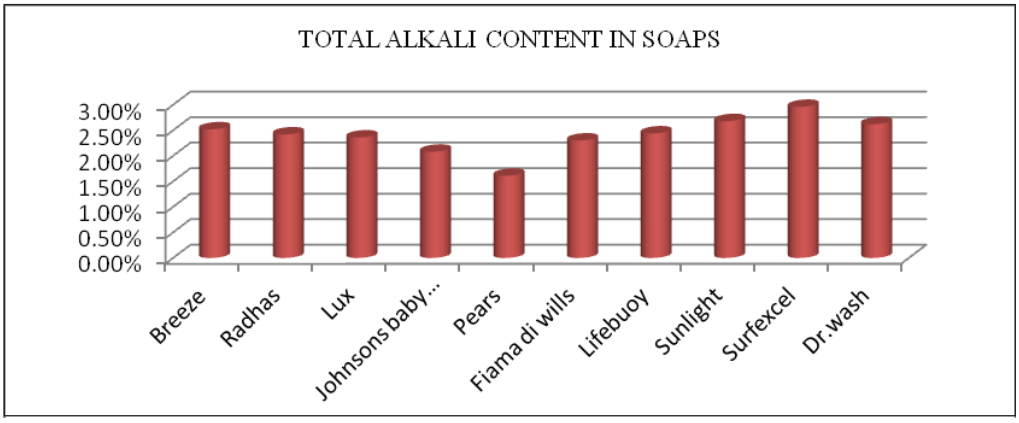

Fig.1Graphical representation of total alkali content in soaps

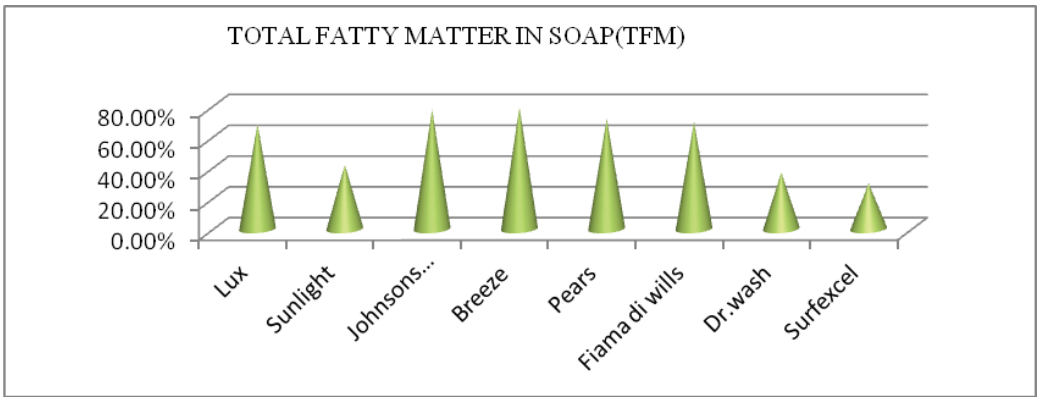

Fig.2 Graphical representation of total fatty matter in soap

IV. Conclusion

It can be summarized that the study indented to determine the total alkali content and total fatty matter of soaps, revealed that, the soaps which have high total fatty matter and low alkali content are having good quality. The low total fatty matter is associated with hardness and lower quality of soap and it is the most important characteristics describing the quality of soap. The bathing samples which we have studied are all in the standard range of TFM values. Washing soaps are in the low TFM range is up to the standard levels.

By the analysis of bathing soaps and washing soaps, we have observed a marginal variation in alkali content as well as fatty matter when compared with Indian standard specification for toilet soap. The values we obtained were closer to the International standard values. According to this, the total free alkali content is 2% [ISO 644] and total fatty matter content is 76 % [ISO 685]. Among the bathing and washing soaps we have analysed, it is observed that, all of them is having alkali content in the range of 3-5% and the fatty matter content between 70-80%, which shows an indication of good quality. From this we can conclude that our commonly used soap samples are of having lower alkali content and higher TFM value, making them good for health and environment.

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