

Review

A report on soap making in Nigeria using indigenous technology and raw materials

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In everyday life we use soap to wash dishes, clean clothes, or keep our bodies presentable to nose and eye. Soap therefore has numerous applications in our daily life. One of its great values is keeping our household a far better place to live and work. However, contrary to what one may think, soap was invented not only for the purpose of personal hygiene; rather, it was invented to solve other purposes. Colourful yarns were valued very early in the history of textiles; wool as it comes from the sheep is coated with a layer of grease that interferes with the application of dyes, soap was used to solve this problem. This report attempts to explore the technology of soap production in Nigeria using indigenous raw materials.

Key words: Soap, raw materials, technology, chemistry, quality control.

INTRODUCTION

There could be hundred different ways of explaining what really a soap is and what can be regarded as a soap; we can regard it as any cleaning agent, manufactured in bars, granules, flakes, or liquid form, made from a mixture of mostly sodium or potassium salts of various fatty acids of natural oils and fats.

In addition to basic raw materials, other substances of medicinal importance are added as ingredient to produce medicated soaps; there are other types of soap which are soaps of metals other than sodium and potassium called metallic insoluble soaps that are not used as cleaning agents, but are used for other purposes. Examples are, calcium and magnesium soap used as lubricants and driers, aluminum and chromium soaps for sizing paper, lithium stearate (a lithium soap) for thicken oils into grease etc.

In this context, our discussion will be limited to soaps as cleaning agents.

A short history

Throughout history people were known to have taken bath in herb waters and other additions to the bathing medium thought to be beneficial. Cleopatra of Egypt for example used mare's milk, honey and essential oils in her bathing rites.

Historical studies revealed that soap were utilized in both ancient Egypt and Babylonia 5000 years ago. Mixtures of animal fats and alkaline plant ash were used to produce soap (Phanseil, 1998). Ancient peoples were believed to have employed wood ashes and water for washing and to have relieved the resulting irritation with grease or oil. In the first century A.D., Pliny describes a soap of tallow and wood ashes used by Germanic tribes to brighten their hair. It is recorded that Babylonians were making soap around 2800 B.C and it was known to the Phoenicians around 600 B.C. These early references to

Table 1. Fatty acid profiles Shea butter versus competitors.

Oil type	Lauric (12:0)	Myristic (14:0)	Palmitic (16:0)	Stearic (18:0)	Oleic (18:1)	Linoleic (18:2)	Linolenic (18:3)
Cocoa butter			25	35	30 - 40	2 - 4	
Olive			12	2	72	8	1
Palm oil (husk)	44	16	8	3	5	2	
Coconut							
Shea butter							
Literature	0 - 0.5	0 - 1.6	3 - 9	30 - 50	41 - 50	4 - 11	0 - 7.5
Uganda			6.5	26.4	59.3	6.2	0.2
Nigeria			3.2	38.9	47.5	6.5	0.2
Burkina Faso			12.1	42.5	39.3	4.5	0.2
Mali			19	31.1	42.6	5.7	0.2

Source: (Ferris et al., 2001).

soap and soap making were for the use of soap in the cleaning of textiles fibers such as wool and cotton in preparation for weaving into cloth. From the long history of ancient civilizations until today, the basics of soap making has not fundamentally changed, meaning that the basic process has not changed. Hence, blending the old tradition with modern day knowledge of surface active agents, accuracy, combination of good and carefully selected ingredients mixed and stirred at the right temperature and time can with experience produce the finest soaps (Ellis, 2008)

In this work, attempt was made to explore the ways of improving indigenous technology for soap production by the use of available local raw materials.

TECHNOLOGY OF SOAP PRODUCTION UTILIZING INDIGENOUS RAW MATERIALS

Indigenous raw materials

Animal fat

Tallow is one of the principal fatty materials used in soap making. Romans were doing soap made from animal fats and wood ashes 2500 years ago (McGraw-Hill Encyclopedia of Science and Technology, 2007). Soaps made from animal fat contain more of 16- and 18- carbon fatty acids and are generally harder and easy to form into shapes (Robertson, 2006). Tallow oil include, palmitic acid $(\text{CH}_3(\text{CH}_2)_{14}\text{CO}_2\text{H})$, stearic acid $\text{CH}_3(\text{CH}_2)_{16}\text{COOH}$ and oleic acid $(\text{CH}_3(\text{CH}_2)_7\text{CHCH}(\text{CH}_2)_7\text{COOH})$

Shea nut fat

Shea nut solid fat (butter or stearin) is ideal for use in making cosmetics, soap and detergents (Fintrac, 1990).

Shea nut fat is composed principally of triglycerides (triacylglycerols) containing an oleic acid moiety at the 2-position and saturated fatty acids, usually stearic or palmitic acids, at the 1- and 3-positions (Acquaye et al., 2001). Chemical analysis of Shea butter extracted from nuts samples from four African countries (Uganda, Nigeria, Burkina Faso and Mali) were conducted by the Ben Gurion University, Isreal, as part of the ongoing EU funded INCO project on Shea. Fatty acid analysis shows there is a high level of variability in Shea oils across Africa (Table 1). The Ugandan sample had a 59% oleic acid content compared with 47% for Nigeria and only 39% for Burkina Faso (Ferris et al., 2001).

Jatropha seed oil

Oil for soap making is the most profitable use; the fruit of *Jatropha* contain viscous oil that can be used for soap making (Openshaw, 2000). It is rich in palmitic acid, with high levels of hydrophobicity, and makes a soft, durable soap under even the simplest of manufacturing processes (Pratt et al., 2002). High oil content of *Jatropha curcas* indicated that *J. curcas* are suitable as non-edible vegetable oil feedstock in oleochemical industries (biodiesel, fatty acids, soap, fatty nitrogenous derivatives, surfactants and detergents (Akbar et al., 2009).

Castor seed oil

Abitogun et al. (2009) confirmed the presence of ricinoleic acids, oleic acid, palmitic acid, stearic acid and dihydroxylstearic acid; this is an indication of good quality that can be modified so as to be useful in cosmetics. This oil differs from all other commercial oils in being rich in ricinoleic acid (~90%, 12-hydroxyoleic). Compared with

Table 2. Some physical and chemical characteristics of oils extracted from sesame seed grown in Jigawa State, Nigeria* (Mohammed and Hamza, 2008).

S/N	Analysis/physical and chemical characteristics	W	R
1	Colour	White	Red
2	Iodine value (gI ₂ /100 g)	103	116
3	Oil content (%)	48	50
4	Specific gravity (g/cm ³)	0.915	0.923
5	Acid value (mg KOH/g)	0.5	0.45
6	Peroxide value (Meq KOH/g)	8	7.45
7	Saponification value (mg KOH/g)	189	191
8	Cyanide test	Negative	Negative

*The values are mean of three replicates.

the common vegetable oils, castor oil is more viscous, less soluble in hexane, and more soluble in ethanol, all as a consequence of the presence of the hydroxy acid. This hydroxy acid has several interesting properties by which it can be converted to useful products. CH₃(CH₂)₅CHOHCH₂CH=CH(CH₂)₇COOH [ricinoleic acid (12-hydroxyoleic acid)]. Sulfation converts the hydroxyl group to a sulfate (-OSO₂OH) with improved surfactant properties. Apart from soap, it is the earliest anionic surfactant (Gunstone, 2005). One of its uses is in the manufacture of transparent soaps (Kochhar, 1998). The inferior qualities of the oil are frequently employed in India for soap making (Grieve, 2009). In Nigeria, castor bean was cultivated on over 6,000 ha across most of the states. The crop grows in the wild even where it is not cultivated. Benue, Gombe, Yobe, Cross Rivers, Kogi, Ebonyi, Kwara, Zamfara and FCT are the promising producers where the bulk of the hectares are cultivated. The output is estimated at twelve thousand metric tonnes (12,000 mt) (Raw Materials Research and Development Council, 2009).

Neem seed oil

Oil extracted from its seeds composed primarily of triacylglycerols of oleic, stearic, linoleic, and palmitic acids. The seeds yield 40% of a deep yellow oil, the well-known 'Margosa oil' (Girish and Shankara, 2008). Of all other industrial uses in India, neem oil has been a major ingredient in soaps for at least 50 years (National Research Council, 1992). The indigenous neem seed oil is presently obtainable at Saberg International Ltd., producers of proudly Nigerian Naija Neems (Neem oil) at Technology Incubation Centre, Birnin Kebbi, Kebbi State, Nigeria.

Sesame seed oil

Sesame is an important export crop in Nigeria, and

Nigeria has a substantial role in the global sesame trade. Annual exports of sesame from Nigeria are valued at about US\$20 million and Nigeria is the primary supplier of sesame seed to the world's largest importer, Japan (Chemonics International Inc., 2002). The seed has been called "queen of the oil seed crop" because of the high yield of oil and its quality. Apart from its uses in cosmetics and perfume, it is also used for the manufacture of soap (Gandhi and Taimini, 2009). The hot-expressed oil is used chiefly for soap making (Jamieson and Baughman, 1924). The work of Mohammed and Hamza (2008) justified some quality characteristics of Nigerian variety of sesame seed oil (Table 2).

TECHNOLOGY

There are five major steps for soap making process:

- (a) Saponification,
- (b) Soap washing or glycerol extraction,
- (c) Fitting,
- (d) Moulding,
- (e) Drying.

Although in some simple hard soap making, the steps can be classified further into seven main steps:

- (1) Getting the right mixture of oil/fat and alkali, called "proving",
- (2) "Boiling down" – removing the unwanted water, and checking for "doneness",
- (3) Treating with salt to remove water, impurities, and glycerin a process called 'graining' this step makes a good solid soap for washing clothes,
- (4) Adding colouring agents (colourants) and perfumes,
- (5) Pouring into moulds, called "setting",
- (6) Breaking the "green" soap out of the mould and splitting it into finished sizes and,
- (7) Drying and airing the "green" soap.

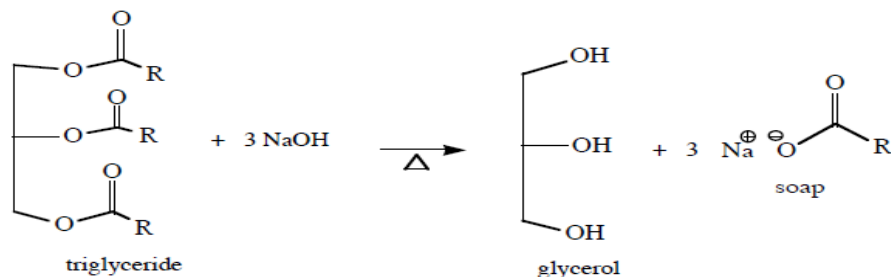


Figure 1. Saponification reaction. R is the long chain of carbon and hydrogen atoms.

Concise chemistry of soap making

Chemical reactions in soap making (that is, saponification)

In saponification reactions, esters are split into alcohols and salts of carboxylic acids (Figure 1). The word “Saponification” is derived from the Latin word “saponins”, meaning ‘soap’ though the word has a wide application, for example, in papermaking, many components of wood pitch may become saponified under alkaline papermaking conditions (Mini-encyclopedia, 2008). Saponification is also widely used in more general terms to refer to alkaline hydrolysis of any type of ester.

The overall reaction of triacylglycerol saponification can be thought of occurring in two steps. The first step is the hydrolysis of the ester linkages to produce glycerol and three fatty acid molecules: Fat or oil + 3H₂O → fatty acids + glycerol. The second step involves a reaction between the fatty acid molecules and base (usually NaOH) in the alkali solution. This is an acid-base reaction that produces water plus salts: 3 fatty acids + 3NaOH → 3 fatty acid salts + 3H₂O

Indigenous technology saponification

Mixing the fat or oil with base (alkali) can be done using a specially designed mixer. Small scale soap makers in Nigeria mostly use manual mixer.

Simple cold-process soap making procedure

For each soap formulation, pour directly 200 g/dm³ NaOH solution into the stainless steel container (pot) containing the fat and oil in the ratio 1:1 (v/v). Warm gently the fats/oil and pour into the stainless steel soap making pot followed by the alkali solution to form an intimate mix and then stir frequently for 10 to 15 min using wooden stirrer. Perfume and other ingredients can be added as additives at the last time before pouring the saponification mixture into moulds. After pouring, the soap is allowed to harden

by air-drying for 24 h to obtain the soap bars, according to the method reported by Warra (2009) and the soap bars can then be observed for colour, texture, lathering and cleaning power.

Moulding and cutting

In this step, melted soap is poured into shaped-mould for it to “set” and harden in. Sometimes, the soap is “broken out” of the mould and “split” down to required sizes with a wire. The soaps are cut using cutting machine which can be made locally into different designs and size.

Stamping

This is the use of special stamp (either electric or manual) and trade marks on the products (soap products). Murjanatu Muhammad Abba illuminated the growing role of stamping in selling products in Nigeria when she wrote “This is very vital in selling products in Nigeria as most Nigerians buy name not the quality of the product” (Abba, 2008). Wooden or plastic, handmade stamp and stamp box or manual stamping machine are used.

Drying

Soap is normally obtained as having moisture content. Drying is required to reduce this water content of the soap to a carefully defined and controlled level, especially for toilet soap bars. Soap at control moisture content will generally produce, after, subsequent processing, a bar of the required appearance. This cannot be achieved until the soap has been aired for hours or up to about 1 month in the case of dry hard soap that takes longer to use up.

Packaging

This is the use of special materials to package products

to the market. The products are finally packed in cartons. Wrapping the soaps into nice paper or clean polythene will add greatly to its sales value. The cost associated with packaging material is an important factor in the cost of production. The cost packaging could be high for consumer products. Therefore, it is always important for a soap producer to estimate his packaging cost in order to represent his operating expenses which have great impact on the selling price and profit or gain.

Safety precautions/hazards

- 1) Wear your gloves and goggles throughout the entire soap making.
- 2) If sodium hydroxide touches the skin, immediately rinse the affected area with running water
- 3) If a spill happens, take care of your skin first; rinse the area with cool water. Then apply vinegar to the area and rinse again.
- 4) Do not attempt to pour vinegar into your eye. Seek medical attention for any sodium hydroxide spill that had entered your eye.
- 5) Avoid contact with hot oils, as they can burn the skin. Consult a professional for assistance.
- 6) Avoid contact with essential and fragrance oils. Wear gloves and goggles while using them.
- 7) Flush the affected area with water.

Safety data and record keeping

Any soap making industry being it large or small scale should have documented information on safety categories and record keeping. The following parameters are some of the important references used.

Material safety data sheet (MSDS)

This is a reference that contains pertinent information related to the following safety categories for specific material: Manufacturer or vendor information, chemical composition, hazards and potential health effects, first aid measures, fire fighting measures, spill measures, handling and storage, exposure and protection, physical and chemical properties stability and reactivity, toxicological information, environmental information, disposal considerations, transportation information, and regulatory information. MSDS are usually available from chemical manufacturer, a commercial source, or a private library developed by the chemical plant.

According to Crawl and Louvar (2002), the industrial hygienist or safety professional must interpret the physical and toxicological properties to determine the hazards associated with a chemical. These properties are also used to develop a strategy for the proper control and

handling of these chemicals.

Workplace safety

Workplace safety means having ingredients properly labeled and stored, maintaining a clean, orderly, well-lit, and well ventilated work area for making soap restricting the access of children and pets to the storage and work areas, having easy access to personal protective equipment: a telephone, a fire extinguisher, and running water.

Complaint file

This is a file that contains a record of a customer complaint, the date of the complaint, and the action taken by the soap maker.

Batch code

This is a numbered record of each batch of soap. The batch code sheet lists the company of manufacture, the name of the soap maker(s), the date made, the ingredients, weight numbers, any variation from the normal soap making procedure, the cure date or "do not use before" date, the expiration date, and any additional comments.

Ways of improving soaps quality

The use of glycerine

The presence of several polar-OH groups makes it strongly attracted to water, a feature that makes glycerine useful as a skin softener in products such as lotions, cosmetics, shaving creams, and liquid soaps.

The use of sequestrants

Many manufacturers use chelating molecules in their commercial soap products, often EDTA derivatives are used which helps to bind with any free calcium or magnesium ions to prevent soap scum (a process called sequestration). These also help to reduce fragrance loss, discolouration and rancidity.

Checking the soap pH

Checking the pH of soap is necessary not only for the purpose of improving soaps quality but to regulate the pH level which shall not contribute to the harshness of hands

and skin. For the purpose of protecting public health, high pH levels in the 9 to 11 range or low in the 3 to 5 level are considered deleterious to the skin. This is in accordance with NAFDAC regulatory requirements on cosmetics, soaps and detergents (Umar, 2002).

The use of silicates

Sodium silicate [$\text{Na}_4(\text{SiO}_4)$] - an example of large family of silicates, (commonly known as 'water glass') is used commercially in detergents, where it maintains a constant pH and can degrade fats by hydrolysis. (Housecroft and Constable, 2006). Sodium metasilicate is a basic salt used in detergent, partly as a basic buffer and partly to keep dirt from settling back on to the fabric (Jones and Alkins, 2002). The SiO_3^{2-} ions are attached to dirt particles, giving the particles a negative charge and thereby preventing them from merging with others into larger, insoluble particles.

Perfuming and colouring

When the soap is melted for the last time before being poured out into moulds, it can be coloured and perfumed. It is best not to do this any earlier in the method, as the lye water could hurt the perfume or colouring. If you have perfumes or colouring, try them out on small amounts of soap.

Chemical analysis of fats and oils

To determine the industrial value of a particular oil or fat which is dependent on composition and purity, a number of chemical tests are carried out to have quality control over fats and oils used as raw materials for the production of soaps. Parameters: (1) saponification value (2) and iodine value (3) acid value

CONCLUSION

Soap production can be regarded as one area of business that is lucrative and needs only little capital to start with, and considering the vast available resources in Nigeria there is need to design and develop strategy on war footing in order to explore and utilize full benefits of these raw materials using the available indigenous technology.

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