

QUALITY ASSESSMENT OF SOME BATH SOAPS SOLD IN PORT HARCOURT MARKETS

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ABSTRACT

Some bath soaps sold in Rivers State were assessed for physicochemical parameters including declared and actual weight, hardness, perfume level, colour, staining and cracking test, foam value and rate of ware, free caustic alkali (FCA), moisture content (MC), total fatty matter (TFM), pH and total alkali contents (TAC). The samples were labeled A, B, C, D, E, F, G, H, and I. Standard analytical test methods were followed in determining the physical and chemical properties of the soaps. Upon analysis, variations in some physicochemical properties were observed. Results obtained showed that all the soap brands failed in their declared and actual weights. There were variations also in foam value and rate of ware. The pH, moisture, free caustic alkali and alcohol insoluble matter ranged from 9.0-10.0, 11.2-18.8%, 0.03-0.10% and 1.1-1.8%, respectively, in samples A to G. Similarly, alcohol and water insoluble matter, total fatty matter and chloride content varied from 1.1-1.8%, 0.03-1.5%, 75-81.0% and from 0.2-1.0% respectively in the entire bath soap samples. Most of the samples met the standard set by Nigerian industrial standard (NIS) in terms of chemical properties. Quality of soap is very important therefore, it is recommended that the physical and chemical analysis of soap samples be monitored by regulatory agencies in order to fish manufacturers who fraud consumers through declared weight, high caustic content and low total fatty matter.

Keyword: Physicochemical, samples, weight, properties, standard, analysis.

INTRODUCTION

Soaps are a part of our daily life for personal hygiene and cleansing of our bodies. It is therefore important to check the quality of the soaps before making a purchase. Soap is formed by the process of saponification into different forms and types, subject to their uses, application and material composition. Examples include; laundry soap, bath soap, toilet bar and medicated soaps [1,2].

The general formula for formation of soap is: Fat (Triglyceride) + NaOH → Soap + Glycerol

Bath soaps have strict specifications of fine texture free from objectionable odour and have good lathering and cleansing properties [3]. Assessment of soap quality is very important because poor quality soaps can cause skin discomforts such as acne, eczema, hives, rashes, skin irritation and possibly lead to cancer [4]. Bath soaps should be made according to specifications. The fat used should be used of high-quality standard. Fat oil & lye (sodium-

hydroxide) must be weighed accurately, if the lye is weighed more, the soap will be hard and harmful to skin and if the lye is low, the fat will not be saponified properly [5].

Two types of toilet/bath soaps are sold in Port Harcourt, Rivers State markets, namely, toilet /bath soaps and bathing bars. Quality of soap depends on total fatty matter (TFM), which imparts soaps their feels. The TFM and insoluble matter in the soap largely distinguishes toilet soaps from bathing bars. Toilet soap has the highest grade whereas bathing bars have less fatty substance (generally around 40 per cent) [6].

Presently, so many brands of bath soaps are sold in markets. Consumers decide features and characteristics of soap product to meet their needs, however, bath soaps sold directly to consumer are usually made to manufacturer's own formulations and specifications, rather than to any official quality specifications. Sadly, most soap samples sold as toilet or bath soaps are below the standard, therefore, consumers are cheated in most cases. Soap manufacturers are expected to send their samples for safety assessments and subject them to NIS tests before they are allowed to be sold in the markets. The aim of this study is to assess the quality of some bath soaps sold in Port Harcourt, Rivers State, markets.

MATERIALS AND METHODS

Soap samples

Nine (9) bath soap tablets labeled A to I were purchased from some markets in Port Harcourt, Rivers State, Nigeria. They were sent to the

laboratory for analysis of their physicochemical properties.

Soap weight

The actual weight of each tablet was determined using Sartorius top loading weighing balance (sensitivity of 1.0mg) model BL 150 S. After that, the soap samples were chopped into pieces and kept in an air- tight container for analysis.

Soap pH

pH of each soap sample was determined with a pH meter after dissolving the soap in hot distilled water and cooling to 30°C. The pH was determined as described by Habib et al. [7] with little modification. 1 g of soap was dissolved in 10 mL distilled water and left to stand for 1 h with occasional shaking. HANNA pH 210 with microprocessor was used after calibration with standard buffer solutions of pH 4, 7 and 10.

Soap Hardness, perfume, colour, cracking and rate of ware were determined using the Standard Organization of Nigeria test methods [8].

Staining test

A drop of oil from cooked food was placed on a strip of white cloth. The cloth was washed using soapy water of each soap sample and rinsed with distilled water. The stain removing power of each soap sample was observed and recorded as per the International Standards Organization (ISO) number 685 of 2020 (ISO 685:2020) [9].

Foam value and Stability

Five (5 g) grams of each soap sample was dissolved in 1L measuring cylinder containing 100 mL of distilled water. The mixture was shaken vigorously so as to generate foams and left

standing until the water came to its initial mark. The height of the foam in the solution was measured and recorded as foam value according to Osagie and Enyi [10]. The mixture in the cylinder was allowed to stand for 5 minutes; the height of the foam for each sample was observed and recorded. The time taken for the foam to completely disappear was recorded as foam stability.

Moisture content

Moisture content was determined as described by Idoko et al. [11] with some minor modifications. Five (5 g) of each sample was weighed into a tarred petri-dish and placed in the oven at $105^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for 2 h. The petri-dish with the sample was allowed to cool in a desiccator and re-weighed. Percent moisture content was calculated using the formula below:

$$\% \text{ moisture} = \frac{P1 - P2}{P1 - P3} \quad 1.0$$

P1 = weight of crucible + sample
P2 = weight of petri-dish after drying
P3 = weight of crucible

Free caustic alkali (FCA)

Free caustic alkali was determined by the method described by Arun, [12]. According to the method, 5g of each soap sample was weighed and dissolved in 100 cm^3 of re-distilled ethanol. Then few drops of phenolphthalein indicator and 10 cm^3 of 20 % BaCl_2 were added. The resulting solution was titrated against 0.05M H_2SO_4 . The FCA was calculated using equation 2.0.

$$\text{Free Caustic Alkali} = \frac{0.31 \times V_a}{W} \quad 2.0$$

V_a = volume of acid used, W = weight of sample

Alcohol Insoluble Matter

Five (5g) grams of each soap sample was weighed into a 250 mL conical flask and dissolved in 50 mL hot ethanol. The mixture was quantitatively transferred to pre-weighed filter paper. The residue was dried in the oven at 105°C for 30 min, cooled in desiccator and weighed again. Matter insoluble in alcohol (MIA) was calculated using equation 3.0.

$$\% \text{ MIA} = \frac{W_f - FP}{W} \quad 3.0$$

Where W_s = weight of sample + filter paper, FP = weight of filter paper, W = weight of the sample.

Matter Insoluble in Water (MIW)

Sample obtained from the determination of alkali as alkaline salts was dried and dissolved in 100 mL distilled water. It was quantitatively transferred to pre-weighed filter paper. The residue was dried in the oven at 105°C for 2 h, cooled in desiccator and weighed again. Matter insoluble in water (MIW) was calculated using equation 4.0.

Percentage of total insoluble matter;

$$\% \text{ MIW} = \frac{W_f - FP}{W} \quad 4.0$$

W_s = weight of sample + filter paper, FP = weight of filter paper and W is weight of sample.

Total Fatty Matter (TFM)

This was determined as described by Hamisi et al. [13] with little modifications. 5 g of each soap samples was weighed and dissolved in 100 mL distilled water. The mixture was heated on the water bath until the entire sample dissolved, 5 ml of 0.5 N H₂SO₄ was added followed by gentle shaking. The solution was left to cool to ambient temperature and transferred to a 250 mL separatory funnel. The fatty acids were extracted three times with 50 mL petroleum ether. The three organic portions were then combined and dried by using anhydrous sodium sulphate to remove any traces of water and evaporated on a tarred receiving flask. The aqueous layer was kept for determination of chloride content while the total fatty matter was calculated as below;

$$\% \text{ fatty matter} = \frac{RF - WF}{W_s} \times 100 \quad 5.0$$

RF = weight of receiving flask + sample after evaporation, WF= weight of empty flask W_s = weight of sample

Chloride

Neutral potassium chromate (K₂CrO₄) solution was added to the neutral solution from the titration of total alkali and then titrated with 0.1 N AgNO₃. The chloride content, expressed as a percentage (rn/rn) of sodium chloride, is given by the formula:

$$\% \text{ Chloride content} = \frac{V \times T \times 0.0585 \times 100}{m} \quad 6.0$$

V = the number of mL of silver nitrate used to reach the equivalence point, T = normality of the silver nitrate solution used, m = mass, in g, of the soap sample

RESULTS AND DISCUSSION

The results of the physical properties of the soap samples are presented in Table 1, using various parameters like soap weight, hardness, perfume, colour, staining, foam value and stability, rate of ware.

Table 1: Physical Properties of Some Bath Soaps Sold in Port Harcourt markets

Soap Sample	Declared weight (g)	Actual weight (g)	Hardness	Perfume	Colour	Staining test	Cracking test	Foam value & Stability (ml)	Rate of ware %
A	70	66	Hard	Okay	Yellow	Nil	Nil	69	25
B	75	70	Hard	Very good	White	Nil	Nil	80	10
C	75	72	Hard	Very good	White	Nil	Nil	70	10
D	75	72	Hard	Very good	White	Nil	Nil	76	12
E	70	66	Hard	Good	Blue	Nil	Nil	80	10
F	70	65	Hard	Good	Cream	Nil	Nil	79	15
G	75	70	Hard	Good	Yellow	Nil	Nil	81	12
H	75	65	Hard	Good		Nil	Nil	82	8

I	75	72	Hard	Okay	Pink	Nil	Nil	71	9
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Soap weight: The results of the analysis on Table 1 show that all the soap brands failed in the actual and declared weight. This shows that manufacturers defraud consumers by declaring false weight knowing that consumers do not weigh soaps before buying.

Hardness: The results on Table 1 reveal that all the brands are hard. The test was done by using the thumb to press on the soap samples. Good soaps are by standard hard and not soft or brittle [14].

Perfume: The results obtain show that the soap brands have good fragrance.

Foam value and Stability: Sample I had the highest foam height of 82 mL followed by sample G, B and G respectively. The lowest foaming

height was observed in sample A. The results are not very far from foam stability of other commercial soaps. Foaming is the ability of soap to form lather [15].

Staining: Cleansing effect of soap depends largely on total fatty mater. High fatty acid content means high TFM content in the soap. Fatty acids are cleansing agent. It helps soaps lather more and form micelle that traps dirt and removes them from the material being cleaned. Soaps with low fatty acids do not remove dirt easily.

Rate of ware: Sample A had the highest rate of ware while sample I had the least. High TFM content soap does not dissolve as quickly as other soaps so it last longer than low grade soaps. This makes high TFM soaps cost-effective.

Table 2: Chemical Properties of Soap Samples

Parameters	A	B	C	D	E	F	G	H	NIS
Soap pH	10.0	9.0	9.0	9.0	10.0	9.5	11.0	10.0	7-10
% moisture content	18.8	12.3	11.6	12.2	15.5	15.5	19.3	11.2	10-20
% free caustic	0.10	0.03	0.03	0.03	0.04	0.04	0.08	0.05	0.05
% Alcohol Insoluble Matter	1.8	1.1	1.2	1.5	1.6	1.2	1.8	1.2	2.0
% water Insoluble Matter	1.5	0.03	0.05	0.8	0.7	0.8	1.5	0.8	2.5
Total Fatty Matter	75.3	80.0	81.0	78.0	78.0	78.0	75.0	78.0	76.0

% Chloride	0.8	0.2	0.5	0.4	0.5	0.4	1.0	0.5	0.75
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NIS = Nigeria Industrial Standards

Results of chemical properties of the soap samples are presented in Table 2 using parameters like Soap pH, moisture content, free caustic, Alcohol Insoluble Matter, water Insoluble Matter, Total Fatty Matter and Chloride. The results were compared to Nigeria Industrial Standards to ascertain the quality and safety of the soaps for use.

Soap pH:

The pH of the soaps' samples are slightly alkaline and fall within the acceptable limits for household soaps of 8.0 to 10.5 as reported by Shehata, [16]. Soaps that are slightly alkaline are preferred because they are gentle on skin but tough on bacteria. The results agreed with results of commercial sunflower oil soap which ranged from 10.03 to 10.30 [17]. Soap with pH values below 5 and those with pH way above 10 are associated with harshness on the hands and skin. pH values in soaps could result from incomplete alkali hydrolysis resulting from the saponification process. Higher pH values in soap can be controlled by the addition of excess fat/oil known as super-fatting in acceptable quantities addition of pH adjusters to reduce its harshness and corrosiveness on the skin [18].

Moisture content

Moisture content is a degree of the amount of free water existing in the soap. It is an important

parameter used to determine the shelf life of soap. Moisture content of the entire soap sample in this study is within the recommended values specified by the Nigerian Industrial Standard (NIS) [19]. Surplus water in soap reacts with unsaponified fat and undergoes hydrolysis to form free fatty acids and glycerol on storage in a process referred to as hydrolysis [1]. Hence, high moisture content in soap affects the quality of soap and reduce its shelf life. Moisture content of 10% - 20% will present a harsh environment for the growth of microbes. Again, high moisture content in soap increases the solubility of the soap leading to wastage. Also, foaming strength increases as moisture content decreases [20].

Free caustic

Free caustic alkali (FCA) of the entire bath soap was within the recommended values 0.05% [19] except for Sanitol which had free caustic of 0.10%. Good quality soap contains little or no free alkali [21, 22]. High FCA irritates the skin leading to skin dryness; in this case, the excess alkali saponifies the fats and oils that serve as protective coat to the skin and form soluble soap which when washed away renders the skin dry and scaling exposing the skin to fungal attacks. Again high free caustic alkali soap wear-out clothes [23].

Alcohol Insoluble Matter (AIM)

High amount of matter insoluble in ethanol suggests lower purity of the soap. The higher amount of matter insoluble in alcohol may be attributed to the level of impurity in the form of fillers and crude nature of the alkali. Samples A and G had the highest matter insoluble in alcohol of 1.8% while sample B had the least with 1.1%. However, the entire soap samples complied with the maximum of 2% matter insoluble in ethanol specified by SON for toilet.

Water Insoluble Matter (WIM)

Water insoluble matter is a property that describes how insoluble the soap will be when dissolved in water. From the study, matter insoluble in water of sample A (1.5%) was the highest while sample B (0.03%) was the least. NIS specification is 2.5 % maximum. The amount of insoluble matter indicates the level of purity of the soap. Higher level of matter insoluble implies low purity of the soap.

Total Fatty matter (TFM)

Total fatty matter (TFM) is the most vital parameter in determining soap quality. The entire bath soap passed the recommended specification for total fatty matter of 76% except for sample A and G which had 75.3 and 75%, respectively. Soaps having TFM of 76% and above are grouped as Grade 1 while soaps with TFM content of 70% and above but less than 76% are considered Grade 2 soaps. Soaps with TFM content of 60% and above but less than 70% are graded as Grade 3. Grades 2 and 3 have low TFM. Low TFM could

result from many additives like fillers, preservatives, colour [24]. Sometimes, these fillers contain asbestos which can have an adverse effect on skin [25]. They have tendency of getting mushy in water and tend to get consumed faster. Low grade soaps have poorer lathering. Grade 1 soaps on the other hand have a higher TFM content and provide very high cleansing efficiency while being gentle on skin. Cleansing properties of soap can be categorized based on TFM content [26]. The higher the TFM of soap better, the better its cleansing ability. Dry skin needs soaps that are high in TFM because the fatty matter rehydrates the skin making it smooth and acts as lubricant for the skin [27]. Low TFM is usually associated with hardness, poor quality and ineffective removal of grease and other fatty matter from clothing during laundry [28].

Chloride

Sodium chloride is often used to grain soap (salting out). High NaCl content in soap helps to enhance the soap's hardness. The entire soap samples except samples A and G passed the chloride test when compared to the standards of 0.75%.

CONCLUSION

Soaps are crucial part of human daily routine and hygiene. It is therefore important to choose wisely the type of soap to use, in order to avoid bad effects like dryness, itchiness, and rashes on the body. It is important to keep the skin healthy by

choosing the right soap. Regular assessment of the physicochemical properties of soap samples is very important. The regulatory standards for bath soaps are stipulated by SON in Nigerian Industrial Standard (NIS), (2015). TFM and caustic alkali are indicators for good or bad soap to the skin. Lower alkali content and higher TFM value are less harmful to the skin. From the findings of this study, SON should carry out continuous monitoring of the products in the market to ensure continuous compliance with standard.

REFERENCES

1. P. Onyango, O. Vivian, A.O. Nathan, M. Linda, & N.O. Wesley. (2014). Assessment of the physicochemical properties of selected commercial soaps manufactured and sold in Kenya. *Open Journal of Applied Sciences*, 4, 433-440.
2. O. Tamuno-Boma, C.O Nwaokezi, D. George, & O.D. Izuagha. (2024). Assessment of physicochemical properties of liquid soaps in Port Harcourt, Rivers State, Nigeria. *Singapore Journal of Chemical Biology*, 13(1), 1-7.
3. E.K. Ossai. (2014). Preparation and characterization of metal soaps of Cocos nucifera seed oil. *Applied Science of Environmental Management*, 18(2), 359-363.
4. R.M. Chandira, S. Lokeshwaran, & G. Gracy. (2022). Formulation and evaluation of herbal soap by using melt and pour. *Indian Journal of Natural Sciences*, 13(72).
5. W.M. Gichuki. (2022). *Saponification reaction: preparation of soaps*. ResearchGate, 1-2.
6. I. Jimoh, & A. Jimoh. (2021). Preparation of soap from palm kernel oil (PKO) and potash. *Central Asian Journal of Theoretical & Applied Sciences*, 2(11), 139-144.
7. A. Habib, S. Kumar, S. Sorowar, J. Karmoker, M. K. Khatun, & S.M. Al-Reza. (2016). Study on the physicochemical properties of some commercial soaps available in Bangladeshi market. *International Journal of Advanced Research in Chemical Science*, 3, 9-12.
8. Standard Organization of Nigeria (SON). (2015). *SON Test Methods*.
9. International Organization for Standardization (ISO). (2020). *ISO 685:2020, Analysis of soaps*.
10. Osagie, O. F. & Enyi, C. C. (2015). Utilization of agricultural waste (rubber seed oil, kolanut pods and almond leaves) for soap production. *International Journal of Geography and Environmental Management*, 1, 121-135.
11. O. Idoko, S.A. Emmanuel, A.A. Salau, & P.A. Obigwa. (2018). Quality assessment on some soaps sold in Nigeria. *Nigerian Journal of Technology*, 37, 1137-1143.
12. S. K. Arun. (2023). Formulation and evaluation of herbal soap. *World Journal of Pharmaceutical Research*, 12(9), 2136-2147.
13. H.Y. Nchimbi. (2020). Quantitative and qualitative assessment on the suitability of seed oil from water plant (*Trichilia emetica*) for soap making. *Saudi Journal of Biological Sciences*, 27, 3161–3168.

14. East African Community. (2011). *EAS 31: Laundry soap — Specification*. East African Standards.
15. Y. Kunatsa, & D. R. Katerere. (2021). Checklist of African soapy saponin—rich plants for possible use in communities’ response to global pandemics. *Plants*, 10(5), 842.
16. E.E. Shehata. (2020). Quality analysis of selected toilet soaps in Saudi Arabia markets. *Asian Journal of Applied Chemistry Research*, 7(2), 7-14.
17. M. Bertin, T. Kedar, & D. Masamba. (2020). Quality improvement of soaps perfumed with some selected essential oil. *Journal of Scientific and Innovative Research*, 9(1), 11-16.
18. American Cleaning Institute. (2019). *The Science of Soap: An Introduction to the Science of How Things Get Clean*.
19. Nigerian Industrial Standard (NIS). (2015). *Standards for Medicated Soaps* (NIS 515:2015). Standards Organization of Nigeria.
20. T. M. Barnes, D. Mijaljica, J.P. Townley, F. Spada, & I.P. Harrison. (2021). Vehicles for drug delivery and cosmetic moisturizers: Review and comparison. *Pharmaceutics*, 13(12), 2012.
21. M.R. Chirani, E. Kowsari, T. Teymourian, & S. Ramakrishna. (2021). Environmental impact of increased soap consumption during COVID-19 pandemic: Biodegradable soap production and sustainable packaging. *Science of the Total Environment*, 796, 149013.
22. J. G. Nangbes, N.A. Zukdimma, B.M. Wufem, T.D. Lawam, & N.N. Dawam. (2014). Quality survey and safety of some toilet soaps in the Nigerian market: A case study of B/Ladi, Bokkos and Pankshin, Plateau State. *IOSR Journal of Applied Chemistry*, 7, 29-35.
23. N.J. Maduelosi, U.J. Okwechime, & F.U. Arodiogbu. (2025). Quality evaluation of some laundry soaps sold in markets of Port Harcourt, Rivers State, Nigeria. *ChemClass Journal*, 9(2), 192-203.
24. N. Stroebinger, S. M. Rutherford, S.J. Henare, J. F.P. Hernandez, & P.J. Moughan. (2021). Fatty acids from different fat sources and dietary calcium concentration differentially affect fecal soap formation in growing pigs. *The Journal of Nutrition*, 151(5), 1102-1110.
25. S. Arasaretnam, & K. Venujah. (2019). Preparation of soaps by using different oil and analyze their properties. *Natural Products Chemistry and Research*, 7(1), 1000357.
26. F. Jabr. (2020). Why soap works. *New York Times*, Health section, online edition, 13.
27. M. Isaa, I. Isaac, O. Mathew, B. Shalangwa, & M. Sunday. (2020). Physicochemical analysis for quality and safety of some selected animal soaps compared to human soaps in Plateau State, Nigeria. *IOSR Journal of Applied Chemistry*, 13(3), 25-28.
28. C. Liu, Z. Meng, X. Chai, X. Liang, M. Piatko, S. Campbell, & Y. Liu. (2019). Comparative analysis of graded blends of palm kernel oil, palm kernel stearin and palm stearin. *Food Chemistry*, 286, 636-643.