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Chemical characteristics of toilet soap prepared from neem *(Azadirachta indica* A. Juss) seed oil

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ABSTRACT

Neem oil was obtained from the seeds of the neem tree, Azadirachta indica, exploiting a manually operating bridge press, and used to prepare toilet soap. The chemical properties of the soap were 63.75 %, 0.24 %, 0.06, 1.15 %, 12.6 % and 10.4 as its total fatty matter, total alkali, free caustic alkali, percentage chloride (% Cl^-), % moisture and pH respectively. Due to the phytoconstituents in neem oil and the favourable chemical characteristics of the soap, it can be used as medical and cosmetics toilet soap. Such neem soap may act to protect the skin.

Key words: Herbal Soap, *Azadirachta indica*, neem oil and chemical characteristics.

INTRODUCTION

Soap is sodium or potassium salt of fatty acid produced by saponification reaction using sodium or potassium hydroxide. Based on its chemical properties as an anionic surface active agent (surfactant), soap is used to clean and wash skin and clothing [1]. The fatty acids, stearic, palmitic, myristic, lauric and oleic acids, contribute to lathering and washing properties of the soaps [2]. Palm oil has been widely used as fatty raw material in the manufacture of soap [3]. The chemical characteristics of soap depend on several factors: the strength and purity of alkali, the kind of oil used, completeness of saponification and age of the soap. Such chemical characteristics include moisture content, total fatty acids (TFM), pH, free alkali, and percent chloride [4].

Neem oil has been used in the manufacture of natural cosmetics, soap, toothpaste, hair and skin care products, emulsions, liquors, ointments and medicinal cosmetics [5]. However neem oil can be produced mechanically (hot or cold press) or chemically (solvent extraction) from dried neem seeds. The best quality neem oil with a majority of phytoconstituents intact is obtained through cold press. In cold press the oil is lighter in colour and has a milder odour [6]. Moreover potential residual solvents in chemical extracted oil that may pose health hazards to consumers are eliminated since solvents are not used in the pressing techniques.

Neem oil contains polysaccharides and limonoids that reduce tumors and cancers eg lymphocytic leukemia and skin cancers [7]. Some of the limonoid compounds are azadirachtin, salannin, meliantriol, nimbin and nimbidin [8] desacetylnimbin, Azadiradione, Azadirone, Nimbolin, Nimbinene, Nimbolide [43]. The phenolic compounds containg catechin reduces inflammation, pain and swelling that occur in arthritis [9]. Neem oil combats vaginal infections and sexually transmitted diseases, kills lice [10], scabies [11], ringworm, athlete's foot fungus [12] and *Phytophthora infestans* [42], repels mosquitoes, fleas and houseflies when applied to the skin [13] and solves the problem of dandruff, baldness and graying of hair [14]. It cures leprosy, rheumatism, chronic syphilitic sores and indolent ulcer. It clears gonorrhoeae, herpes simplex-2, HIV-1, resistant strains of *E. coli*, *Staphylococcus aureus*, chicken pox [15], cholera, pneumonia, tuberculosis [12], peptic ulcer, diabetic foot, dry psoriasis and heals wound and other skin disorders [16].

Neem oil is rich in essential fatty acids (EFAs), triglycerides, vitamin E and calcium. Because of its EFAs and vitamin E, neem oil penetrates deep within the skin to heal the minute cracks brought on by severe dryness. Fatty acids present in the neem kernel oil are oleic acid (52.8%), linoleic acid (2.1%), palmitic acid (12.6%) and stearic acid (21.4%) and other lower fatty acids (2.3%) [8] and linolenic acid (1%) [17]. Acid value of neem oil is <20.0, [18]. Neem also stimulates collagen production, good for aging skin [19]. Vitamin E acts as a free radical scavenger, by hindering the oxidizing processes in the skin. It promotes soft and supple skin, helps in reducing old scars and promotes healing [20].

Ghana produces only 800,000 tonnes of palm oil annually [21] and as a result she uses hard earned scarce resources to import palm oil to supplement domestic production. The colour of palm oil, due to carotenoids [22], is one of the main problems encountered during processing [23]. Other limitation of using palm oil in soap industry is that it is utilized as a feedstock for production of biofuel [24]. Exploitation of neem oil as a substitute for palm oil in soap production will not merely reduces competition between cosmetic industries and domestic use of palm oil for cooking, but also minimizes palm oil imports. The neem soap will also be antimicrobial. In addition, the neem soap will be acceptable to people suffering from skin diseases such as acne, psoriasis and eczema who are allergic to soaps containing Diethanolamine, Isopropyl alcohol, Butylated hydroxyl toluene and Triclosan additives [25]. However work on the chemical properties of soap using only neem seed oil has not been published. Therefore, the purpose of this work is to use neem oil as a cheap source of fatty material in toilet soap preparation. It was also aimed at to determine the chemical characteristics of the produced soap which may help to impart its medicinal properties.

MATERIALS AND METHODS

Neem Fruits: Ripe matured fruits of neem, were collected in the morning from trees near the St. Stephens Anglican Church, Our Lady of Mercy Secondary School and Tema General Hospital, all in Tema, Ghana.

Extraction of neem seed oil

Neem seeds were dried for 14 days in the sun at a temperature range of 60–80 ^{O}C to obtain seeds with the same weight. Dried seeds were crushed and kernels were dried for 2 days and milled into fine powder using a blender and grinder (Crown star, Shenshen, China). Powder was poured into the bridge press manually screwed and pressed to obtain oil with all phytoconstituents intact.

Soap preparation

The method in [26] was modified and used for neem soap preparation. Neem oil, 100 g was weighed into a 500 ml beaker, heated to about 100^{o}C and saponification was initiated by adding 20 ml of 23.5 % NaOH. To the resulting solution, 60 g of NaOH pellets dissolved in 100 ml of distilled water was added gradually while stirring until completion of saponification. NaCl, 8 g dissolved in 30 ml of distilled water was added to grain soap. The salt was added to separate the spent lye in the bottom, while saponified mass floats on the surface to reduce the soap viscosity and to separate the glycerol water in the bottom. The glycerol water was isolated by siphoning. Therewith, the soap paste was washed again by (5-10%) hot water (90 °C) to reduce excess sodium hydroxide and sodium chloride and any impurities found in the soap paste. The soap obtained was washed with 10 ml of distilled water, filtered using a linen cloth, air-dried, then a small amount of water was added to soften it whist heating. The soap was placed in a cast and allowed to dry.

Determination of total fatty matter (TFM)

A modified method [27] was used. The total fatty matter test is carried out by reacting soap with acid in the presence of hot water and measuring the fatty acids obtained About 10 g of finished soap was weighed and 150 ml distilled water was added and heated. The soap was dissolved in 20 ml of 15 % H_2SO_4 while heating until a clear solution was obtained. Fatty acids on surface of the resulting solution was solidified by adding 7g of bee wax and reheated. The set up was allowed to cool to form cake. Cake was removed and blotted to dry and weighed to obtain the total fatty matter using a formula:

$$\% \text{ TFM} = \frac{A - X}{W} \times 100,$$

where A= weight of wax+ oil
X= weight of wax and
W= weight of soap.

Determination of total alkali

The total alkali is determined by titrating excess acid contained in the aqueous phase with standard volumetric NaOH solution. Procedure in [28] was modified and used. Ten grams of finished soap was weighed and 100 ml of neutralized alcohol was added to it. Five milliliters of 1 N H_2SO_4 solution was added to the mixture and heated till the soap sample dissolved. Test solution was titrated against 1 N NaOH using phenolphthalein as indicator. The total alkali was obtained with the formula;

$$\% \text{ Total alkali} = \frac{V_A - V_B}{W} X\ 3.1$$

where V_A= Volume of acid
V_B= Volume of base
W= weight of soap.

Determination of free caustic alkali

A modified method was used [29]. Five grams of finished soap was weighed and dissolved in 30 ml of ethanol. Few drops of phenolphthalein indicator and 10 ml of 20 % $BaCl_2$ were added. The resulting solution was titrated against 0.05 M H_2SO_4 [26]. Free caustic alkali- the volume of the acid obtained was calculated using the formula;

$$\text{NaOH} = \frac{0.31 \times V_A}{W},$$

where Va – Vol. of acid
W – weight of soap

Determination of percent (%) chloride.

Ten grams of finished soap was weighed and 100 ml of distilled water added to it and heated to dissolve sample. The resulting solution was transferred into a 250 ml volumetric flask and 20 ml

of 15 % Ca $(NO_3)_2$ was added to it and shaken to dissolve the soap. Distilled water was added to the solution to the 250 ml mark. The solution was filtered and methyl red added to 100 ml of the filtrate. The solution was titrated against 10 N H_2SO_4 until a pink colour was obtained. Resulting solution was titrated against 0.1 N $AgNO_3$ using K_2CrO_7 as indicator, till a brick-red colour was obtained [30].

$$\% Cl^- = \frac{\text{Titre volume X } 0.585.}{\text{Weight of soap}}$$

Analysis of % moisture Content

Approximately 5 g of samples was accurately weighed using analytical balance (sensitivity 0.1 mg) into dried, tarred moisture dish and dried in an oven (Memmert, Germany) for 2 hr at 101 ± 1 ^{0}C and repeated until a constant weight (difference between two measurement not exceed 0.5 mg/g of sample) was reached. The % moisture was calculated using the following formula [28].

$$\% \text{ Moisture} = \frac{C_s - C_h}{Cs - Cw} \times 100$$

Cw= weight of crucible
Cs= weight of crucible + sample
Ch= weight of crucible + sample after heating.

Determination of pH

Ten grams of the powdered soap was weighed and dissolved in distilled water in a 100 ml volumetric flask. This was made up to prepare 10 % soap solution. The pH of the 19 % soap solution was determined using a pH meter. Two grams of finished soap was dissolved in 10 ml of distilled water and stirred till sample dissolved. The pH was determined with pH meter (Sper 840087).

RESULTS

The neem oil extracted from the neem seed kernels through mechanical pressing was shown in Plate A, while the soap prepared from this oil was depicted in Plate B. However, the results of chemical analysis reflecting the characteristics of the soap were demonstrated in Table1.

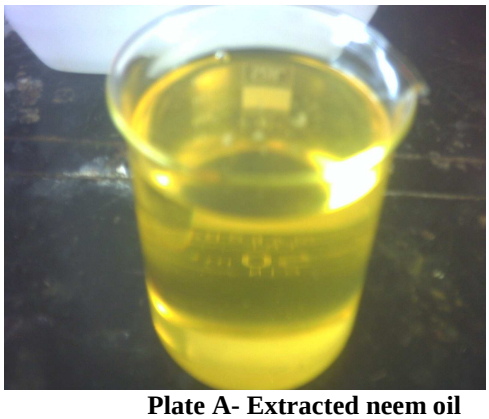

Plate A- Extracted neem oil

Plate B- Neem soap

The Plate A indicates the extracted neem oil using the mechanical press and Plate B is the soap prepared.

Table 1. Chemical characteristics of the prepared neem soap, compared with a toilet soap brought from Kumasi Central Market as control

Characteristics	Neem soap	Control
% Total fatty matter	63.75 ± 0.07	67.01± 0.04
% Total alkali	0.24 ± 0.01	0.20 ± 0.01
% Free caustic alkali	0.06 ± 0.002	0.06 ±0.003
% Chloride	1.15 ± 0.02	1.20 ± 0.02
% Moisture	12.63 ± 0.04	12.42 ±0.01
pH	10.4 ± 0.04	10.1 ± 0.02

(Values are mean ± Standard deviation, n = 3).

TFM is how much fat substance the soap has, i.e., it is the indication of soap quality. The more it has better the quality of the soap. TFM 63.75% (Table 1) was higher than 59% Ghana standards (unpublished) but close to the control 67.01%. Moisture content in the soap is 12.63% (Table 1), the soap in the form of shavings is heated to $101^{O}C$ until the weight is constant. Total alkali content was 0.24, pH 10.4, Chloride content 1.15% and free caustic 0.06%. All the results for the sample were close to those of the control (Table 1).

DISCUSSION

A neem soap was prepared as a product of saponification reaction between NaOH solution and oil extracted from neem seed kernel. The soap total alkali value (0.24) compares well with the control and Ghana Standards 0.3% for toilet soaps (unpublished paper). NaOH and NaCl contribute to the total alkali for neem soap. The free caustic alkali is the amount of alkali free to prevent soap from becoming oily. Ghana Standards require toilet soaps to have free alkali of 0.07. The experimental value 0.06 obtained is only 0.01 lower than the standard set, indicating comparable satisfactory effect. Moreover, the detected free caustic alkali content of the soap (0.06%) is in harmony with the Egyptian Standards [31] and [2] for Malaysian soap and less than 1.24% obtained by [32] because of the amount of caustic potash they used. Excess free caustic alkali causes skin itching and clothes wear out. Total alkalinity is the total alkaline materials present in the finished soap. This includes many alkaline components, such as hydroxides, sodium (II) oxide Na_2O, carbonates and bicarbonates. It involves the decomposition of soap by known volume of standard volumetric mineral acid solution, extraction and separation of the liberated fatty matter by heating [33].

The total fatty matter (TFM) of neem soap reported 63.75% was found to be lower than the control and those obtained (65-70%) by [34] and [32], but higher than Ghana standard of 59% (unpublished). These differences in the TFM is responsible for high moisture contents and the kinds and quantities of the used fatty materials and also perhaps due to the difference in the saponification method. The lower TFM value is due to presence of unreacted NaOH in the mixture [27]. However, dry skin needs soap which is high in TFM of 80%. This re-hydrates the skin making it smooth, and additionally the high oil content within the soap acts as a lubricant throughout the day [35].

The determination of percentage chloride levels in soap is important as excess amount causes soaps to crack. The % Cl^- value (1.15) reported in the present study is more than that obtained (0.90) by [32] and lower than the control and Ghana standard value of 1.5. This indicates that the value obtained is enough to sustain soap and prevent it from cracking. Chlorinated water was used to dissolve the NaOH pellets. This may be the reason for high chloride content of the prepared soap compared to the control used by [32].

The moisture content of the neem soap (12.63%) found in the current work was higher than those (6-8%) reported by [2]Aine et al. (1996) and standards of 10.5-12.5% [36]. This value may be due to the difference in the soap preparing methods.

From the results, the pH 10.4 of the neem soap was higher than 10.1 (control) but consistent with the normal pH range for soap 8-10.5 [37] and 9-11 [38]. This value is slightly higher than 9.38 for cotton seed oil soap [39]. This high value is due to incomplete alkali hydrolysis resulting from the saponification process. It can be overcome by the addition of excess fat or oil or any other superfatting agent to reduce the harshness of the soap [39].This indicates that, the prepared soap is not corrosive to the skin. As the salt of a weak acid (fatty acid) and strong base (NaOH), soap is alkaline (pH~10) in aqueous solution. Alkaline substances neutralize the body's protective acid mantle that acts as a natural barrier against bacteria and viruses. Healthy skin has a pH 5.4 to 5.9 [40]. The alkalinity favours detergency [41].

CONCLUSION

Neem soap was prepared from mechanically pressed neem kernel oil. Chemical analysis showed that the obtained soap has 63.75 %, 0.24 %, 0.06, 1.15 %, 12.63 % and 10.40 as its total fatty matter, total alkali, free caustic alkali, percentage chloride (% Cl^-), % moisture and pH respectively. This work shows that neem seed oil could be used as a substitute for palm oil in producing cosmetic toilet soaps with favourable medicinal properties.

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