International Journal of Modern Chemistry, 2012, 3(2): 98-107

Modern Scientific Press

International Journal of Modern Chemistry **ISSN: 2165-0128**

Journal homepage: www.ModernScientificPress.com/Journals/IJMChem.aspx *Florida, USA*

Article

Physicochemical, Cold Saponification and GC-MS Analysis of Sponge Gourd (*Luffa cylindraca* Linn.) Seed Oil

M.K. Gafar [1], A.U. Itodo [2,] *, A.A. Warra [3], G. Wyasu[1], J. Usman [4]

[1] *Department of Chemistry, Federal University Dustin–Ma, Kastina State, Nigeria*
[2] *Department of Chemical Sciences, Federal University, Wukari, Nigeria*
[3] *Department of Biochemistry, Kebbi State University of Science and Technology, Aliero, Nigeria*
[4] *Department of Pure and Applied Chemistry, Kebbi State University of Science and Technology, Aliero, Nigeria*

* Author to whom correspondence should be addressed; E-Mail: itodoson2002@gmail.com.

Article history: Received 10 November 2012, Received in revised form 16 December 2012, Accepted 17 December 2012, Published 18 December 2012.

Abstract: The sponge gourd *Luffa cylindrica* (Linn.) seed oil was extracted from powdered sample of the seeds using Soxhlet extraction method with n-hexane as the solvent. The powdered seeds gave 31.23% oil yield with density of 1.18 g/cm^3. The oil is blackish in colour with pungent smell. Chemical analysis of the oil revealed saponification value of 112 ± 0.27 mg KOH/g, acid value of 2.34 ± 0.19 mg KOH/g and iodine value of 30.33 ± 2.40 g/100 g. The GC-MS analysis of the oil showed the presence of stearic acid, palmitic acid and cis-9-cis-12-linoleic acid with an unsaturated aldehyde, cis-13-octadecenal. The oil was used to produce a brown colour soap which is slightly soluble in water with a soft texture. The solution of the soap has pH value of 12.00 and a measured soap height of 4.10 cm. The pH can be easily adjusted and made fit for usage.

Keywords: *Luffa cylindraca* Linn; sponge gourd; seed oil; chemical analysis; GC-MS; saponification.

1. Introduction

Sponge gourd *Luffa cylindrica* (Linn.) belongs to the family of *Cucurbitaceae*. It is commonly called *Torai* in Hindi & Urdu, *Ghosali* in Marathi, *Jhinga* in Bengali, *Janhi* in Oriya, *Heeray kayi* in

Kannada, *Peechinga* in Malayalam, and *Pirkanga* in Tamil [1]. *Luffa cylindrica* (Linn.) is originated from India and spread across China, Korea, Japan and Central America which are major commercial producers [2]. It is found as wild in wasteland especially along the coastal area in Africa and Asia. In Nigeria, *Luffa cylindrica* plant grows in the wild and abandoned building structures and fences walls in towns and villages [3]. It is a popular vegetable in most countries in Africa, Asia and even in Arab countries and usually cultivated throughout these countries [4]. The plant is a large climbing, hairy with a smooth vine reaching a length of 5 or more meters. Stems are four-angled. Leaves are rounded-ovate to kidney-shaped, 10-20 cm wide, shallowly 5- to 7-angled or lobed, with pointed tips and heart-shaped bases. Fruit is oblong, cylindric, smooth and green, up to 20 cm long and 5 cm wide with a white sweet fibrous pulp inside. Seeds are black, smooth or slightly tubercle and about 1 cm long. When the fruit becomes old and dry the endocarp becomes a persistent fibrous vascular network which is used in various ways [5]. All species of ridge gourd or loofah are edible and usually consumed before they mature, or else they will be too woody and fibrous to eat [6].

One of the major used of sponge gourd is its usage as sponge for washing and scrubbing utensils as well as in bathing. It is also used for the manufacture of hats, insoles of shoes, car-wipers, pot-holders, table-mats, door and bath-mats, sandals and gloves. The fiber has been used for shock and sound absorbing properties, for instance in helmets and armored vehicles, and used as a filter in engines and also to filter water and palm wine [2]. The roasted seeds are edible and contain edible oil. The oil has been used in the United States in soap manufacture. The bitter and toxic seedcake is unsuitable as feed for cattle, but can be used as fertilizer given that it is rich in nitrogen and phosphorus [7].

In traditional African medicine pulp of the whole plant is used as a suppository against constipation. The seeds are credited with emollient and anthelminthic properties. They are also emetic and cathartic. The seeds have been reported to posses both medicinal and nutritional properties, having laxative properties and it is also used in the treatment of asthma, sunicitis fever. It contains dietary iron and low in fat and calories [6]. Over half of the *Luffa cylindrica* seed is oil. The extracts from the seed and the oil possess good anti inflammatory, bronchodilator and antimicrobial activity. The oil is considered as an excellent lubricant and externally used for shingles and boils, leprosy and skin diseases. The kernel of the seed is an expectorant and used in dysentery [8]. In cosmetics, *Luffa cylindrica* seed oil is used in sunscreens, sunless tanning products, anti-aging products, facial moisturizers and treatments, body oils and facial cleansers because of its antifungal, anti-inflammatory and anti-tumor properties since its prevent synthesis of certain proteins and also considered as toxic to skin cancer cells [9]. Luffa sponge is fast becoming an indispensable crop because of its very wide

industrial applications and many medicinal properties [8], for these reasons physicochemical characteristic and soap production from its seed oil is worthwhile.

2. Materials and Methods

2.1. Sampling and Sample Treatment

A mature sponge gourd fruit sample was collected from Argugun town, Kebbi State, Nigeria, and it was authenticated by Dr. Dharmemdra Singh of the Botany unit Biological Department, Kebbi State University of Science and Technology, Aliero. The fruit was cut into two and the seeds were scoop out, wash with distilled water. The seeds were allow to dry and the epicarp was removed and dried under the sun for two days. The seeds were pulverized with the aid of a grounding machine and stored in a plastic container for further use. All reagents were of analytical reagent grade unless otherwise stated. Distilled water was used in the preparation of solutions and dilution unless otherwise stated. The physicochemical analyses were carried out in triplicates unless otherwise stated.

2.2. Oil Extraction

Extraction of oils from seeds is carried out using Soxhlet extraction apparatus. A 70 g of the powdered seed sample was put into a porous thimble and placed in a Soxhlet extraction apparatus, using 150 cm^3 of n-hexane (with boiling point of 40 - 60 ^oC) as extracting solvent for 6 h. The oil was obtained after the solvent was removed under reduced temperature and pressure and refluxing at 70 ^oC to remove excess solvent from the extracted oil. The oil was then stored in freezer at -2 ^oC for subsequent physicochemical analyses [10].

2.3. Determination of Percentage Yield

The oil gotten after the extraction was transferred into a measuring cylinder which was placed over water bath for 30 min at 70 ^oC so as to ensure complete evaporation of solvent and volume of the oil was recorded and expressed as oil content (%) [11].

$$\text{Oil content (\%)} = \frac{\text{Weight of oil}}{\text{Weight of sample}} \times 100\% \qquad (1)$$

2.4. Determination of Specific Density of the Oil

The 10 cm^3 of the oil was measured in a pre-weighed measuring cylinder. The weight of the cylinder and oil were measured, the weight of the oil was then obtained by subtracting the weight of

the cylinder from the weight of the oil and cylinder. The specific density of oil was obtained using equations below [12]:

$$\text{Density of oil} = \frac{W_1 - W_0}{V_0} \qquad (2)$$

Where W_1 = weight of empty measuring cylinder + oil, W_0 = weight of measuring cylinder, V_0 = volume of oil used.

2.5. Determination of Saponification Value

A 2 g of the oil sample was added to a flask with 30 cm^3 of ethanolic KOH and the flask was then attached to a condenser for 30 min to ensure the sample was fully dissolved. After sample had cooled, 1 cm^3 of phenolphthalein was added and titrated with 0.2 M HCl until a pink endpoint has reached. The same analysis was performed using blank. Blank was also prepared using the same reagents as the sample without the oil in it [13]. Saponification value was calculated from the equation below:

$$SV = \frac{(S\text{-}B) \times M \times 56.1}{\text{Sample weight (g)}} \qquad (3)$$

Where S = sample titre value, B = blank titre value, M = molarity of the HCl, 56.1 = molecular weight of KOH.

2.6. Determination of Acid Value

A 100 cm^3 of neutral ethyl alcohol was heated with 10 g of oil sample in a 250 cm^3 beaker until the mixture began to boil. The heat was removed and was titrated with 0.1 M KOH solution, using two drops of phenolphthalein as indicator with consistent shaking for which a permanent pink colour was obtained at the end point [14,15]. The acid value was calculated using the expression:

$$A.V. = \frac{M \times C \times TV}{W} \qquad (4)$$

Where M = molar mass of KOH (56.1), C = concentration of KOH (0.1 M), TV = titre value, W = weight of oil sample (10 g).

2.7. Determination of Iodine Value

A 0.50 g of the oil was dissolved in 15 mL carbon tetra chloride in 100 mL conical flask. A 5 mL of Wijs iodine solution was added to the flask and allowed to stand for 2 h in the dark at 25 ^oC. A 5 mL of potassium iodide (KI) solution was added and the mixture titrated with 0.1 M sodium

thiosulphate using starch indicator. A blank determination was carried out and the iodine value was calculated using the formula below [16]:

$$\text{Iodine value} = \frac{12.69 \times C(V_1\text{-}V_2)}{W} \quad (5)$$

Where C = concentration of sodium thiosulphate, V_1 = volume (mL) of sodium thiosulphate solution used in blank, V_2 = volume (in mL) of sodium thiosulphate solution used in the determination, W = weight of the sample (0.50 g).

2.8. GC-MS Analysis of the Oil

For the analysis of the fatty acids in the oil sample a Shimadzu QP2010 plus series gas chromatography coupled with mass spectroscopy detector (GC-MS) system was used. The temperature programmed was set up from 70 ^{o}C to 280 ^{o}C. Helium gas was used as carrier gas. The injection volume was 2 µL with injection temperature of 250 ^{o}C and a column flow of 1.80 mL/min for the GC. For the mass spectroscopy ACQ mode scanner with scan range of 30 - 700 amu at the speed of 1478 was used. The mass spectra were compared with the NIST05 mass spectral library [17].

2.9. Saponification Procedure

For each soap formulation 70 cm^3 of 170 g/dm^3 alkali solution were poured directly into the beaker containing the oil in the ratio 1:1 (v/v). The oil was warmed gently and poured into the beaker followed by the alkali solution to form an intimate mix and then stirred frequently for 10 - 15 min using stirring rod. The saponification mixture was then poured into moulds and allowed to dry and get harden and formed soap bars [14].

2.10. pH Determination

The pH was determined using pH meter (827PH Metronm Model). A 10 g of the soap shaving were weighed and dissolved in distilled water in a 100 mL volumetric flask. The electrode of the pH meter was inserted into the solution of the soap and the pH reading was recorded [14].

2.11. Foam Ability Test

A 2 g of the soap (shaving) was added to a 500 cm^3 measuring cylinder containing 100 cm^3 of distilled water. The mixture was shaken vigorously so as to generate foams. After shaking for 2 min, the cylinder was allowed to stand for 10 min. The height of the foam in the solution was measured and recorded [14].

3. Results and Discussion

The following results on the physicochemical characteristics of sponge gourd *Luffa cylindrica* are presented in the Tables 1-3 and Figs. 1-4.

From Table 1, the percentage oil yield (31.23%) is lower than 48% as reported for *J. curcas* seed oil [14] and 44.8 ± 1.62% of dehulled seed oil but higher than the 25.7 ± 0.70% for whole seed oil of *Luffa aegyptiaca* [18] and 22.5% of garlic (*Allium sativum* L.) oil [19]. The specific density of the oil is 1.18 g/cm^3, which is higher than 0.90 g/cm^3 presented for garlic (*Allium sativum* L.) oil [19], 0.93 ± 0.14 g/mL and 0.92 ± 0.10 g/mL for dehulled and whole seed oil respectively of *Luffa aegyptiaca* Mill [18]. Oil with low density is an indication that it contain low molecular weight fatty acids, likewise it will have high saponification value which makes it suitable for soap production [20]. The saponification value 112 ± 0.27 mg KOH/g is lower when compared to the 122.49 ± 2.591 mg KOH/g obtained for *J. curcas* seed oil [14], 159.33 ± 1.20 mg KOH/g of *Dennetta tripetala* fruit oil (pepper fruit) [21] and 197 ± 0.61mg KOH/g and 201 ± 1.37 mg KOH/g of dehulled and whole seed oil of *Luffa aegyptiaca* Mill [18].

Table 1. Physicochemical characteristics of *Luffa cylindrica* seed oil

Parameters	Values
Saponification (mg KOH/g)	112 ± 0.27
Iodine value (I g/100 g)	30.33 ± 2.40
Acid value (mg KOH/g)	2.34 ± 0.19
Oil yield (%)	31.23
Density (g/cm^3)	1.18

Note: Values are expressed as mean ± standard deviation.

Table 2. Physical characteristics of soap produced from *Luffa cylindrica* seed oil

Parameters	Values/Observation
pH	12.00
Foam height (cm)	4.10
Colour of soap	Brown
Solubility in water	Slightly soluble
Texture	Soft

Table 3. Summary of the GC-MS chart peaks of *Luffa cylindrica* seed oil

S/No.	Name of compound	Formula	M.W.	SI% to T.C.
peak 1	Palmitic acid	$C_{16}H_{32}O_2$	256	95
peak 2	cis,cis-linoleic acid	$C_{18}H_{32}O_2$	280	91
peak 3	Stearic acid	$C_{18}H_{32}O_2$	280	91
peak 4	cis-13-octadecenal	$C_{18}H_{34}O$	266	87

Note: SI% = Similarity index, M.W. = Molecular weight, T.C. = Target compound.

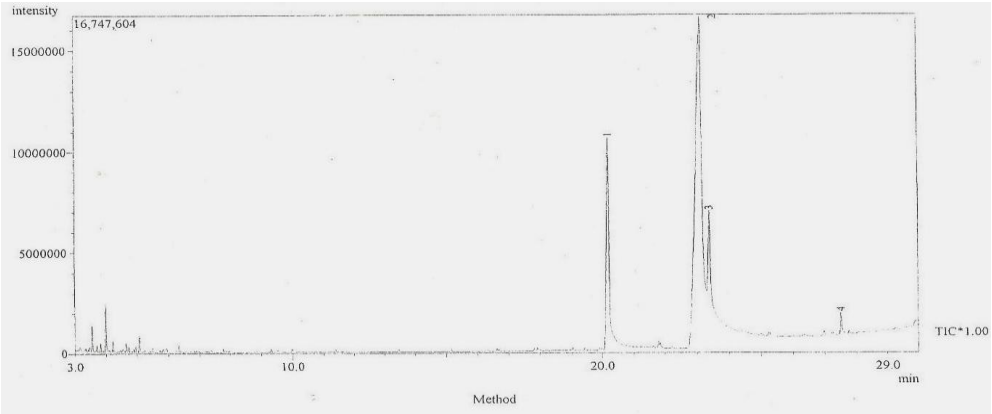

Figure 1. GC-MS chromatogram of *Luffa cylindrica* seed oil.

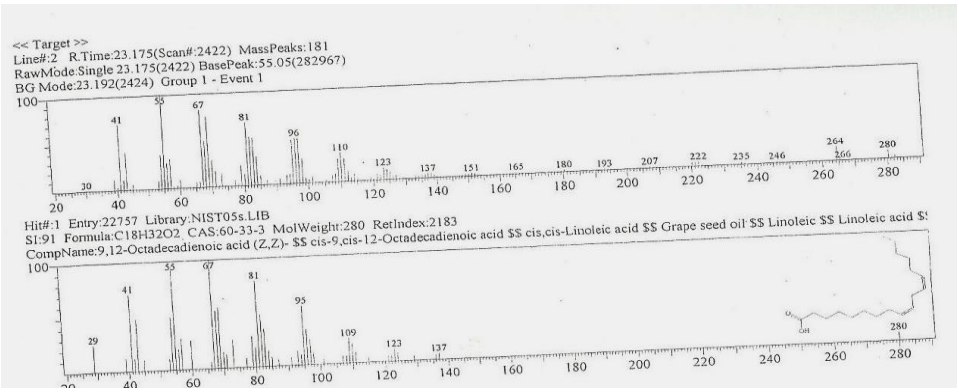

Figure 2. Chart for peak 2 of the chromatogram *Luffa cylindrica* seed oil.

The saponification value is above 100. This is an indication that the oil could be used for soap production since higher saponification value justifies the usage of the oil for soap production [16]. The acid value 2.34 ± 0.19 mg KOH/g is lower when compared with 10.1 ± 0.57 mg KOH/g and 9.36 ± 0.51 mg KOH/g of dehulled and whole seed oil respectively of *Luffa aegyptiaca* Mill [18] and 4.18 ± 0.01 mg KOH/g of garlic (*Allium sativum* L.) oil [19] and higher when compared to 1.20 ± 0.065 mg KOH/g of *J. curcas* seed oil [14]. The low acid value signifies a maximum purity and suitable for soap production [22].

The iodine value 30.33 ± 2.40 g /100 g is higher than 12.69 ± 0.05 g I /100 g for garlic [19] but lower than 73.46 ± 5.00 g I /100 g of *J. curcas* seed oil [14] and 99.3 ± 0.70 g I /100 g and 106.0 ± 0.75 g I /100 g of dehulled and whole seed oil respectively of *Luffa aegyptiaca* Mill [18], oils with iodine value less than 100 g I/100 g are termed as non-drying oils which are useful in the manufacture of soaps [23].

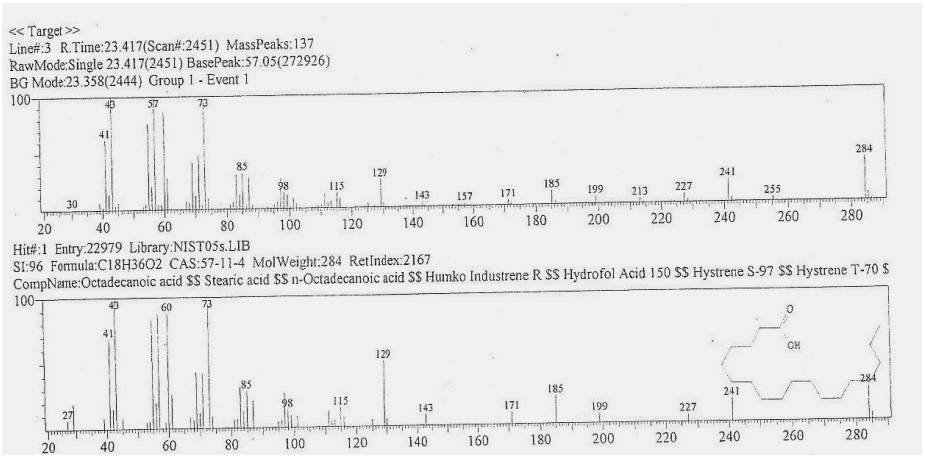

Figure 3. Chart for peak 3 of the chromatogram *Luffa cylindrica* seed oil.

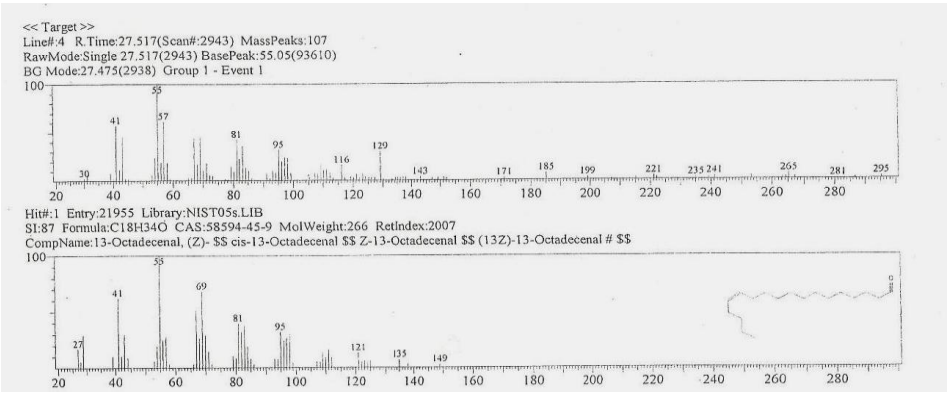

Figure 4. Chart for peak 4 of the chromatogram of *Luffa cylindrica* seed oil.

From Table 2, the pH value of the soap produced from the oil is 12.00 which is higher than pH of 10.11 of soap from *J. curcas* seed oil [14] and higher than the pH range of 9 - 11 which is consider as high level for any soap by National Agency for Food and Drug Administration and Control (NAFDAC), soaps with pH within or above this range are consider to be harsh to skin [24]. The foam height of the soap produced is 4.10 cm which is within the range of 1.4 cm to 5.4 cm of some soap samples [14]. Although foam generation from soaps or detergents has little to do with their cleaning ability, but consumer choice make it necessary parameter in evaluating soaps and detergents [25].

The GC-MS runs from Table 3 are clear indications that sponge gourd *Luffa cylindrica* seed oil may contain the following fatty acids: stearic acid, palmitic acid and cis-9-cis-12-linoleic acid. This

result is in line with the work of [18], where the fatty acid profile *Luffa aegyptiaca* Mill seed oil (another species of sponge gourd) shows high percentage of linoleic acid both in dehulled and whole seeds with also presence of other fatty acids, such as stearic acid, oleic acid, myristic acid, palmitic acid and arachidic acid in considerable percentage. In view of these fatty acids content *Luffa cylindrica* seed oil can be of substitute for vegetable oil.

4. Conclusions

The results obtained from this research work show that the oil has a good storage capacity and can be used to produce soap. The GC-MS runs indicate presence of fatty acids stearic acid, palmitic acid and cis-9-cis-12-linoleic acid, and unsaturated aldehyde compound cis-13-octadecenal. These compounds when properly isolated and purified can be of great importance in nutrition, pharmaceutical as well medicinal formulations.

References

[1] Yoganarasimhan, S. N. Medicinal plants of India. *Karnataka* **1996**, *1*: 29.

[2] Bal, K. E.; Bal, Y.; Lallam, A. Gross morphology and absorption capacity of cell-fibers from the fibrous vascular system of loofah (*Luffa cylindrica*). *Textile Res. J.* **2004**, *74*: 241-224.

[3] Dairo, F. A. S.; Aye, P. A.; Oluwasola, T. A. Some functional properties of Loofa gourd (*Luffa cylindrica*) seed. *J. Food Agric. Environ.* **2007**, *5*: 97-101.

[4] Xie, Z.; Yu, Y. Material medical. *Chin. Terminol.* **1996**, *1*: 22-26.

[5] Ahmad, M. I.; Goel, H. C.; Rizvi, M. M. A. Phytochemical screening and high performance TLC analysis of some cucurbits. *Sci. Alert* **2010**, *4*: 242-247.

[6] Jansen, G. J.; Gildemacher, B. H.; Phuphathanaphong, L. *Luffa P. Asia No. 8. Vegetables*. Pudoc Scientific Publishers, Wageningen, Netherlands, **1993**, pp. 194-197.

[7] Heiser, C. B.; Schilling, E. E. The genus *Luffa*: A problem in phytogeography. In: *Biology and Utilization of the Cucurbitaceae comstock,* Bates, D. M.; Robinson, R. W.; Jeffrey, C. (Eds). Cornell University Press, Ithaca, United States, **1990**, pp. 120-133.

[8] Oboh, I. O.; Aluyor, E. O. *Luffa cylindrical:* An emerging cash crop. *Afric. J. Agric. Res.* **2009**, *4*: 684-688.

[9] Sangh, P.; Amit, K.; Neeraj, K. S.; Jha K. K. *Luffa cylinderica*: An important medicinal plant. *Scholars Res. Library* **2012**, *2*: 127-134.

[10] Warra, A. A.; Wawata, L. G.; Gunu, S. Y.; Atiku, F. A. Soap preparation from Soxhlet extracted Nigerian cotton seed oil. *Pelagia Res. Library* **2011**, *2*: 617-623.

[11] Warra, A. A.; Wawata, I. G.; Gunu, S. Y.; Aujaka, K. M. Extraction and physicochemical

analysis of some selected northern Nigeria, industrial oils. *Arch. Appl. Sci. Res.* **2011**, *3*: 536-541.

[12] John, K. *Analytical Chemistry for Technicians*, 3rd Edn. Lewis Publishers, Kalyani Publisher, New Delhi, India, **2003**, pp. 347-349.

[13] AOAC. Official Methods of Analysis of the Association of Official Analytical Chemists, 16th Edn. Gaithersburg, USA, **1998**.

[14] Warra, A. A.; Wawata, I. G.; Umar, R. A.; Gunu, S. Y. Soxhlet extraction, physicochemical analysis and cold process saponification of Nigerian *Jatropha Curcas* L. Seed Oil. *Canad. J. Pure Appl. Sci.* **2012**, *6*: 1803-1807.

[15] Bassir, O. *Handbook of Practical Biochemistry*. Ibadan University Press, Ibadan, Nigeria, **1978**.

[16] Warra, A. A.; Hassan, L. G.; Gunu, S. Y.; Jega, S. A. Cold-process synthesis and properties of soaps prepared from different triacylglycerol sources. *Nig. J. Basic Appl. Sci*. **2010**, *18*: 315-321.

[17] NARICT. *GC-MS Analysis*. Zaria, Nigeria, **2012**.

[18] Elemo, G. N.; Elemo, B. O.; Erukainure, O. L. Characterization of sponge gourd (*Luffa aegyptiaca* Mill.) seed oil. *J. Tropic. Agric.* **2011**, *49*: 128-130.

[19] Gafar, M. K.; Itodo, A. U.; Warra, A. A.; Abdullahi, L. Extraction and physicochemical characteristics of garlic (*Allium sativum* L.) oil. *Int. J. Food Nutr. Sci.* **2012**, *1*(2): 4-7.

[20] Afolabi, S. I. Chemical qualities of oils from fresh and market vegetable crops within Kwara State Nigeria. *Niger. Soc. Experim. Biol.* **2008**, *20*(2): 71-75.

[21] Nwinuka, N. M.; Nwiloh, B. I. Physicochemical properties and fatty acid composition of *Dennetta tripetala* Fruit oil (Pepper fruit). *Niger. J. Biochem. Mol. Biol.* **2009**, *24*: 42-46.

[22] Oyedele, A. O. The skin tolerance of shea fat employed as excipient in tropical preparations *Niger. J. Nat. Prod. Med.* **2002**, *66*: 26-29.

[23] Kochhar, S. L. *Economic Botany in the Tropics*, 2nd Edn. Macmillian India Ltd, Delhi, India, **1998**.

[24] Warra, A. A.; Wawata, L. G.; Gunu, S. Y.; Atiku, F. A. Soap preparation from Soxhlet extracted Nigerian cotton seed oil. *Pelagia Res. Library* **2011**, *2*: 617-623.

[25] Mainkar, A. R.; Jolly, C. I. Evaluation of commercial herbal shampoos. *Int. J. Cosmet. Sci*. **2000**, *22*: 385-391.