SJCB Singapore Journal of Chemical Biology

OPEN ACCESS

Assessment of Physicochemical Properties of Liquid Soaps in Port Harcourt, Rivers State, Nigeria

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ABSTRACT

Background and Objective: The purposes of soap use may be lost when it induces irritations, allergies and adverse effects on the skin. The quality of soaps can be assessed based on their physicochemical properties. This study assessed some physicochemical properties of four variances of liquid soaps in Port Harcourt, Nigeria. **Materials and Methods:** Morning fresh liquid soap and sunlight liquid soap served as the branded liquid soaps and pink liquid soap and lemon liquid soap served as the unbranded liquid soaps. Standard analytical procedures in line with AOCS and ISO were employed in determining the pH, matter insoluble in water, density, moisture and volatile content and inorganic salts of the liquid soaps. Results were analyzed statistically using SPSS 25. **Results:** The pink liquid soap had the highest pH (12.26±0.38) while morning fresh liquid soap had the lowest pH. Lemon liquid soap had the highest density while the pink liquid soap had the lowest density. Morning fresh liquid soap had the highest moisture and volatile content while lemon liquid soap had the least. Morning fresh had the highest matter insoluble content, the pink liquid had the least. Morning fresh and sunlight soaps had inorganic salt values of 170.78±0.90 and 93.00±1.00, pink and lemon soaps had 95.33±1.17 and 93.33±0.76. **Conclusion:** It is therefore suggested that the scaling, irritations and other adverse effects on the skin from the use of some liquid soaps can be associated with the pH and Inorganic salt content, thus a check on the pH of liquid soaps during production is expedient.

KEYWORDS

Liquid soap, Port Harcourt, pH, matter insoluble content, moisture and volatile content, density, inorganic salt

INTRODUCTION

Liquid soap has been described as a cleansing agent in a liquid form made from the salts of vegetable or animal fat[1]. Soap is one of the major cleansing agents that is used for washing dishes, bathing and laundry[2], it is produced not just for personal cleanliness but also for environmental, medical and industrial use[3]. Soap is prepared by heating animal fat or oil with wood ashes. Wood ashes contain potassium carbonate and sodium carbonate which makes the solution basic[4].

ISSN: 2010-0108 (Online)
ISSN: 2010-0094 (Print)
https://doi.org/10.3923/sjcb.2024.01.07

Received: 14 Jun. 2023
Accepted: 08 Jan. 2024
Published: 17 Jan. 2024

The chemical nature of soap is amphipathic. The lipophilic part of soap plays an important role, it makes the soap soluble in oil, it comprises the potassium or sodium salts of various fatty acids, but chiefly of oleic, stearic, palmitic, lauric and myristic acids i.e., alkali, metal salts of long chain monocarboxylic acids[5], while the hydrophilic part makes soap soluble in water. The use of liquid soap has gradually increased over the years and recently, the use of liquid detergent equals or exceeds the use of solid detergent. Due to an impressive upsurge in the production and consumption of a variety of liquid soap, poor quality is also introduced in the market, which poses a danger to the public.

Depending on different grades of soap for final consumption, various methods are being employed to produce soaps. Willcox[6] stated that a good liquid soap must have fluidity at an ambient temperature range from 5-40°C, good foaming characteristics and the ability to emulsify oil, fats and grease. It should also be environmentally friendly[7]. Soap with high alkalinity causes skin irritation, dryness and scaling which predisposes fungal attack to the skin[8].

Studies have reported that the pH of the skin proportionally increases with the pH of the soap or cleanser used. Dehydration, irritability and proionibacterial count have been associated with increased pH leading to the pathogenesis of some skin diseases[9]. Cleansing agents with a pH of about 5.5 have been reported to be of relevance in the prevention and treatment of some skin diseases[10,11].

Matter insoluble in water measures the non-soap properties and minor constituents in soaps responsible for bleaching, whitening and fluorescing agents in the finished product. The non-soap ingredients include sodium silicate, sodium phosphate and sodium carbonate. A high value of matter insoluble in soap indicates high levels of impurities of the alkali used in the soap production[12]. Hardness in soap could be attributed to the presence of impurities, contributing to the bulkiness of the soap[13].

The chemical composition of soap determines its particular density. Density is the measure of the mass of the substance divided by its volume. Density does not significantly change as the soap varies from solid to liquid[14]. Maintaining optimal moisture levels during the production of soap is critical to achieving the highest quality product. If the moisture content is too high or too low, this can result in a low-quality product and wastage can occur. Moisture attributes the existence of liquid especially water, usually in trace extent.

The viscosity of a liquid solution confers on the soap, the ability to thickness in the liquid soap. It is also used to adjust the pH balance of the soap. The presence of inorganic salts increases the viscosity of the liquid soap[15].

The constituents of soap, which is a mixture of fatty acid salts that are able to form mycelia when combined with lipophilic substances in an aqueous medium confers the soap its ability to extract the lipid content from the stratum corneum and favour its dissolution. This implies the removal of exogenous pollutants, reduction of odors and modification of the skin microbiota[16-18]. Castanedo-Cázares *et al.*[19] observed that excessive or repeated use of soap can damage the skin barriers, with accompanying exposure of epidermal keratinocytes to the chemical components of the product. The disruption of the skin lipid structure causes irritation, oxidative stress and inflammation, with clinical symptoms such as contact dermatitis, redness, scaling, itching and exudate[20]. Baranda *et al.*[21] and Gfatter *et al.*[22] observed that most soaps and detergents are alkaline and induce an increase in cutaneous pH which affects the physiologic protective acidic status of the skin by decreasing the fat content.

In view of the literature reports, scaling and adverse effects observed on the skin of users, this study assessed some physicochemical properties of liquid soaps, sold and consumed in Port Harcourt, Rivers State, Nigeria.

MATERIALS AND METHODS

Study area: This study was conducted at the Biochemistry Laboratory of the Faculty of Science, Rivers State University, Port Harcourt, Nigeria from September, 2021 to January, 2022.

Sample collection: Four samples were collected for this study; morning fresh liquid soap, sunlight liquid soap, pink liquid soap and lemon liquid soap. Morning fresh and sunlight liquid soaps served as branded liquid soap while the pink and lemon liquid soaps were unbranded liquid soap. The branded liquid soaps were obtained from a retail shop in mile 3 market, Port-Harcourt, Rivers State while the unbranded liquid soaps were obtained from a local soap producer in mile 3 market in Port Harcourt, Rivers State.

Physicochemical analysis of soap sample: Samples were analyzed for density, matter insoluble in water, moisture and volatile content, inorganic salts and pH using the method described by Gfatter *et al*.[22].

Determination of density: Fifty milliliters of the weight of the liquid soap sample was measured and transferred into a clean dry density bottle. The density bottle and its content were weighed and the density of the weight of the liquid detergent sample was calculated as follows:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Determination of matter insoluble in water: Two grams of liquid soap was dissolved in hot water and filtered through a weighed filter paper. The residue was washed with some portions of distilled water several times to remove all the water-soluble. The residue was dried in the oven at 105°C for 30 min, cooled and weighed again and a reading was taken. The calculations were carried out by using the following formula[3]:

$$\frac{WS - FP}{W} \times 100$$

Where:
WS = Weight of sample+filter paper
FP = Weight of the filter paper
W = Weight of the sample

Determination of moisture and volatile matter: To the nearest 0.001 and 5 g of liquid soap was weighed in a tarred evaporating dish, which was previously dried and cooled. The procedure as described by Firestone[23] was adopted.

Calculation: The moisture and volatile matter content is given as a percentage by mass by the formula[23]:

$$\frac{M1 - M2}{M1 - M0} \times 100$$

Where:
M0 = Mass in grams of the dish
M1 = Mass in grams of the dish and the sample before heating
M2 = Mass in grams of the dish and the sample after heating

Determination of pH: The pH meter was calibrated with the standard solution (pH = 7). Liquid soap (10 mL) was dissolved in 100 mL of deionized water, stirred for a homogenous mixture and kept to settle for 30 min. The pH was measured at room temperature using a pH meter (ELICO L1613) equipped with a glass electrode capable of measuring pH value to an accuracy of 0.1.

Determination of Inorganic salts: The procedure as described by Firestone[23] was adopted.

Calculation: The organic salt content is given as a percentage by mass by the formula[23]:

$$\frac{M1-M3}{M1-M0}\times 100$$

Where:
M0 = Mass in grams of the dish as in moisture and volatile matter
M1 = Mass in grams of the dish and the sample before heating in moisture and volatile matter
M3 = Mass in grams of the dish and the residue

Statistical analysis: Descriptive statistics were carried out on the data obtained using IBM SPSS version 25. Significance was at $p \leq 0.05$.

RESULTS AND DISCUSSION

The results showed the values of pH, density, matter insoluble in water, moisture and volatile content and Inorganic salt levels of four liquid soaps sold and consumed in Port Harcourt; morning fresh liquid soap and sunlight liquid soap. Pink unbranded liquid soap and lemon unbranded liquid soap.

This study evaluated some physicochemical properties of four liquid soaps sold and consumed in Port Harcourt, Rivers State in Nigeria. Table 1 revealed that for the pH values, pink liquid soap, an unbranded product had the highest pH (12.26±0.38) while morning fresh liquid soap had the lowest pH value (7.05±0.05). Sunlight liquid soap, also a branded soap had a pH value (8.31±0.43) while lemon liquid unbranded soap had a pH of 9.53±0.39. pH which is a measure of the degree of acidity or alkalinity of a substance is a determinant of the quality of soap[24]. The average adult skin pH has been reported to be 5.7, however, it could vary, depending on the area of the body, lesser exposed areas such as the armpits, genitals and buttocks maintain natural acidity while exposed areas like the hands and face etc. tend to be more alkaline. The pH of the skin could be affected by; detergents, cosmetics, air pollution, acne etc.[25,26]. Soap with pH values below 5 and above 10 has been associated with harshness on the hands and skin[27]. In view of the above works of literature on the pH of soap and skin, it could be suggested that the adverse effects such as scaling, itching etc., exhibited on the skin when some of the unbranded liquid soaps are used may be attributed to the high pH of the soaps. The investigated soaps in this study were all within the pH range except the pink unbranded liquid soap which was above pH 10.

The density of soap does not significantly change as the soap varies from solid to liquid[14]. Density is the ratio of liquid soap mass to the water at the same volume and temperature. The use of soap with high density could be corrosive to the skin. The densities of the experimental liquid soaps from Table 1 revealed that lemon unbranded soap had the highest density (0.99±0.01) while the pink unbranded soap had the lowest density (0.41±0.01). Morning fresh branded and Sunlight branded soaps had densities of 0.94±0.01 and 0.96±0.01 respectively.

Table 1: Physicochemical properties of liquid soaps

Sample	pH	Density (g)	Matter insoluble in water (%)	Moisture and volatile content (%)	Inorganic salt (%)
Morning fresh branded	7.05±0.05	0.94±0.01	2.20±0.26	153.86±0.01	170.78±0.90
Sunlight branded	8.31±0.43	0.96±0.01	1.03±0.02	64.20±0.10	93.00±1.00
Pink unbranded	12.26±0.38	0.41±0.01	0.15±0.05	73.00±1.00	95.33±1.17
Lemon unbranded	9.53±0.39	0.99±0.01	1.50±0.10	50.80±0.10	93.33±0.76

Values are Mean±Standard Deviation

Morning fresh liquid soap had the highest moisture and volatile content (153.86±0.01) while lemon liquid soap had the least (50.80±0.10). Sunlight liquid soap had 64.20±0.10 and pink liquid soap had 73.00±1.00. Maintaining optimal moisture levels during the production of soap is critical to achieving the highest quality product. Moisture attributes the existence of liquid especially water, usually in trace extent. The moisture content in soaps has been reported to be a determinant of the shelf life of the soap, it is measured as the amount of free water present in the soap[4]. A high moisture content depicts an increase in solubility of the soap, thereby leading to wastage[28].

Table 1 also revealed that morning fresh had the highest matter insoluble content 2.20±0.26, while pink liquid soap had the least 0.15±0.05 and sunlight had 1.03±0.02. Matter insoluble in water is a measure of the purity of the soap. The higher the level of matter insoluble, the lower the purity of the soap[13]. In view of the above literature, it is suggested that morning fresh liquid soap contains high levels of impurities and these impurities may be attributed to the alkali used for the production of the soap. Hardness could be accounted for by the presence of impurities which contributed to the bulkiness of soap[13].

Morning fresh and sunlight branded soaps had inorganic salt values of 170.78±0.90 and 93.00±1.00, while pink and lemon unbranded soaps had 95.33±1.17 and 93.33±0.76. The highest inorganic salt content was seen in Morning Fresh liquid soap while Sunlight liquid soap had the least content of inorganic salt. The addition of inorganic salts to soap solution with optimum pH, at first increases and decreases the detergent effect, their presence in high quantity could also inhibit the growth of microbes on the skin and irritate the skin[29]. Inorganic salts in liquid soaps also regulate bubbles formed by surfactants or forming agents. The foaming ability of soap has been attributed to minute inorganic salt. High salt in soaps inhibits foam production, which causes difficulty in cleaning due to a lack of friction in the washing process between the hands and the object to be washed. Inorganic salts also act as preservatives in soaps, as well as their ability to adjust pH[15].

This study recommends a further study on the other physical and chemical properties of soap that were not investigated in this study due to limited funds and equipment availability. Also, an increased sample size is recommended for a holistic conclusion.

CONCLUSION

The findings of this study have provided information on some physicochemical properties of liquid soaps in Port Harcourt. It is therefore suggested that the scaling, irritations on the skin and other adverse effects from the use of some liquid soaps can be associated with the pH and inorganic salt content of the soaps, thus a check on the pH and Inorganic salt content of liquid soaps during production is expedient.

SIGNIFICANCE STATEMENT

The adverse effect observed when some liquid soaps are used for laundry has posed a great concern, thus a need to investigate some physical and chemical properties of the soaps as a measure of their quality. The results from the study suggested that the adverse effects including scaling and irritation on the skin from the use of some liquid soaps can be linked with the pH and inorganic salt content, thus a check on the pH of liquid soaps during production is expedient. This study recommends a further study on the other physical and chemical properties of soap that were not investigated in this study due to limited facilities.

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