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Characterization of Fatty Acid Used In Soap Manufacturing In Nigeria: Laundry, Toilet, Medicated and Antiseptic Soap

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Abstract: *This study characterized the fatty acids in Nigeria made soap ranging from medicated, antiseptic, toilet and laundry soaps. Each sample after preparation was analyzed in a gas chromatography to obtain the chromatogram. The fatty acid distribution in Delta soap showed that palmitic acid (c_{16}) has the highest percentage of 40.48 % approximate followed by oleic acid ($c_{18.1}$), 34.35 % approximate. In Temosol, oleic acid has the highest percentage of 39.35 % approximate and next to it was palmitic acid, 29.11 % approximate.Carex antiseptic soap also contain c18.1 and c16 as the dominant fatty acid with percentage of 36.06 % and 29.96 % approximate respectively. The dominant fatty acids in Jumbo tab and Truck bar (laundry) are c18.1 and c16.Jumbo tab contains 43.47 % c16and 36.20 % c18.1 approximate. While Truck bar contains 43.89 %and 31.73 % approximate of oleic and palmitic acids respectively.Lux and Joy soap also contain comparable fatty acids. In Lux, oleic acid is 41.51 %, palmitic acid is 26.70 % approximate. In Joy, oleic acid is 40.60 %and palmitic acid 24.99 %approximate. Other fatty acids present in the soap sample were shown. Eleven different fatty acids were found in the soap analyzed. They are capric, caprylic, lauric, myristic, myristoleic, palmitic, plamitoleic, stearic, oleic, linoleic and linolenic acids.*

Keywords: *Characterization, fatty acids, fats and oil, soap, chromatography*

I. Introduction

Fatty acids are merely carboxylic acids with long hydrocarbon chains. The hydrocarbon chains length may vary from 10-30 carbons (mostly12-18). The non-polar hydrocarbon alkane chain is an important counterbalance to the polar acid functional group. In acids with only a few carbons, the acid functional group dominates and gives the whole molecule a polar character. However, in fatty acids, the non-polar hydrocarbon chain gives the molecule a non-polar character.

There are two groups of fatty acids: the saturated and the unsaturated. Beef fat contains mainly the saturated fatty acid while olive oil contains the unsaturatedfattyacids.

Soap is a function of acids and fatty acids are functions of fats and oil. In the simplest sense, oils that are solid at room temperature are hard whereas those that are liquid at room temperature are soft. The degree of hardness and softness differs according to their sources and other parameters. Oils that are hard contributes to hardness and/or lather in soap. Oils that are soft contribute to conditioning. Oils are made up mainly of a variety of fatty acids. The main conditioning fatty acids are oleic (1 unsaturated bonds), linoleic (2 unsaturated bonds) and linolenic (3 unsaturated bonds). The more unsaturated bonds, the better the conditioning and the more easily it is absorbed by the skin, but the softer the oil is in soap, the more prone to oxidation. Making soap therefore means choosing a combination of oils with different degrees of hard/soft, conditioning and leather, to get the particular product that fits you best. www.soap-making-resource.com/fatty-acids.The aim of this project is to extract and characterize the fatty acid in the finished soaps, thereby identifying their sources; evaluation of fats/oils used in soap manufacturing. Evaluation of blending of fats/oils in soap making, and possible reasons why that blend was adopted. Another objective of this work is to determine the properties of the fatty acids by running a gas chromatography which will reveal their chain length and based on their chain length, the source could be traced.

Fats and oil as well as their blends are used in the manufacturing of soaps in Nigeria. These fats are of vegetable or animal origin. Their use in soap manufacturing is determined by: Cost, Availability; Easy of handle; Government Policy and functioning of the fatty acids in soap. Therefore, this project becomes important in the sense that the fats/oils, the precursor of fatty acids should be carefully studied so as to know their cost relative to the manufacture, the sources of the soap menu in terms of the fatty acids will be ascertained and the sources that are readily available should be recommended. The functioning of the fatty acids in soap will also be determined by carefully studying their characteristics and properties. By knowing their properties, the handling of the fatty acids and the soap in general in terms of storage, packing, transportation etc will be overcome.

According to Roman Legend, soap was named after mount Sapo, and ancient site of animal sacrifices. After an animal sacrifices, rain would wash the animal fat and ash that collected under the ceremonial alters down the slopes to the banks of the Tiber River. Women washing clothes in the river noticed that if they washed their clothes in certain parts of the river after a heavy rain their clothes were much cleaner (Ahmed) [2]. A soap-like material found in clay cylinders during the excavation of ancient Babylon is evidence that soap making was known as early as 2800 B.C .Inscriptions on the cylinders revealed that fats were boiled with ashes, a soap making method. It is generally agreed that the Hebrew word “borith” which has been translated as soap, is a generic term for any cleaning agent. By the second century A.D, the Greek physician, Galen, recommended soap for both medicinal and cleansing purposes. In other words, it is a substance, that when dissolved in water removed dirt from dirty materials. Scientifically, soap is one of the higher fatty acid or a mixture of such compound. A typical soap contains 80%

mixed oils and 20% coconut oil with about > 0.2% free alkali.

Soaps are water-soluble sodium or potassium salts of fatty acids. Soaps are made from fats and oils or their fatty acids, by treating them chemically with a strong alkali. The fats and oils used in soap making come form animal 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 glycerine. There are many types of triglyceride each type consist of its own particular combination of fatty acids. The fatty acids are the components of fats and oils that are used in making soap.

An alkali is a soluble salt of an alkali metal like sodium or potassium, originally, the alkalis used in soap making where obtained from the ashes of plants, but they are now made commercially. The common alkalis used in soap making are sodium hydroxide (NaOH), also called caustic soda' and potassium hydroxide (KOH),(Kuye and Okorie) [4].Saponification of fats and oils is the most widely used soap making process, the process involves heating fats and oils and reacting them with a liquid alkali to produce soap and water (neat soap) plus glycerine. Fats and oils are hydrolyzed (split) with a high pressure steam to yield crude fatty acids and glycerine. The fatty acids are then purified by distillation and neutralized with an alkali to produce soap and water (neat soap). When the alkali is sodium hydroxides sodium soap is formed. Sodium soaps are "hard" soaps. When the alkali is potassium hydroxide, potassium soap is formed. Potassium soaps are softer and are found in some liquid hand soaps and shaving creams. The carbonxylate end of the soap molecule is attracted to water. It is called the hydrophilic (water-loving) end. The hydrocarbon chain is attracted to oil and grease and repelled by water. It is known as the hydrophobic (water-hating) end. (www.sdchg. org/cleaning/chemistry/) [5].

In soap making the properties of the fats and oils are important; the fatty acid composition in oil determines its properties (Nwoko) [6]. The acids may be distributed at random in the triglycerides. In the soap making, it's the fatty acid content that matters the most. The chain length (C number) is usually cited and helps describes the molecule's properties in relation to others in its same series. Saturated fatty acids contain no double bonds. They are stiff molecules which tend to increase the melting point of oils. Saturated fatty acids themselves are solids at room temperature. As they increase in size from lauric to stearic, the melting point of the oil increases. Saturated fatty acids in soap have good cleaning properties and support foam. The longer chains also tend to harden soap. Unsaturated fatty acids are liquids. They tend to have good cleaning power, but lather poorly. These fatty acids also tend to make milder soaps (www.soap-making-resource.com/fatty-acids) [7]

II. Experimental

Apparatus/Reagents

The materials used include methanol, round bottom flask, Condenser, Electro-thermal heater, methanolic HCL; N-heptane; brine,sygrines and Gas Chromatography. Four samples of soap: Laundry soap (Jumbo tab and Truck bar), Toilet soap (joy and lux); Medicated soap (Delta and Tetmosol); Antiseptic soap (Carex)

Procedure

0.8 g of each samples was weighed into the round bottom flask, 12 ml of methanol was added and the flask was connected to a condenser and heat applied with the help of electro thermal heater. The setup was allowed to reflux for 30 mins and 2 ml of methnolic HCl (prepared in the ratio 4:1) is added and the sample was allowed to reflux for another 30 min. At this point, the heater was turned off for 3 min in order to allow the sample to cool. 10 and 20 ml of N-heptane and brine were added respectively. The bottom portion (non-volatile) portion of the sample was run off with the help of separating funnel. Finally, the separated volatile portion was transferred into a test tube where 0.5µl was injected into the gas chromatography.

In the chromatography, the carrier gas, nitrogen, carries the sample into the packed column, made of the stationary phase where the fatty acids were adsorbed accordingly. As the sample was continuously introduced, the weakly adsorbed fatty acids was detected by the detector, amplified by the amplifier and was recorded by the recorder. The procedure was repeated for other samples.

III. Results and Discussion

The results obtained are presented in the following Tables.

Table 1: Retention Time, Peak Area and Fatty acid in Medicated Soap (Delta)

Ret Time (min)	Type	Width (min)	Area (pA*s)	Area %	Name
1.635	MM	0.1724	3079.05894	0.54880	C8 (caprylic)
2.955	MM	0.2327	2402.12915	0.42815	C10 (Capric)
4.965	MM	0.3376	5.20290e4	9.27343	C12 (Lauric)
7.445	MM	0.3527	2.18125e4	3.88778	C14 (Myristic)
10.174	MM	0.3879	2.27123e5	40.48154	C16 (Palmitic)
13.890	MM	0.4423	1.43764e4	2.56238	C18 (Oleic)
15.073	MM	0.6506	1.96110e5	34.95381	C18:1 (Linoleic)
17.409	MM	0.7507	4.41220e4	7.86412	C18:2 (Linolenic)

Table 2: Retention Time, Peak Area and Fatty acid in Medicated Soap (Tetmosol)

Ret Time	Type	Width (min)	Area (pA*s)	Area %	Name
1.518	BP	0.2027	2032.75427	0.56782	C8(Caprylic)
2.776	VP	0.2260	1216.58179	0.33984	C10 (Capric)

3.676	VP	0.1329	38.13793	0.10165	?
4.726	MM	0.2704	1.54146e4	4.30587	C12 (Lauric)
7.170	MM	0.3235	1.78511e4	4.98648	C14 (Myristic)
9.826	MM	0.3464	1.04202e5	29.10741	C16 (Palmitic)
10.626	MM	0.3416	6391.75098	1.78545	C16:1 (Palmitoleic)
13.431	MM	0.4472	5.60052e4	15.64434	C18 (Stearic)
14.462	MM	0.6038	1.40859e5	39.34707	C18:1 (Oleic)
16.661	MM	0.7227	1.33802e4	3.73759	C18:2 (Linoleic)
19.19.4	BV	0.6098	599.57849	0.16748	C18:3 (Linolenic)

Table 3: Retention Time, Peak Area and Fatty acid in Antiseptic Soap (Carex)

Ret Time	Type	Width (min)	Area (pA*s)	Area %	Name
4.540	MM	0.4914	5.20886e4	12.20891	C12 (Lauric)
7.270	MM	0.4619	1.42345e4	3.33638	C14 (Myristic)
8.255	MM	0.2966	1208.89429	0.28335	C14:1 (Myristoleic)
10.104	MM	0.4209	1.15023e5	26.96005	C16 (Palmitic)
11.029	MM	0.3563	4569.29883	1.07099	C16:1 (Palmitoleic)
13.972	MM	0.4980	7.30369e4	17.11892	C18 (Stearic)
15.102	MM	0.6530	1.53843e5	36.05897	C18:1 (Oleic)
17.453	MM	0.7658	1.26391e4	2.96244	C18:2 (Linoleic)

Table 4: Retention Time, Peak Area and Fatty acid in Toilet Soap (Joy)

Ret Time	Type	Width (min)	Area (pA*s)	Area %	Name
4.674	MM	0.4323	4.25007e4	10.97616	C12 (Lauric)
4.674	BV	0.0269	3052.90454	0.78844	?
7.338	MM	0.4027	1.09988e4	2.84053	C14 (Myristic)
8.293	MM	0.2080	1443.69824	0.37285	C14:1 (Myristoleic)
10.116	MM	0.3972	9.67820e4	24.99474	C16 (Palmitic)
11.022	MM	0.3640	6071.27441	1.56796	C16:1 (Palmitoleic)
13.934	MM	0.4838	5.18703e4	13.39599e5	C18 (Stearic)
15.081	MM	0.6661	1.57199e5	40.59795	C18:1 (Oleic)
17.444	MM	0.7441	1.72907e4	4.46547	C18:2 (Linoleic)

Table 5: Retention Time, Peak Area and Fatty acid in Toilet Soap (Lux)

Ret Time	Type	Width (min)	Area (pA*s)	Area %	Name
1.442	BV	0.0890	1002.72699	0.22181	C8 (Caprylic)
2.703	PV	0.2553	2627.35010	0.58118	C10 (Capric)
3.636	VP	0.2410	106.2824	0.02351	?
4.776	MM	0.3401	3.28632e4	7.26953	C12 (Lauric)
7.355	MM	0.3321	2.28118e4	5.04610	C14 (Myristic)
10.104	MM	0.3635	1.20686e5	26.69649	C16 (Palmitic)
11.000	MM	0.3544	7695.71240	1.70233	C16:1 (Palmitoleic)
13.949	MM	0.4557	5.45182e4	12.05973	C18 (Stearic)
15.073	MM	0.6553	1.87653e5	41.50984	C18:1 (Oleic)
17.409	MM	0.7420	2.21038e4	4.88949	C18:2 (Linoleic)

Table 6: Retention Time, Peak Area and Fatty acid in Laundry Soap (Jumbo tab)

Ret Time	Type	Width (min)	Area (pA*s)	Area %	Name
1.630	BP	0.1466	619.59766	0.14643	C8 (Caprylic)
2.963	VP	0.2115	698.89987	0.11790	C10 (Capric)
3.865	VP	0.3242	200.86070	0.04747	?
4.986	VV	0.2879	7676.72266	1.81419	C12 (Lauric)
7.466	MM	0.3051	7319.01074	1.72965	C14 (Myristic)
8.781	MM	0.3919	1418.19214	0.33515	?
10.194	MM	0.3601	1.92407e5	45.47033	C16 (Palmitic)
11.091	MM	0.2173	474.09613	0.11204	C16:1 (Palmitoleic)
13.934	MM	0.4484	2.23890e4	5.29105	C18 (Stearic)

15.102	MM	0.6358	1.53160e5	36.19526	C18:1 (Oleic)
17.470	MM	0.7263	3.69854e4	8.74052	C18:2 (Linoleic)

Table 7: Retention Time, Peak Area and Fatty acid Laundry Soap (Truck bar)

Ret Time	Type	Width (min)	Area (pA*s)	Area %	Name
5.002	MM	0.2630	595.93256	0.14011	C12 (Lauric)
7.455	MM	0.3176	1.68864e4	3.97016	C14 (Myristic)
8.416	MM	0.2105	1184.1386	0.27840	C14:1 (Myristoleic)
10.163	MM	0.3599	1.34951e5	31.72821	C16 (Palmitic)
11.056	MM	0.3465	9230.44727	2.17017	C16:1 (Palmitoleic)
14.027	MM	0.4776	6.57836e4	15.46635	C18 (Stearic)
15.142	MM	0.6525	1.86689e5	43.89235	C18:1 (Oleic)
17.465	MM	0.7245	1.00135e4	2.35427	C18:2 (Linoleic)

Table 8: Fatty acid distribution in different soap

Soaps	Type	Lauric	Palmitic	Stearic	Oleic
Joy	Toilet	10.98	24.99	13.40	40.60
Lux	Toilet	7.27	26.70	12.06	41.51
Jumbo tab	Laundry	1.81	45.47	5.29	36.20
Truck bar	Laundry	0.14	31.73	15.47	43.89
Delta	Medicated	9.27	40.48	2.56	34.95
Tetmosol	Medicated	4.31	29.11	15.64	39.35
Carex	Antiseptic	12.21	26.96	17.12	36.06

Delta and tetmosol soap after the analysis yielded the result shown in Tables 1 and 2. From the result, it was seen that both of them had C_8-$C_{18:2}$ in common but tetmosol had in addition $C_{16:1}$ and $C_{18:3}$.It was also shown by analysis that the major fatty acids has the highest peak in the chromatogram as shown in Figures 1 and 2 respectively. Of the two soaps, the major fatty acids, oleic and palmitic acid in tetmosol was traced to tallow and palm kernel oil (PKO). Whereas that of Delta soap, was traced to palm oil and palm kernel oil. These fatty acids gave the soaps its characteristics. Hence, delta soap is more active than tetmosol. Their values are for tetmosol palmitic ($C_{16,}$ 29.11%), oleic ($C_{18:1}$, 39.35%) it also contains the following fatty acids in lesser amounts; caprylic acid (C8, 0.57%), capric acid (C10, 0.34%), lauric acid (C12, 4.31%), myristic (C14, 4.99%), palmitoleic (C16:1, 1.79%), stearic acid (C18, 15.64%), linoleic (C18:2, 3.74%), linolenic (C18:3, 0.17%), whereas for delta soap, palmitic, 40.48% and oleic, 34.95% dominates, while caprylic (C8, 0.55%), capric (C10, 0.43%), lauric acid (C12,9.27%), myristic acid (C14, 3.89%), palmitic acid (C16, 40.48%), oleic acid (C18, 2.56%), linoleic acid (C18:1, 34.95%), linolenic acid (C18:2, 7.86%) are in lesser quantity.

It was found from the chromatogram that carex soap contain 12.21% lauric acid, 26.96% palmitic acid, 17.12% stearic acid, 36.06% oleic acid and 2.96% linoleic acid. Myristic (C14, 3.34%), myristoleic (C14:1, 0.28%), palmitoleic (C16:1, 1.07%) in lesser amount (Table 3). These fatty acids were mainly from tallow.

The fatty acids present in Joy and Lux soap were shown in Tables 4 and 5 respectively. It was seen that Joy soap contains 10.98% lauric acid, 24.995% palmitic acid, 13.4% stearic acid and 40.60 % oleic acid. The lesser quantities are myristic (C14, 2.84%), myristoleic (C14:1, 0.37%), plamitoleic (C16:1, 1.57% and linoleic (C18:2, 4.47%).While in Lux,the fatty acids found include 7.3% lauric, 26.70% palmitic, 12.06% stearic and 41.51% oleic acid, others are in lesser quantities caprylic (C8. 0.22%), capric (C10. 0.58%), myristic (C14, 5.05%, palmitoleic (C16:1, 1.70%) linoleic (C18:2, 4.89%).The Joy fatty acids were mainly from tallow and palm oil while that of Lux was form tallow and PKO. From the analysis, it was clear that there was no much difference between Joy and Lux soap except myristoleic acid present in Joy alone and caprylic and capric present only in Lux. They share similar properties in their cleansing activities.

The analysis of Jumbo and Truck bar soaps were tabulated in Table 6 and 7 respectively. The result showed that palmitic acid present in Jumbo soap is 45.47% and oleic acid 36.20% and others caprylic (C8 0.15%), capric (C10, 0.12%), Lauric (C12, 1.81%), myristic (C14, 1.73%), palmitoleic (C16:1, 0.11%), stearic (C18,5. 29%) and linoleic (C18:2, 8.74%) in minor quantities, whereas in Truck bar soap, it is 31.73% palmitic acid, 43.89% oleic acid and 15.47% stearic acid, it also contain the following fatty acids in lesser quantities, lauric acid (C12, 0.14%), myristic (14, 3.97%), myristoleic (C14:1, 0.28%), palmitoleic (C16:1, 2.17%), linoleic (C18:2, 2.35%). The major source of the Jumbo tab fatty acid is tallow while that of truck bar is tallow and PKO.

It was obvious from the analysis that, every soap whether medicated, antiseptic, toilet, and laundry is a function of palmitic and oleic acid. The soap samples analysed also had fatty acids with carbon atoms in the neighborhood of C_8, C_{10}, C_{12}, and C14 in very little quantities. Although the soaps analyzed had palmitic and oleic acids as their major fatty acid, they were in different percentage composition as shown in Table 8.

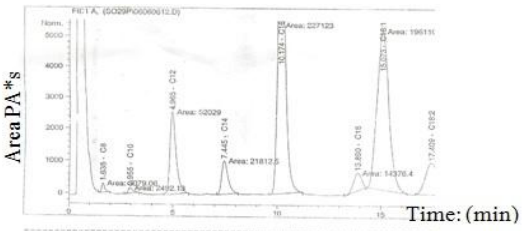

Figure 1: Determination of fatty acid in Delta Soap

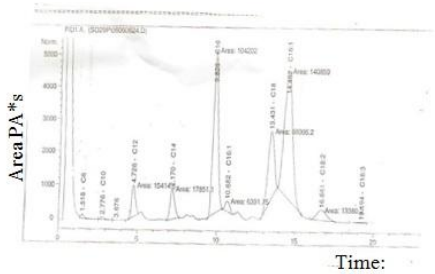

Figure 2: Determination of fatty acid in Tetmosol

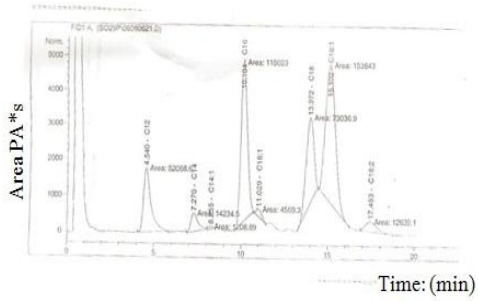

Figure 3: Determination of fatty acid in Carex Soap

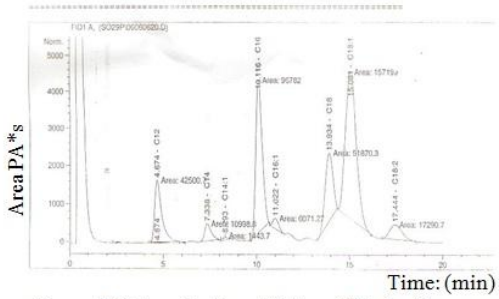

Figure 4: Determination of fatty acid in Joy Soap

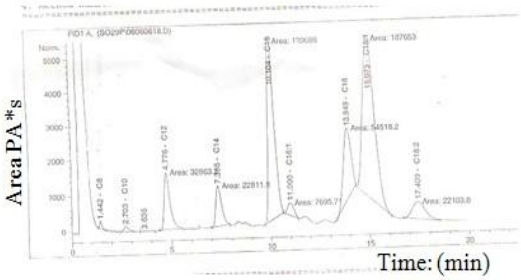

Figure 5: Determination of fatty acid in Lux Soap

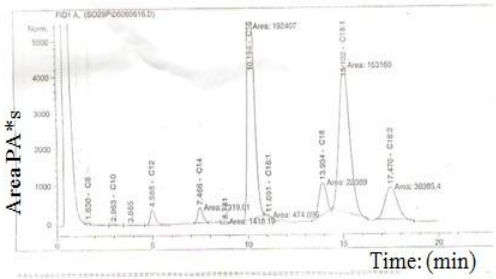

Figure 6: Determination of fatty acid in Jumbo Soap

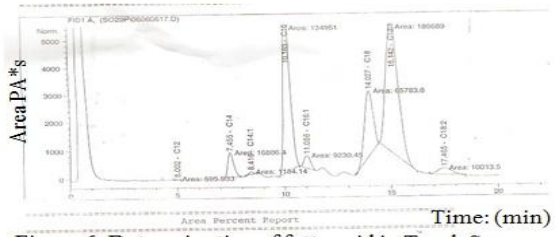

Figure 6: Determination of fatty acid in Truck Soap

IV. Conclusion

The chief fatty acids in soap making are lauric acid, myristic acid, palmitic acid, stearic acid oleic. They are obtained from mutton, tallow, beef tallow (animal fats), palm oil, and palm kernel oil. Joy, Lux, Delta and Carex soap have more percentage of lauric acid. Lauric acid is saturated fatty acids whose single bond helps in soap hardening. It also has good cleansing agent and supports foaming. The percentage of plamitoleic acid is between 0.00-2.20 percent. This acid is unsaturated. It makes soap to be mild, have good cleaning power but foams poorly. It was seen that palmitic acid can be saturated and unsaturated fatty acids, the C_{16} and $C_{16:1}$ respectively. Stearic acid i.e. the C_{18} has three members the oleic acid $C_{18:1}$, the linoleic acid $C_{18:2}$ and the linolenic acid $C_{18:3}$. The stearic itself is a saturated fatty acid while the other three are unsaturated fatty acids. They help increase mildness in soap.

Regerences

[1]. www.elmhurst.edu/..../SS1fattyacids.html.
[2]. Ahmed, Y. I. (2002) Extract of Saponin for Development of soap. Unpublished Thesis submitted to Chemical Engineering Department, Federal University of Technology, Minna, Nigeria, pp. 48.
[3]. www.chgrinvalleysoapandcraft.com/.
[4]. Kuye A. O. and Okorie C (1990) Factors Affecting the Lixiviation of Palm Bunch Ash as Source of Alkali for Soap Production Ife Journal of Technology 3(2):33-37.
[5]. www.sdchg.org/cleaning/chemistry.
[6]. Nwoko V.O. (1982) Effects of Mixing Oils on the Preparation and Properties of Soap. Private Communications.
[7]. www.soap-making-resource.com/fatty-acids...