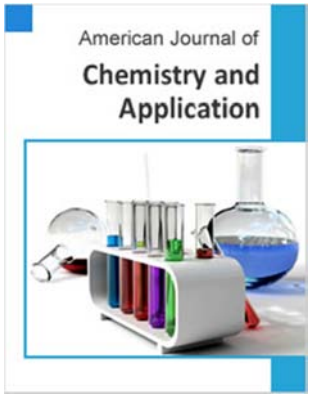
American Journal of Chemistry and Application
2017; 4(2): 11-15
http://www.aascit.org/journal/ajca
ISSN: 2375-3765

AASCIT American Association for Science and Technology



Keywords
Balanites aegyptiaca,
Phytochemical,
Biodegradable,
Saponin,
Haemolysis,
Commercial Surfactant

Received: March 17, 2017
Accepted: June 6, 2017
Published: August 23, 2017

Evaluation of *Balanites aegyptiaca* Linna. Delile. Stem Bark and Synthetic Surfactant for Surface Activity

Agu Matthew Onyema[1, *], Onwuka Jude Chinedu[2], Muhammad Sani Ahmad[1]

[1]Department of Science Laboratory Technology, Federal Polytechnic Bali, Bali, Nigeria
[2]Department of Chemistry, Federal University Lafia, Lafia, Nigeria

Email address
mataguonyema@gmail.com (A. M. Onyema)
[*]Corresponding author

Citation
Agu Matthew Onyema, Onwuka Jude Chinedu, Muhammad Sani Ahmad. Evaluation of *Balanites aegyptiaca* Linna. Delile. Stem Bark and Synthetic Surfactant for Surface Activity *American Journal of Chemistry and Application*. Vol. 4, No. 2, 2017, pp. 11-15.

Abstract
The surfactant properties of Desert date (*Balanites aegyptiaca* Linna. Delile.(Family-Balanitaceae) stem bark has been traditionally identified as natural surfactant in North Central States of Nigeria (especially in Taraba and Adamawa States) and it's been evaluated in this work. The successive extract of the stem bark was carried out using separating funnel on four solvents with respect to their polarity and the extract obtained was subjected to preliminary phytochemical screening analysis. The phytochemical screening investigation revealed the presence of alkaloids, saponins, tannins and flavonoids. The stem bark of *Balanites aegyptiaca* (BS) extract was evaluated based on saponin value, surface activity and p^H at different concentrations and compared with two commercial surfactants (symbolized SS and ZS). The *Balanites aegyptiaca* stem bark extract shows presence of saponin using frothing and haemolysis test. The crude saponin obtained from *Balanites aegyptiaca* stem bark methanol extract yielded 35.2% for 100g. An amount of 2g/100mL of the extract tested for surface activity yielded 51.63Nm^{-1}, 25.15 Nm^{-1} and 24.32 Nm^{-1} for BS, SS and ZS respectively, Also an amount of 4g/100mL of the extract yielded, 50.01 Nm^{-1}, 23.62 Nm^{-1} and 22.06 Nm^{-1} for BS, SS and ZS respectively. The following was obtained at different high concentrations, that is, 48.54 Nm^{-1}, 22.49 Nm^{-1} and 20.39 Nm^{-1} for 6g/100mL; 48.51 Nm^{-1}, 21.20 Nm^{-1} and 21.49 Nm^{-1} at 8g/100mL; and 44.70 Nm^{-1}, 24.41 Nm^{-1} and 22.90 Nm^{-1} at 10g/100mL for BS, SS and ZS respectively. The p^H of the Balanites extracts (BS) shows a range from neutral to weakly acidic with increase in concentration whereas the commercial detergents (ZS and SS) were moderately basic. The p^H obtained ranges from 7.50, 10.87 and 10.92 for BS, SS and ZS respectively at 2g/100mL; 7.02, 10.94 and 11.11 at 4g/100mL; 6.80, 10.99 and 11.27 at 6g/100mL; 6.61, 11.06 and 11.43 at 8g/100mL and 6.39, 11.11 and 11.57 at 10g/100mL for BS, SS and ZS respectively. Our preliminary findings may be useful for industrialist that may wish to produce eco-friendly and biodegradable soap. Also this research is timely with reference to the economic recession most countries are into, as well as the down fall in petroleum products from where the active ingredients of synthetic commercial surfactants are made.

1. Introduction

Balanites aegyptiaca Linn. Delile. is also known as "desert date" in English. It is called Aduwa in Hausa and Tanni inFulfulde. It belongs to the family of Balanitaceae and one of the most common but neglected wild plant species of dry land area of Africa and South Asia [9]. This tree is native to most African countries and part of the Middle East. The tree can grow to 6-10 meters in height; it's highly resistant to stresses such as sandstorm and heat waves. It can grow with minimal rainfall and moisture. In India, it is particularly found in Rajasthan, Gujarat, Madliya Pradesh, and Deccan [8]. This is one of the most common trees in Senegal, [12]. It can be found in different kinds of Habitat and tolerates a wide variety of soil types, from sand to heavy clay, and climates moisture level [5].

Studies have shown that some plants have been used as substitute for soap apart from *Balanites aegyptiaca*, these are plants that also contain Saponins in sufficient quantities to produce lather when mashed and dissolved in water, and can be used as either soap or shampoo [11].

The bark of *Balanites aegyptiaca* can be used to produce fibers, the natural gum for the branches are used as glues while the seeds have been used to make jewelry and beads. The plant is used as source of fiber, firewood, timber and gum (resin) [14].

2. Materials and Methods

2.1. Collection and Identification of Plant

The stem bark of the plant (*Balanites aegyptiaca*) was collected from Jalingo in April 2016 and was taken to the Department of Science Laboratory Technology of Federal Polytechnic Bali for identification by Mr. Ukwubile C. A. where a voucher specimen number FEDPOLYBALI2016ZYG001 was deposited in the herbarium of Biology Unit, of Science Laboratory Technology Department, Federal Polytechnic Bali, Taraba State.

2.2. Preparation of Plant Material and Extraction

The collected stem barks of *Balanites aegyptiaca* were cut into small pieces and air- dried at room temperature of 27°C for 14 days. After drying it was reduced into fine powder using electronic blender. The dried and pulverized plant material (100.6g or 0.1006kg) was defatted in 650 mL petroleum ether and then extracted with methanol (650mL) in an air tight separating funnel for 48 hours at room temperature. The extract was then filtered using a What man filter paper. The filtrate was concentrated in vacuo at room temperature.

2.3. Determination of Extraction Yield for the Plant Stem Bark

The extraction ® yield was calculated by the expression

$$\% \mathrm{R} = \frac{\mathrm{Mr}}{\mathrm{Mi}} \times 100 \quad (1)$$

Where, Mr = weight of concentrated extracts (Final weight of the methanol stem bark extract = 34.5 g). Mi = weight of powdered sample (Initial weight of the stem bark of the plant = 100.6 g).

Therefore the % yield of extract

$$(\mathrm{R}) = \frac{34.5}{100.6} \times 100 = 34.29\% \quad (2)$$

2.4. Tests for Saponin

2.4.1. Frothing Test

The method described by [13] was used. An amount of 0.5 g of the sample powder was vigorously shaken with 10 mL of water in a test tube for 30 seconds; it was then observed on standing for 30 minutes. Formation of honey comb froth was observed which indicates the presence of saponins.

2.4.2. Haemolysis Test

An amount of 1 g of the sample was dissolved in water and 2 mL of NaCl solution was added to the filtrate in the test tube. Then three drops of an animal blood was added to the tube by means of a syringe and mixed gently by inverting the tube (no shaking) and allowed to stand for 15 mins. The scattering of the red blood cell indicates the presence of saponins [15].

2.5. Qualitative Phytochemical Screening of Extracts

Phytochemical analysis of freshly prepared stem bark of *Balanites aegyptiaca* extracts were performed to evaluate and detect the various constituents using procedures described by [2]. The successive extraction of the stem bark extract of *Balanites aegyptiaca* was subjected to the following tests for the identification of its various active constituents using the standard methods described below.

A. Test for Alkaloids

The aqueous and methanol extracts were evaporated to dryness and the residue was stirred in 5mL of 1% HCl on a steam bath and filtered while hot. Distilled water was added to the residue and 1mL of the filtrate was treated with a few drops of Wagner's reagent. The reddish brown precipitate indicates the presence of alkaloid

B. Test for Flavonoids

An amount of 2mL of dilute Sodium hydroxide was added to 2ml of the extract. The appearance of a yellow color indicates the presence of flavonoids.

C. Test for Saponins

An amount of 1mL of distilled water was added to 1mL of the extract and shaken vigorously. A stable persistent froth indicates the presence of Saponins.

D. Test for Tannins

A portion of the extract was dissolved in water, after which the solution was clarified by filtration. 10% ferric chloride Solution was added to the resulting filtrate. The appearance of a bluish black color indicates the presence of tannins.

Chemical tests were carried out on the extracts of stem bark of *Balanites aegyptiaca* for carbohydrate determination using standard procedures by [6].

E. Test of Carbohydrates

Molisch Test

In a test tube containing small portion of the extract, few drops of Molisch reagent was added followed by concentrated sulphuric acid down the side of the test tube to form a reddish colored ring at lower layer, as an interphase which indicates the presence of carbohydrates.

Fehling's Test

To a small portion of the extract in a test tube, 5 mL of an equal mixture of Fehling solution A and B was added and boiled on a water bath, brick red precipitate was observed which indicates the presence of reducing sugar.

2.6. Determination of Surface Tension

The surface tension measurement was carried out using modified drop weight method by [7]. This was repeated for all the surfactants at different concentrations. All analysis was carried out at room temperature, and the surface tension was calculated using the formula below;

$$(r_2) = \frac{r_1 n_1 p_2}{n_2 p_1}$$

Where; r_2 = surface tension of the sample

r_1 = surface tension of the distilled water

n_1 = number of drops of water

n_2 = number of drops of samples

P_1 = Density of water

P_2 = Density of sample

The Surface tension of 72.13 Nm^{-1} was adopted for distilled water, taken as standard at 25°C [3].

2.7. P^H Determination

The method described by [11] was adopted. The sample solutions (BS, SS, and ZS) were poured into a clean dry beaker and a standardized P^H meter was used to determine their P^H

3. Results

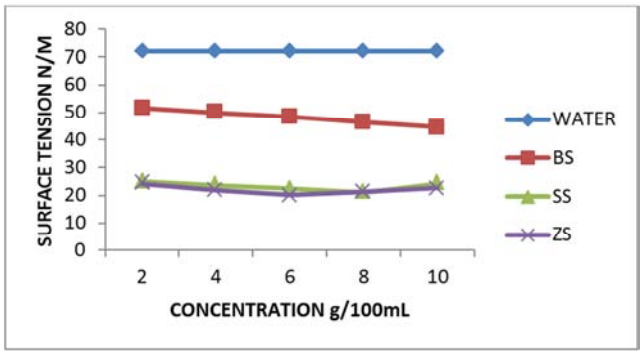


Figure 1. *Indicates the graphical representation of the surface tension determination (Nm^{-1}) for BS, SS and ZS at different concentrations.*

Table 1. *Some preliminary phytochemical constituents of stem bark extracts of successive extraction of Balanites aegyptiaca. Note, + indicates dictated; - not dictated.*

Constituents	Pet. ether	Methanol	Acetone	Water
Carbohydrate	+	+	+	+
Tannins	+	+	+	-
Alkaloids	-	+	-	+
Flavonoids	-	+	+	+
Saponins	+	+	+	+

Table 2. *Showing the saponin test carried out on the stem bark of Balanites aegyptiaca plant.*

Test	Observation	Result
Frothing test	Foam	+
Haemolysis test	Scattering of red blood cell	+

+ = detected

Table 3. *Showing Surface Tensions determination (Nm^{-1} on BS, SS and ZS at Different Concentrations.*

Concentration (g/100mL)	Surface tension Values		
	BS	ZS	SS
2	51.63	24.32	25.15
4	50.01	22.06	23.62
6	48.54	20.39	22.49
8	46.51	21.49	21.20
10	44.70	22.90	24.41

Table 4. *Indicates the P^H level of 'BS, SS and ZS' at Different Concentrations.*

Concentration (g/100mL)	P^H Values		
	BS	SS	ZS
2	7.50	10.87	10.92
4	7.02	10.94	11.11
6	6.80	10.99	11.27
8	6.61	11.06	11.43
10	6.39	11.11	11.57

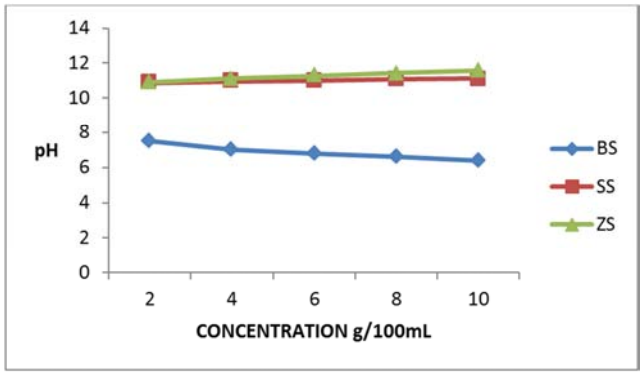


Figure 2. *Indicates the graphical representation of the pH determination for BS, SS and ZS at different concentrations.*

4. Discussion

The stem bark extract of *Balanites aegyptiaca* was tested for the presence of saponins and was found positive. This approves the report by [4]. In this work, the percentage yield of 34.29% was obtained from 100 g of the sample powder after being defatted. Remember, saponins are special class of glycosides with soapy characteristics [10]. The

phytochemical screening of the plant stem bark showed the presence of saponins, flavonoids, tannins and alkaloids as indicated in Table 1. These chemical constituents contributed to the biological activities of the plant. The presence of these phytochemicals mostly in the crude stem bark extract, is responsible for the regular and continuous use of the stem bark by traditional health practitioners in treatment of various diseases, since each of these constituents play various roles in biological activities of the plant.

In case of surface activity, the *Balanites aegyptiaca* sample (BS) showed a good reduction in surface tension with increase in concentration, but not as observed in commercial surfactants (SS and ZS). Generally, the observed decrease in surface activity of the synthetic surfactant ZS as compared with water at room temperature showed a decrease with increase in concentration from 2 g to 10 g of the plant extract. On the other hand, the synthetic surfactant SS decreases the surface activity with increase in concentration from 2 g to 10 g at room temperature as compared with water which serves as a control. All these variations may be due to solute-solvent balance ratio. The dragging drop in surface tension of *Balanites aegyptiaca* solution (BS) could be attributed to poor solubility of the extract due to the presence of impurities as reported by [4]. However this may be improved by further purification of the extract and addition of formulating ingredients to stabilize and improve the surface activity.

The P^H of the *Balanites aegyptiaca* solution (BS) varies from neutral to weak acid with increase in concentration, and this could be attributed to its crude nature i.e. absence of formulation ingredients as reported by [1]. On the other hand, the synthetic or commercial surfactants (ZS and SS) are moderately basic.

5. Conclusion

The analytical investigation of surfactant properties of stem bark extract of *Balanites aegyptiaca* in comparison with some synthetic surfactants (ZS and SS), proves that *Balanites aegyptiaca* stem bark extract at all concentrations can compete with the synthetic surfactants in most of its wetting and foaming properties. This may serve as substitute in household and industrial applications. This quality of serving as a substitute may be based on its availability, low cost, non-toxic nature and yield expectation [1]. A look at the above advantages and the possibility of the plant being propagated easily and hybridized for better yield and growth may transcend into commercial production of Desert Date (*Balanites aegyptiaca)* stem bark for the purpose of surfactant production. Hence it may stand as a reliable alternative if the source (petroleum and coal base) of synthetic surfactants depletes with time. Lastly, this study showed that (*Balanites aegyptiaca) stem bark* can be regarded as a natural surfactant being that it possesses similar properties with the tested commercial surface active agents as was established by the work of [1]. This indicates that (Balanites aegyptiaca) stem bark could serve as a wetting and cleansing agent for household and industrial applications.

Acknowledgements

The authors are sincerely grateful to Mallam Muhammad Sanusi Ahmad for providing the sample materials from Jalingo, Taraba State. We recognize the assistance rendered by the Technicians of the Chemistry Unit, Department of Science Laboratory Technology, Federal Polytechnic Bali, Taraba State at the time this study was carried out.

References

[1] Agu M. O. (2013). Evaluation of some properties of Violet Plant (*Securidaca longepedunculata)* Roots as a Surfactant; *International Journal of Biotechnology and Biochemistry*; 9 (1); 75-85.

[2] Anyasor, G. N, Ogunwenmo K. O, Oyelana O. D and Akpotenure B. G., (2010). Phytochemical constituents and antioxidant activities of aqueous and methanol stem extract of *Costus afer*- Ker Gawl. (Costaceae). *African Journal of Biotechnology;* 96 (31); 4880-4884.

[3] Arthur W. A. (1990). Physical Chemistry of Surfaces, 5th Edition, Wiley Interscience Publication, New York.

[4] Barminas, JT., Nkafamiya II., Kime B., Ayodele, A (2016). Extract and Evaluation of foam formation and surface tension of saponin-base surfactants from *Balanites aegyptiaca (L.)* Plant. *The Pharmaceutical and Chemical Journal.* 3 (1); 34-38.

[5] Daya L., Chothami and H. U (2011). A review on *Balamites aegyptiace Del.* (Desert Date); Phytochemical constituents, traditional uses and pharmacological activity. Pharmacogn Rev. 5 (9) 55-62, http://www.nobi.nlm.nin.gov/pmc/articles/PMC3210001

[6] Evans, W. C (2006). Trease and Evans Pharmacognosy 16th ed. W. B Saunders Elsevier Science Ltd; London, UK pp 52-58.

[7] Fell J. T. (1988). Surface and Interfacial Phenomena in: Pharmaceutics the science of Dosage from Design (Aulton, M. E. Editor) ISE Churchill Livingstone, New York, pp 60-61.

[8] Gerplasm, R. I. N (2008). *Balamites aegyptiaca (L.) Delile* United states, Department of Agriculture. http://www.avsgnn.gov/cgi-bin/ngps/html/taxen.pl?6322

[9] Hall JB, Walker HD. 1991. Balanites aegyptiaca: a monograph. School of Agriculture and Forest Sciences Publication Number: 3. University of Wales, Bangor pp 1-12.

[10] Kennedy, D. O, Wightman, E. L (2011). Herbal extracts and phytochemicals: plant secondary metabolites and the enhancement of human brain function. AdvNutr Res; 2: 32-50.

[11] Manji, A. J. Sarah, E. E. and Modibbo, U. U (2013). Studies on potentials of *Balanites aegyptiaca* seed oil as raw material for the production of liquid cleaning agent. *International journal of physical science*. 8 (33) 1660-1664.

[12] Ndeye, M (2004). Productive biology in *Balamites aegyptiaca (L.) Del*; a semi-arid forest tree. *African Journal of Biotechnology*, 3: 40-46.

[13] Sofowora, A (1993). Medicinal plants and traditional medicine in Africa. Spectrum books Ltd. Ibadan Nigeria. Pp 191 – 289.

[14] Tesfaye, A (2015). Balanites (Balanites aegyptiaca Del) multipurpose tree. A prospective review. *International journal of chemistry and applied science 2 (3): 189-194*.

[15] Yusuf, A. Z., Zakir, A., Shemau, Z., Abdullahi, M., and Halima, S. A (2014). Phytochemical analysis of the methanol leaves extract of *paullinia pinnata* Linn. Journal of pharmacognosy and phytotherapy. Vol. 6 (2). Pp. 10-16.