International Research Journal of Pure & Applied Chemistry

21(14): 1-6, 2020; Article no.IRJPAC.58842
ISSN: 2231-3443, NLM ID: 101647669

Extraction, Charaterization and Preparation of Soap from *Legenaria siceraria* Seed Oil

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Authors' contributions

This work was carried out in collaboration among all authors. Author WNK designed the study, performed the physicochemical analysis, wrote the protocol and wrote the first draft of the manuscript. Author IU managed the analyses of the study. Author AEB effected corrections on the revised manuscript. Author TD managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IRJPAC/2020/v21i1430242
Editor(s):
(1) Dr. Bengi Uslu, Ankara University, Turkey.
Reviewers:
(1) João Henrique Dantas, Estate University of Maringá, Brazil.
(2) Mohammed Hassan Jabal, University of Technology, Iraq.
Complete Peer review History: http://www.sdiarticle4.com/review-history/58842

Original Research Article

Received 10 May 2020
Accepted 14 July 2020
Published 01 September 2020

ABSTRACT

Due to the high demand for vegetable oil by soap industries, the quest for alternative raw material is on the increase. In this study, vegetable oil was extracted from the underutilise seeds of *Lagenaria siceraria* using n-hexane; The Physico-chemical properties of the oil were analysed: iodine value 65 lg/100 g, acid value 2.50 mg/KOH/g, saponification value 256 mgKOH/g, pH 6.20, specific gravity 0.902, the refractive index of 1.47 and oil yield 52%. The properties of the oil were compared with oil extracted from other sources. The properties of the oil suggest it can use for both commercial and industrial purposes. The extracted oil was then used to prepared soap and its properties were compared with the properties of soaps prepared from other oils. The physicochemical parameters of the prepared soaps which include foam height, hardness, pH and cleansing power were evaluated. The soap made from *Lagenaria siceraria* seeds oil has foam height of 2.0 cm lower than palm kernel oil (2.1 cm) and higher than soya beans (0.55 cm). Soap made from *Lagenaria siceraria* seed oil has an appreciable degree of hardness and good cleansing power compared to soaps prepared from other oils. The pH of all the soaps prepared is within the

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standard of the regulating agency in Nigeria. From the result obtained, it shows the underutilised *Lagenaria siceraria* seed oil can use as an alternative raw material in the commercial production of soap.

Keywords: Lagenaria siceraria seed oil; physicochemical; pH; soap; raw material; saponification.

1. INTRODUCTION

Fats and oils are triesters of the triad alcohol glycerol with fatty acid [1]. Oils obtained from the seeds of plants are called vegetable oil [2]. It has vast applications such as raw material in food, detergent, coating, paints, cosmetics, and soap industry [3]. Due to its vast application, there is high global demand for vegetable oil for both human and industrial consumption [4]. In cosmetic industries, vegetable oils are used to protect the skin by retaining water moisture [5] and they are the main constituents or raw materials in soap production.

Soap is sodium or potassium salt of fatty acid containing 12 or more carbon atoms. It is formed by the hydrolysis of triacylglycerol in fatty acid with an alkaline reaction medium, a chemical process called saponification [6]. Fatty acids such as stearic acid, palmitic acid, oleic acid, and lauric acid are the determinant of the leathering and washing properties of the soap. Soaps are used as cleansing agents to improve health and maintaining physical cleanliness [7].

Soap industries use vegetable oils from plant sources such as palm kernel oil as one of the main raw materials for production. The high demand for vegetable oils from other industries such as petroleum industries for biodiesel production has created a shortage of raw materials in soap industries [8]. Hence need to look for alternative raw materials for soap production. In an attempt to find alternative raw materials, several research has been carried using different plants seeds oil such as shea butter and palm kernel oil [9], soya bean and neem seeds oil [10], cotton seeds oil [11], *Daniella oliveri & Elaeis guinessis* [12], eucalyptus oil [13].

Lagenaria siceraria (bottle gourd) is a native to African but now grown across the world [14]. It belongs to the plant family Cucurbitaceae or cucurbit which has 118 general and 825 species. [15]. The fruit is a hard, hollow, and a bottle - like shell with seeds embedded in spongy pulp in the inside of the fruit [16]. The fruits are used as containers, musical instruments, or float while its seeds are used for oil and protein [17]. In this region of the country most of the seeds are discarded as waste thereby underutilizing it. Therefore, this research aims to extract oil from *Lagenaria siceraria* seeds, characterize the oil, prepared soap from the oil and compare its property with soap made from other oils.

2. MATERIALS AND METHODS

2.1 Sample Collection and Treatment

Mature *Lagenaria siceraria* fruits were collected around the school premises. The fruits were broken and their seeds were collected and washed with water. The seeds were de-shelled by hand and sundried for 7 days, then grounded and properly stored.

2.2 Oil Extraction

70 g of the grounded seeds sample was put into the porous thimble and place in a soxhlet extraction apparatus using 150 cm^3 n-hexane. After 3 hours the oil was obtained by removing the solvent (n-hexane) under reduce temperature and pressure and refluxing at 70℃.

2.3 Percentage Yield

The oil obtained after extraction was transferred into a measuring cylinder and was placed over a water bath for 30 minutes at 70℃ to ensure complete evaporation of n-hexane from the oil. The volume of the oil was measure and express as oil content. The percentage yield is calculated using the formular:

$$\text{Percentage yield} = \frac{\text{weight of oil}}{\text{weight of sample}} \times 100$$

2.4 Determination of Physicochemical Parameter of the Oil

2.4.1 Saponification value

2 g of the oil sample was added to the flask with 30 cm^3 of ethanolic KOH were then attached to a condenser for 30 minutes to ensure the sample was fully dissolved. After the sample had cooled,

1 cm^3 of the phenolphthalein was added and titrated with 0.5M HCl until a pink endpoint has reached [18]. Saponification value was calculated from the equation:

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

S = sample titre value
B= blank titre value
M = molarity
56.1 = molecular weight of KOH

2.4.2 Acid value

1 g of the oil was measured into a conical flask. 25 cm^3 of carbon tetrachloride was added. Two drops of phenolphthalein indicator were added to the mixture. The mixture was titrated against 0.1M KOH until a colour change was observed [16]. The acid value was calculated using the equation:

$$\text{Acid value} = \frac{V\times M}{W}\times 56.1$$

Where

V = volume of KOH
M = concentration of standard KOH
W = weight of oil
56.1= molar mass of KOH

2.4.3 Iodine value

0.05 g of the oil was dissolved in 15 ml of carbon tetrachloride in a 100 ml conical flask. A 5 ml of Wiji's iodine solution was added to the flask and allow to stand for 30 minutes in the dark at 25℃. 5 ml potassium iodide solution was added and the mixture titrated with 0.1M sodium thiosulphate using starch indicator [16]. A blank determination was carried out and the iodine value was calculated using the equation:

$$\text{Iodine value} = 12.69 \times \frac{C(V1-V2)}{W}$$

Where

C = concentration of thiosulphate
$V1$ = volume of thiosulphate
$V2$ = volume of thiosulphate used in the determination
W = weight of sample

2.4.4 Refractive index

Abbey refractometer was used to determine the refractive index of the oil at 38℃ [18].

2.4.5 Specific gravity

The specific gravity was determined using the density bottle. It was calculated using the formular:

$$\text{Specific gravity} = \frac{(\text{weight of bottle+oil}) - (\text{weight of bottle})}{\text{weight of water}}$$

2.5 Saponification

70 cm^3 of 170 g/dm^3 Sodium Hydroxide (NaOH) solution was measured and poured into a beaker. 70 cm^3 of the oil was also measured and poured into another separate beaker. The oil was warmed gently and the Sodium Hydroxide solution was poured into the beaker containing the oil in the ratio of 1:1(v/v) to form a mixture. The mixture was stirred for 15 minutes and then poured into a mold. It was allowed to cure and harden for 24 hours after which it was subjected to testing [11].

2.6 Soap Characterizations

The soap prepared was characterized by its pH, foaming ability, and cleansing power whilst its value is been compare with soap made palm kernel oil and soya beans oil.

2.6.1 pH determination

10 g of the soap shavings were weighed and dissolved in distilled water in a 100cm^3 volumetric flask. This was made up to prepare 10% soap solution as reported in the literature. The electrode was inserted into the solution and the readings were recorded [12,19].

2.6.2 Determination foaming ability

2 g of soap sample was added to a 500 cm^3 measuring cylinder containing 100 cm^3 of distilled water. The mixture was shaken vigorously to obtain foams. After shaking for 2 minutes, the cylinder was allowed to stand for 10 minutes; the height of the foam was measure and recorded [18].

2.6.3 Cleansing property

To determine the cleansing property of the prepared soaps, 2 g of the soap dissolved in 100 ml of distilled water. Drops of the oils were placed in 3 separate strips of filter paper. The filter papers containing the oil spots were immersed into a separate test tube containing soap solutions. Each was shaken vigorously for 1

minute. The filter papers were removed and rinse with distilled water and the degree of cleanliness was observed [18].

3. RESULTS AND DISCUSSION

3.1 The Physicochemical Characteristics of the Oil

Lagenaria siceraria had higher extraction yield (50.3%) compared to the oil produced from castor seed oil [11], soya bean, avocado, and jatropha, but similar to sesame seed oil [4]. The refractive index is 1.47 which falls within the acceptable range of virgin, refined and refined–pomace [2]. The specific gravity of the oil is 0.902 less dense than water which makes it suitable for cream production [19]. The oil had a saponification value of 256.9 mgKOH/mg higher compared to the value reported by Warra, et al. [20], Danjuma & Danbago [21], Kubde et al. [22]. A higher saponification value indicates that the oil is good for soap production. The iodine value of the oil is 65.6 lower than 100 g. Oils with low iodine value are classified as non-drying and are suitable for soap production [20]. The acid value of 2.50 is within the FAO/WHO recommended value for edible oil.

3.2 Properties of Soap Made from *Lagenaria siceraria* Seeds Oil

From Table 2, the pH of the prepared soap from *Lagenaria siceraria* seeds oil was 10.61 which falls within the pH range of 9.2-12 recommended by the regulating agency in Nigeria: National Agency for Food and Drug Administration and Control (NAFDAC). The foam height is 2.0 cm. The soap is hard in texture, whitish in colour and it has a pleasant odour.

3.3 Comparison of Soap Made from Different Oils

The soap made from *Lagenaria siceraria* seed oil was compared with soap made from palm kernel oil and soya beans oil. Table 3 shows the physicochemical properties.

The soaps made from *Lagenaria siceraria* seed oil has a pH of 10.6, palm kernel oil has a pH of 9.7 while soya bean oil has a pH of 11.0. The pH values of the three soaps prepared fall within the standard of regulating body in Nigeria which indicates that the pH is not toxic to the skin. According to Zubair et al. [23] soap with high pH values causes an increase in skin pH resulting in dehydration, irritation, and destruction of the upper layer of the skin.

The foam height of the soap made from *Lagenaria siceraria* seed oil is 2.0 cm; lower than palm kernel oil, but higher than of soya bean oil. Soap made from *Lagenaria siceraria* seed oil cleanse more effectively compared to soap made from palm kernel oil and soya beans. According to Warra [24], foam generation is not tantamount to cleaning ability of soap.

Table 1. Physicochemical property of *Lagenaria siceraria* oil seed

Parameter	*Lagenaria siceraria*	*WHO/FOA*
Oil yield	50.3	-
Colour	Brownish yellow	-
pH	6.20 ∓ 0.02	-
Specific gravity	0.902 ∓ 0.01	-
Refractive index at 30℃	1.47 ∓ 0.11	-
Iodine value I/100g	65.6 ∓ 0.46	80-106
Acid value mgKOH/g	2.50 ∓ 0.05	4
Saponification value mgKOH/g	256 ∓ 0.65	181.4 ∓ 2.60

Table 2. Properties of soap made from *Lagenaria siceraria* seeds oil

Parameter	Properties
pH	10.6 ∓ 0.25
Foam height	2.0 ∓ 0.01
Cleaning	Effective
Texture	Hard
Colour	White
Odour	Pleasant

Table 3. Comparison of soap made from different oil

Parameters	*Lagenaria siceraria*	Palm kernel oil	Soya bean oil
pH	10.6 ∓ 0.25	9.7 ∓ 0.05	11.0 ∓0.01
Foam height	2.1 ∓ 0.02	2.0 ∓ 0.01	0.55 ∓ 0.06
Cleansing ability	more effective	Effective	Less effective
Colour	brown	white	Cream
Texture	hard	hard	soft

Soap from *Lagenaria siceraria* seed oil and palm kernel oil have high degree of hardness compared to soap from soya bean. This hardness property indicates the ability of the soap to last longer [12].

4. CONCLUSION

Vegetable oil was extracted from the underutilize seeds of *Lagenaria siceraria* and its properties were analysed. The results obtained indicated that the oil can be used for soap production. Its potential for preparing soap was investigated. The properties of soap prepared from *Lagenaria siceraria seeds oil* were compared with soaps made from palm kernel and soya beans seeds oil. soap prepared from *Lagenaria siceraria seeds oil* showed an appreciable degree of hardness and good cleansing power. From the result obtained it can be concluded that the underutilsed seed oil of Lagenaria *siceraria* can be exploited for the commercial production of soaps.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by the personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/58842