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Quality Analysis of Selected Toilet Soaps in Saudi Arabia Markets

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Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Soap is sodium or potassium salt of fatty acid produced by saponification reaction. The physicochemical properties of soaps determine their quality and hence determine their efficiency. Four toilet soaps from local markets in Saudi Arabia were analyzed for moisture, pH, free caustic alkali or free fatty acid, total fatty matter and insoluble matter in alcohol. The percentage of the moisture ranged between (3.0534±0.1782 -5.1235±0.4891 %), total fatty matter (79.6907± 0.0534 - 94.8253 ± 0.0622), insoluble matter in alcohol (0.7939± 0.0134 - 1.0368± 0.0234%) and there is no excess free caustic alkali. However, the pH values between (8.715±0.0219 - 9.745±0.0212). This study showed that the percent of moisture, free caustic alkali, insoluble matter, total fatty matter and pH values for different samples found to be in limited range. Finally, the percentage of free fatty acid are (1.0433±0.0813 -1.4107±0.1731%). The soaps analyzed proved to be of high quality and meet the standard values.

Keywords: Soap; moisture; free caustic alkali; insoluble matter; total fatty matter.

1. INTRODUCTION

Soaps may be defined as water soluble salt of fatty acids which contain more than eight carbon atoms. The cleansing properties of soaps depend on its chemical properties as an anionic surface active agent or surfactant. It was prepared by treating a strong alkaline solution with animal or vegetable fats or oils [1]. The soaps which are made by using fatty

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acids containing twelve or more carbon such as coconut oil is very soluble and will lather easily even in sea water. On the other hand, fatty acids with only ten or fewer carbons are not used in soaps because they irritate the skin and have obnoxious odors [2]. Fatty acids are simply carboxylic acids with long hydrocarbon chains. These lengths may vary from 10-30 carbons (mostly12-18). The nonpolar hydrocarbon alkane chain is an important counter balance to the polar acid functional group. However, in acids with only a few carbons, the acid functional group dominates and gives the whole molecule a polar character [3]. On the other hand, the quality of good soap depends on the composition of fatty acids such as, (saturated fatty acid) give light open foam bubbles, solid and hard consistency, while (unsaturated fatty) acids provide moisturizing, conditioning and nourishing properties. These fatty acids are generally a mixture of saturated, di-unsaturated, mono-unsaturated polyunsaturated [3].

The physicochemical characteristic of soap depends on several factors which include the strength and purity of alkali, the kind of oil used and completeness of saponification. Such physicochemical characteristics include moisture content, total fatty matter (TFM), pH, free caustic alkalinity etc. Good quality soap for cleansing purpose is one that strikes a balance in all the mentioned physicochemical properties [4]. This study will determine the physicochemical properties such as moisture, pH, free caustic alkali or free fatty acid, total fatty matter, insoluble matter in alcohol for some commonly used toilet soaps from markets in Saudi Arabia and compared with the standard values. These values are important in determining the quality of a soap and suitability in the cleansing applications.

2. MATERIALS AND METHODS

2.1 Samples

Different soap samples were purchased commercially from different manufacturers in Saudi Arabia in three replicate measurements for each bar soap, the information about different soap samples are collected in Table 1.

2.2 Preparation of Solutions

2.2.1 0.1N NaOH solution

4 g of NaOH was weighed and dissolved in little amount of deionized water and transferred to 1000 mL volumetric flask and shacked well. The exact concentration of NaOH was determined by titration against standard potassium hydrogen phthalate [5].

2.2.2 0.1N HCL solution

8.3 ml of HCL was measured and transferred to 1000 ml volumetric flask and make volume up to the mark with distilled water then shake well [6].

2.2.3 Methyl orange indicator (Acid/Base indicator)

0.1 g of methyl orange was weighed and dissolved in 100 ml of distilled water, filtered and used [6].

2.2.4 1N H_2SO_4 solution

54 ml of H_2SO_4 was measured and transferred to 1000 ml volumetric flask and complete the volume with water to the mark and shacked well [7].

2.2.5 Phenolphthalein indicator (Acid/Base indicator)

1 g of phenolphthalein was weighed and dissolved in 100 ml of 95% ethanol solution [7].

2.3 Instruments and Working Procedures

2.3.1 Potentiometric measurements

The Potentiometric measurement was measured by pH/mV & Temperature meter (AD1000).

Table 1. Information about different toilet samples

Name		Expiry date	Manufacture date	Color	Odor
Lux	A	3/3/ 2019	3/9/2016	Blue	Seaweed
Fa	B	17/2/2020	14/2/2016	Green	Aloe Vera
Johnson's	C	10/2/2020	10/3/2017	White	Jasmine odor
Palmolive	D	12/8/2018	13/8/2016	Off-white	Strawberry

2.3.2 Standardization of HCl with Na_2CO_3

0.2 g of Na_2CO_3 was weighed in an Erlenmeyer flask, then 75 ml of distilled water, and two drops of methyl orange was added. The Na_2CO_3 solution was titrated with 0.1 N HCl [6]. The average normality of HCl was found to be 0.0987 ± 0.000577.

2.3.3 Standardization of NaOH with KHP

Potassium hydrogen phthalate (KHP) used as the primary standard, and phenolphthalein as an indicator. 0.2 g of KHP was weighed and 50 ml of distilled water was added in an Erlenmeyer flask, two drops of phenolphthalein was added and titrated with 0.1 N NaOH [5]. The average normality of NaOH found to be 0.1027 ± 0.000208.

2.3.4 Determination of the moisture

5 g of each soap sample was weighed in a Petridis, and then placed in the oven at a temperature of 105°C for 3 hours, allow to cool, then measure the weight and calculate the percentage of moisture [8]. The percent of the moisture was calculated using the following formula:

$$\text{Moisture \%} = \frac{\text{Weight of sample before} - \text{Weight of sample after}}{\text{Wieght of sample}} \times 100 \quad (1)$$

2.3.5 pH measurements

Ten grams of soap was weighed and dissolve in distilled water in a 100ml volumetric flask. This was made up to prepare 10% soap solution. However, 5% soap solution was prepared by adding 5g of soap to 100 ml distilled water. The pH values for different soap samples were measured by using a pH meter [9].

2.3.6 Determination of free caustic alkali or free fatty acid

2 g of soap sample was weighed in an Elementary flask then 100 ml of hot neutral ethanol was added. The flask was putted in water bath until completely dissolved of soap, after cooling, two drops of was added phenolphthalein. If the solution turn to pink then titrated with HCl until color disappears and calculate the alkalinity, if not titrate the solution with NaOH until pink color appears and calculate the percent of free acid as oleic acid ($C_{18}H_{34}O_2$) [10].

$$\text{FFA \%} = \frac{\text{V(NaOH)} \times \text{N(NaOH)} \times 28.25}{\text{Weight of sample}} \quad (2)$$

V= End point of NaOH in ml.
N= Normality of NaOH.

$$\text{Alkalinity \%} = \frac{\text{V(HCl)} \times \text{N(HCl)} \times 36.45}{10 \times \text{Weight of sample}} \quad (3)$$

V=End point of HCl in ml.
N= Normality of HCl.

2.3.7 Total fatty matter (TFM %) [11]

1. 5 g of each soap sample was weighed and dissolved completely in 100 ml of hot distilled water, transferred into a separating funnel and washed the beaker with small quantities of hot water.
2. Few drops of methyl orange indicator were added. Conc. H_2SO_4 was added until the color turned pink, then excess 5ml of H_2SO_4 was added to be sure that all of fatty acid broken, after that allowed solution to cool at room temperature.
3. 100 ml of diethyl ether was added into separating funnel and shaked well several times until the aqueous layer has become clear and allowed to stand.
4. Collected the organic layer separating into weighted flask, then the aqueous layer was run into a second separating funnel and extracted with 50 ml of diethyl ether. Another 50 ml of diethyl ether used to extract the fatty acid from the aqueous layer.
5. Washed with 50 ml of water and alcohol several times until the solution become clear.
6. The flask was putted on the hot plate to evaporate the diethyl ether, then 5 ml of acetone added was and dried it for one min.
7. The flask was placed in oven at 90°C for 10 min, after that cooled and weighted. The percent of (TFM%) was calculated using the following formula:

$$\text{TFM \%} = \frac{\text{Wight of flask after drying} - \text{Wight of empty flask}}{\text{Wight of soap}} \times 100 \quad (4)$$

2.3.8 Insoluble matter in alcohol

2 g of each sample was weighed in conical flask, 100 ml of hot neutral alcohol was added. Dissolution of the soap appears to be complete, filter solution and washed with hot ethanol until

the filter paper free from soap. The filter paper was placed in the oven at a temperature of 103°C for an hour, allow to cool to room temperature and weighed [11]. The insoluble matter was calculated using the following formula:

Insoluble matter %=

$$\frac{\text{Weight of filter paper after} - \text{Weight of filter paper before}}{\text{Weight of sample}} \times 100 \quad (5)$$

3. RESULTS AND DISCUSSION

3.1 Moisture

Moisture content of soap pellets differs depending on the desired characteristics of the soap bar. On-line moisture measurement at the exit of the Spray Dryer/Pelletizer provides immediate feedback on moisture levels enabling more rapid optimization of the process upon start-up, on-going cost savings from more efficient usage of the drier, and consistent high quality product. The moisture for each soap sample was measured and found to be 3.0534 ± 0.1782, 4.4786 ± 0.0032, 3.8912 ± 0.0052%, 5.2142 ± 0.6174 for A, B, C and D, respectively as shown in Fig.1, Table 2. The highest moisture percent was found to be in D. The difference in results may be due to soap preparing methods. All the percent of moisture for different soap samples within the limited range (10.5-12.5) [12].

Table 2. The percent of moisture for different soap samples

Sample	Moisture (%)	ISO specification
D	5.1235±0.4891	10.5-12.5
B	4.4786±0.0032	10.5-12.5
C	3.8912±0.0052	10.5-12.5
A	3.0534±0.1782	10.5-12.5

3.2 pH

The pH was measured for 5% and 10% soap solutions. From the results, the pH of 5% soap solution was found to be 8.715 ± 0.021, 8.940 ± 0.0282, 8.950 ± 0.042 and 9.745 ± 0.0212 for B, D, C and A respectively as shown in Fig. 2, Table 4. However, the pH for 10% was found to be, 8.725±0.021, 8.995 ± 0.063 and 8.965 ± 0.035, 9.705 ± 0.01414 for B, D, C and A, respectively as shown in Fig. 2, Table 3. From the previous results, the difference in pH values between 5% and 10% soap solutions is very small for all soaps which mean that pH values not dependent on the concentration of soap solution. All soap samples in the normal pH range (8-10.5) [12,13].

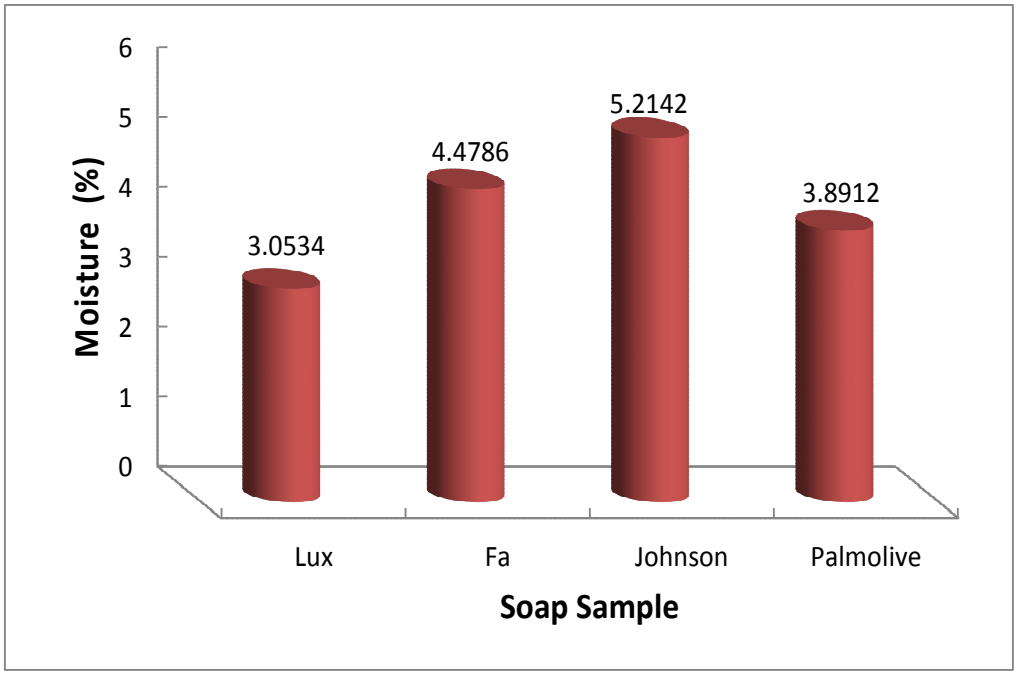

Fig. 1. The percent of moisture for different soap samples

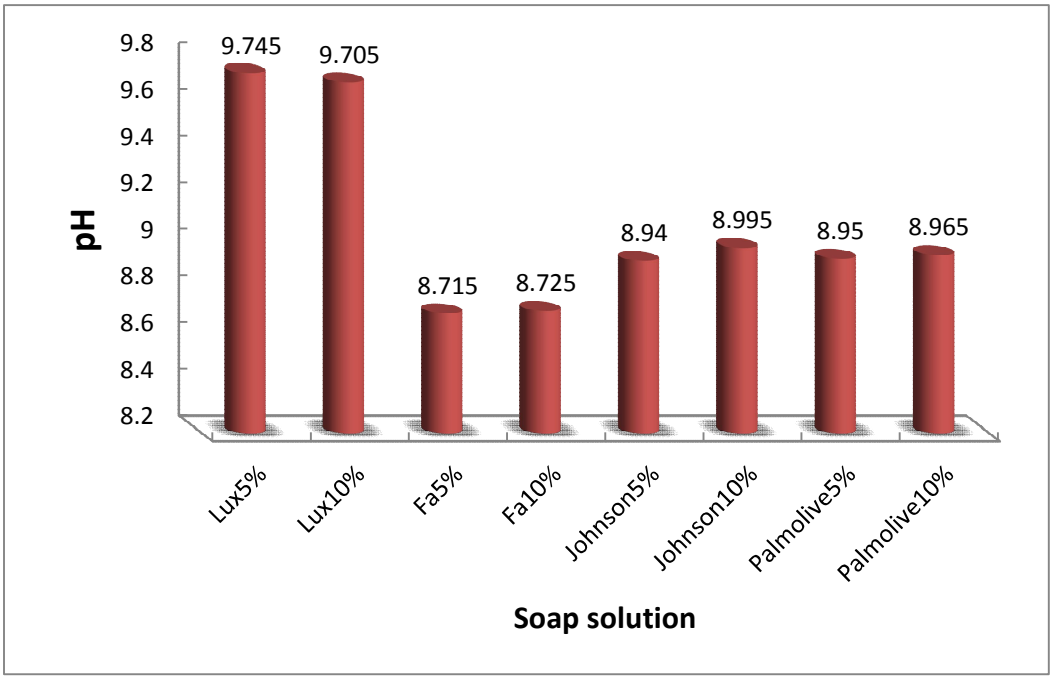

Fig. 2. The pH value for each soap sample

Table 3. The pH value for each soap sample

Sample	pH for 5% soap solution	pH for 10% soap solution	ISO specification
A	9.745±0.0212	9.705±0.014	8-10.5
D	8.940±0.0282	8.995±0.063	8-10.5
C	8.950±0.042	8.965±0.035	8-10.5
B	8.715±0.0219	8.725±0.021	8-10.5

3.3 Free Caustic Alkali or Free Fatty Acid

The percent of free fatty acid for each soap sample was determined by titration against 0.1N of NaOH. It was found to be 1.0433 ± 0.0813, 1.3262 ± 0.0671, 1.3590 ± 0.0008 and 1.4107±0.1731 % for D, A, C and B, respectively as shown in Fig. 3, Table 4. On the other hand, the free caustic alkali was found to be zero in all samples. According to ISO specification, soaps should have only below 2% of alkali content indicated high quality of soaps [14].

3.4 Total Fatty Matter

Total Fatty Matter was one of the crucial characteristics describing the quality and nature of soap. The precept of total fatty matter for different soap samples were observed as 79.6907± 0.0534, 85.9776± 0.0936, 91.9111 ± 0.0724 and 94.8253 ± 0.0622 for C, D, B and A respectively as shown in Fig. 4, Table 5. These differences in the (TFM%) is responsible for high moisture contents and the kinds and quantities of the used fatty materials and also perhaps due to the difference in the saponification method. All the percent of (TFM%) for different soap samples within the normal range (more than 76%) [15].

3.5 Insoluble Matter

The soap is dissolved in ethanol, filtrated and the undissolved residue is weighed. The substance which not dissolved in alcohol corresponding to the additives and foreign matter which added to soaps such as alkali carbonates, chlorides, borates, perborates, suphates, silicates, phosphates etc. The percent of insoluble matter in alcohol were measured for different soap samples and was found to be 0.7939± 0.0134, 0.8478± 0.0111, 1.0368± 0.0234 and 1.1086± 0.0100for A, B, C and D respectively as shown in Table 6. All the soaps

registered small percentages of insoluble matter which is an indication that insoluble substances may have been introduced to the oils before they did undergo saponification. All the percent of insoluble matter for different soap samples within the ideal range (less than 3%) [15].

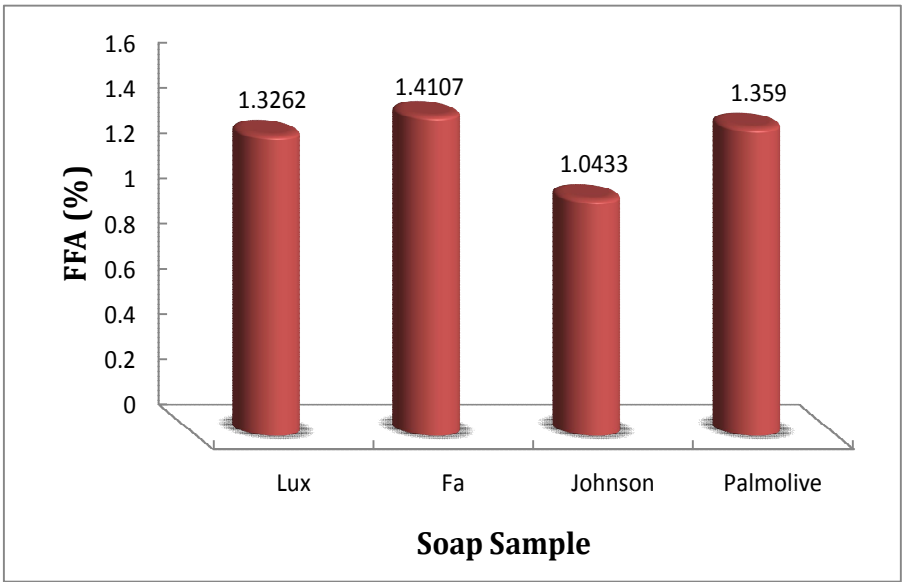

Fig. 3. The percent of free fatty acid (%) for different soap samples

Table 4. The percent of free caustic alkali or free fatty acid for different soap samples

Sample	FFA (%)	Free caustic alkali	ISO specification max
B	1.4107±0.1731	0.00	2%
A	1.3262±0.0671	0.00	2%
C	1.3590±0.0008	0.00	2%
D	1.0433±0.0813	0.00	2%

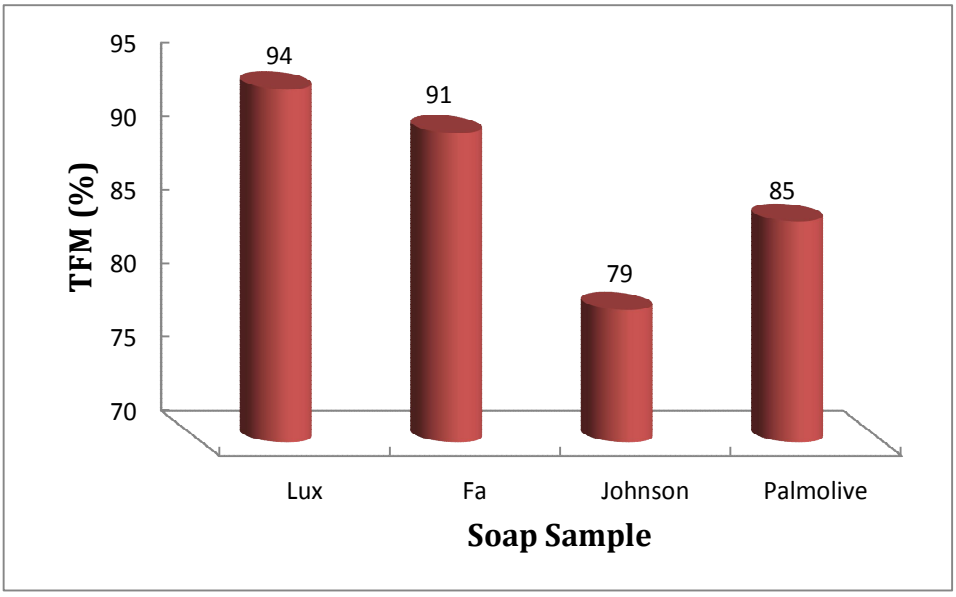

Fig. 4. The percent of total fatty matter (TFM%) for each soap sample

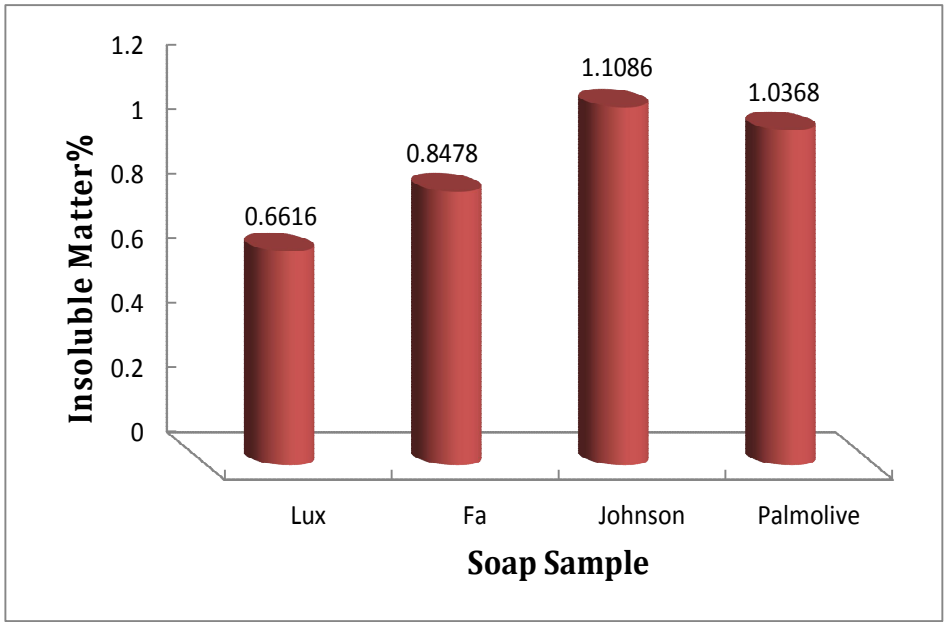

Fig. 5. The percent of insoluble matter in alcohol (%) for different soap sample

Table 5. The percent of total fatty matter (TFM%) for each soap sample

Sample	TFM (%)	ISO specification min
A	94.8253 ± 0.0622	76%
B	91.9111± 0.0724	76%
C	85.9776± 0.0936	76%
D	79.6907± 0.0534	76%

Table 6. The percent of insoluble matter in alcohol (%) for different soap samples

Sample	Insoluble matter (%)	ISO specification max
A	0.7939± 0.0134	3%
B	0.8478± 0.0111	3%
C	1.0368± 0.0234	3%
D	1.1086± 0.0100	3%

4. CONCLUSION

Four different samples of toilet soap was studied to determine the percent of moisture, free caustic alkali or free fatty acid, total fatty matter, insoluble matter and pH values. The results concluded that we should select a soap that keeps a balance among the physicochemical properties. Soap that contain a minimum amount of moisture will increase the self-life and high amounts of total fatty matter helps for lubricating the skin during washing. It should also need to keep lower levels of caustic alkali to reduce harshness on skin and cloth and higher pH values make the soap basic and lather easily. Any soap that equipoises on these parameters in termed to be high quality soap. The soaps analyzed proved to be of high quality and meet the standard values.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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