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Short Communication

Studies on enhanced African black soap from *Theobroma cacao* (cocoa) and *Elaeis guineensis* (palm kernel oil)

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The indigenous African organic soap is formed by saponification. Using the local and ancient method, with slight modifications, palm kernel oil (*Elaeis guineensis)* and the filtrate of burnt cocoa pod ash (*Theobroma cacao)* were used to prepare African black soap ($C_{11}H_{23}COO^-K^+$). The prepared black soap was thereafter divided into five parts. Part A was the control without additives, while parts B, C and D were enhanced with aloe vera, camwood and lime respectively. Part E was enhanced with both shea butter and camwood. These samples were analyzed chemically by pH determinations, infrared spectroscopic analyses and phytochemical screenings. They were also screened for *in-vitro* antibacterial activities against two Gram-positive bacteria (*Staphylococcus aureus* and *Bacillus subtilis*) and two Gram-negative bacteria (*Pseudomonas aeruginosa* and *Escherichia coli*). The pH determinations showed that all the samples were alkaline in nature with values between 8.7 and 9.1. Infrared spectra analyses of the unenhanced black soap revealed a medium and a strong band due to υ (C=O) frequency of the keto group at 1740 and 1562 cm^{-1} respectively and a medium band at 1119 cm^{-1} due to υ (C-O) frequency of the ester oxygen. These bands appeared almost unchanged in the infrared spectra of the enhanced samples signifying no complexation through the oxygen donor atoms. Thus, the structure of the black soap (A) was intact and it was not denatured by the various additives. Phytochemical screenings revealed that A and D contained saponins, flavonoids and terpenoids; C contained both flavonoids and terpenoids; B and E contained only terpenoids; while tannins and steroids were absent in all the samples. Antimicrobial studies showed that the enhanced black soap were either active against one or both gram-negative bacteria. In addition B, C and D were also active against either one or both gram-positive bacteria. E was inactive against the gram-positive bacteria, while the unenhanced black soap remained inactive against all tested organisms.

Key words: Enhanced African black soap, phytochemical and antimicrobial activities, chemical.

INTRODUCTION

African black soap or black soap, also known as *Alata Samina* or *Alata* originated from West Africa (Bella, 2008). It has being used since ancient time in Ghana and Nigeria, where it also enjoys several names like *Ose Dudu*, *Eko Zhiko* and *Sabulon Salo* (Getradeghana, 2000). This indigenous African organic soap is formed by esterification (Bella, 2008). It has found a wide application for all household cleaning purposes from bathing to washing and cleaning (Getradeghana, 2000). Black soap enjoys a good reputation for its ability to deeply cleanse the skin's pores, remove blemishes and makeup, improve or eliminate uneven skin tone, razor bumps caused by ingrown hairs and skin rashes (Getradeghana, 2000). It is not scented and therefore can be used by anyone who wishes to improve the quality of his/her skin (Getradeghana, 2000). We have previously reported the preparation of African black soap by reacting palm kernel oil and the filtrate of burnt cocoa pods (the ash). The chemical analyses of the black soap revealed moisture content was 26% (w/w); Total Fatty Matter (TFM) was 44.75% (w/w), Total Fatty Alkaline (TFA) was 0.22% (w/w), Total Alkaline (TA) was 11.78% (w/w) and pH was 10 (Ikotun et al., 2017a). Some metal complexes were thereafter prepared by the reaction of the prepared black soap with some transition metal salts. The characterization of the black soap and prepared complexes done by spectroscopic analyses and determination of physicochemical properties revealed that the potassium salt ($C_{11}H_{23}COO^{-}K^{+}$), commonly called African black soap, acted either as a monodentate or bidentate ligand forming metal complexes by coordinating through one or two of its oxygen donor atoms and also by entirely replacing the potassium ion with the transition metal (displacement reaction). Our interest in this indigenous African black soap has previously led to studies using the ash from the sun dried cocoa pods (Ikotun et al., 2017b). This present work was aimed at preparing African black soap using the waste material from cocoa (cocoa pod burnt to ash without prior sun drying) and palm kernel oil. Thereafter, the different portions of the prepared black soap were enhanced with some naturally occurring beautifying organic compounds and analyzed chemically. Also, phytochemical analysis and *in-vitro* antimicrobial studies were carried out on them. This literature therefore serves as the first report on the physicochemical analyses, phytochemical analyses and antimicrobial studies of burnt cocoa pod filtrate prepared African black soap, as well as that of its enhanced samples with some skin-nourishing natural products.

MATERIALS AND METHODS

Chemical

Palm kernel seeds and cocoa pods were locally sourced from a town called Ifeodan, Osun State, Nigeria. All solvents used were purchased as analytical grades from Sigma-Aldrich and SAARChem

Instrumentation

The Infrared spectra were recorded as KBR plates on a Nicolet Avatar FTIR 330 spectrophotometer. Hanna Professional Waterproof pH/ORP meter was used for determining the pH.

Preparation of the black soap

African Black soap was prepared according to literature (Ikotun et al., 2017b) and divided into five portions. Some beauty enhancing natural compounds were added as additives into four of the soap portions in separate labeled containers, followed by manual pounding with a pestle and mortar. Part A was without additives, while part B contained 12.50 g of black soap pounded with half table spoon of squeezed aloe vera. Sample C contained 12.50 g of black soap pounded with 0.7 g cam wood. Sample D contained 12.50 g black soap pounded with 7 drops of lime. Part E was enhanced by pounding 12.50 g black soap with 0.35 g shea butter and 0.35 g camwood. These samples were analyzed by pH determinations, infrared spectroscopic analyses and phytochemical screenings.

Antimicrobial test

15.2 g of Mueller Hinton agar was measured into a 500-ml conical flask, 400 ml of distilled water was added and mixed/shaken till it dissolved, it was then covered with cotton wool and aluminum foil paper and labeled. It was autoclaved at a temperature of 121°C for 15 min. The agar was allowed to cool to a temperature of 45°C and aseptically poured into sterile Petri dishes. The poured agar was allowed to solidify. 0.5 g of the prepared samples and 2.5 ml of distilled water were dispensed into Mac Cartney bottles and allowed to dissolve. Sterile filter paper disc (7 mm in diameter) was then placed inside the dissolved soap mixture and allowed to soak for 10 min. The plates were then inoculated with the test bacteria using the spread plate method with a sterile swab stick. The test bacteria were two Gram-positive bacteria (*Staphylococcus aureus* and *Bacillus subtilis*) and two Gram-negative bacteria (*Pseudomonas aeruginosa* and *Escherichia coli*) (Cheesbrough, 2002; Emeruwa, 1982). The inoculated plates were kept on the work bench for 1 h before further work was carried out. The soaked discs were picked using forceps sterilized by flaming and placed aseptically on the inoculated Petri dishes. The discs were allowed to stick on to the surface of the agar medium before incubation. The plates were incubated at 37°C for 24 h and antibacterial activity of the soap was measured as diameter of zones of inhibition surrounding the impregnated filter paper discs. Zones of inhibition were measured in mm (Bauer et al., 1996; Balogun and Owoseni, 2013).

RESULTS AND DISCUSSION

Dunn (2011) reported the equation for the preparation of black soap as Equation 1, while Figure 1 presents its structure (Ikotun et al., 2017b).

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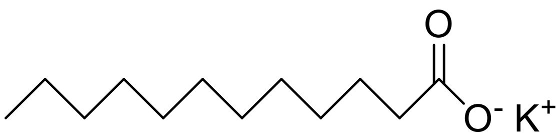
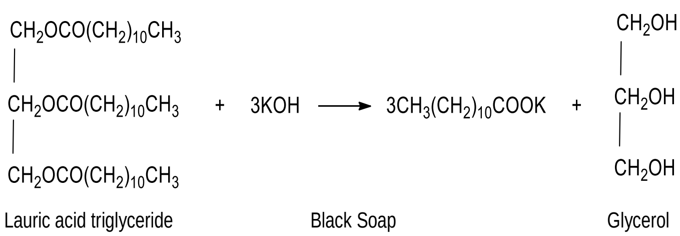


Figure 1. Structure of African Black Soap ($C_{11}H_{23}COO^{-}K^{+}$).

Table 1. pH values of the soap samples.

Sample	pH
A	8.9
B	8.7
C	9.1
D	8.9
E	8.9

Sample A , black soap alone; sample B, black soap with aloe vera; sample C, black soap with camwood; sample D, black soap with lime; sample E, black soap with sheabutter and camwood.



Equation 1: Preparation of African black soap.

pH determinations

Table 1 presents the pH values of the black soap and its enhanced samples. The pH determinations showed that all the samples were alkaline in nature with values between 8.7 and 9.1. Tarun et al. (2014) stated that majority of soaps have a pH value between 9 and 10.

FTIR spectra analyses

The FTIR spectra of the African black soap (Figure 2) and its enhanced samples (Figures 3 to 6) have been analyzed and presented as Table 2. The characteristic vibrational frequencies have been identified by comparing the spectra of the prepared African black soap with the enhanced samples (Ikotun et al., 2017a). The broad medium band at 3381 cm^{-1} in sample A was assigned to the stretching vibration of OH. This band shifted to a lower frequency of 3374 cm^{-1} in samples B and E, while appearing at 3376 cm^{-1} in C and at 3364 cm^{-1} in D. The spectrum of A showed the sp^3 C-H stretching vibrations at 2920, 2957 and 2863 cm^{-1}, respectively. These bands have also appeared at about the same frequencies in all its enhanced samples. The stretching vibrational frequency of C=O for sample A appeared as a medium and a strong band at 1740 and 1562 cm^{-1}. These bands have appeared unchanged in all other samples. The stretching vibrational frequency of C-O of sample A was assigned the value 1119 cm^{-1}. The band appeared unchanged in samples B and C, but shifts to a slightly lower frequency at 1117 cm^{-1} in samples D and E. This analysis shows that the structure of black soap is intact and it was not denatured by the various additives.

Phytochemical screenings

The results of the phytochemical screenings of all the black soap samples are presented below as Table 3. The results showed that samples A and D contained saponin, while all the samples contained terpenoids. Sample C contained flavonoids, while tannins and steroids are absent in all the samples. These results revealed the presence of some essential secondary metabolites which nourish the skin.

Antimicrobial screenings

The results of the antibacterial activities of the black soap and its enhanced samples are displayed in Figure 7. Sample B, which contained aloe vera, was active against both Gram-positive bacteria, as well as *E. coli*. Sample C, which contained camwood, was active against *S. aureus* and *E. coli*. Sample D, which contained lime, was active against both Gram-negative bacteria and the only one active against *P. aeruginosa.* It was also active against *S. aureus.* Sample E, which contained shea butter and camwood, was only active against the *B. subtillis*. African black soap remained inactive against all tested microorganisms.

Conclusion

The results of the phytochemical screenings of black soap revealed it contains some secondary metabolites which are nourishing to the skin. This is a good justification for the reason it cleanses deeply and nourishes all skin types. The enhancement of black soap with some other natural skin beautifying compounds did not affect or denature it, but rather facilitated its antimicrobial activities.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

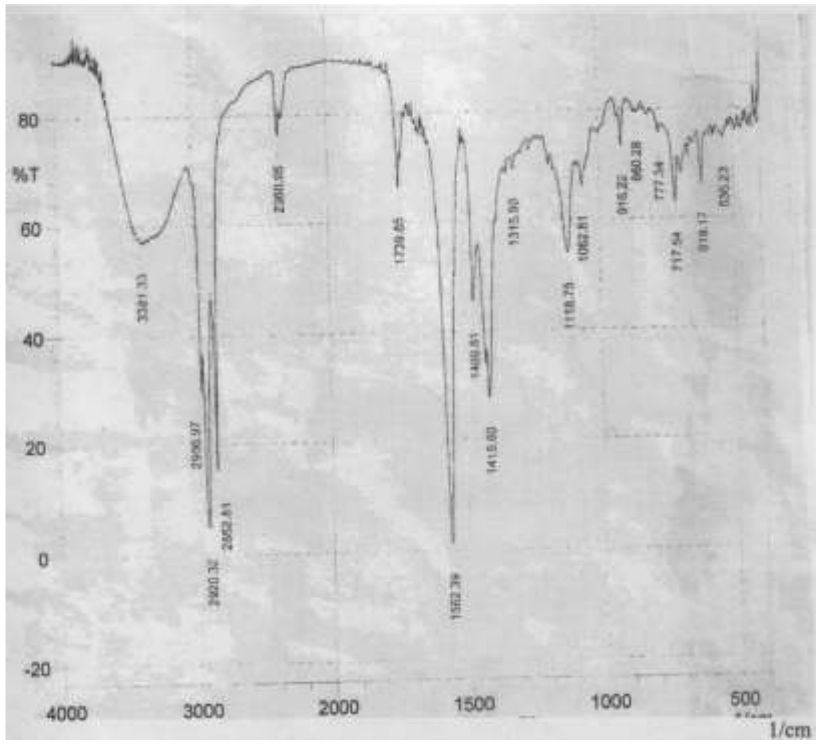


Figure 2. FTIR spectrum of the black soap without enhancement (Sample A).

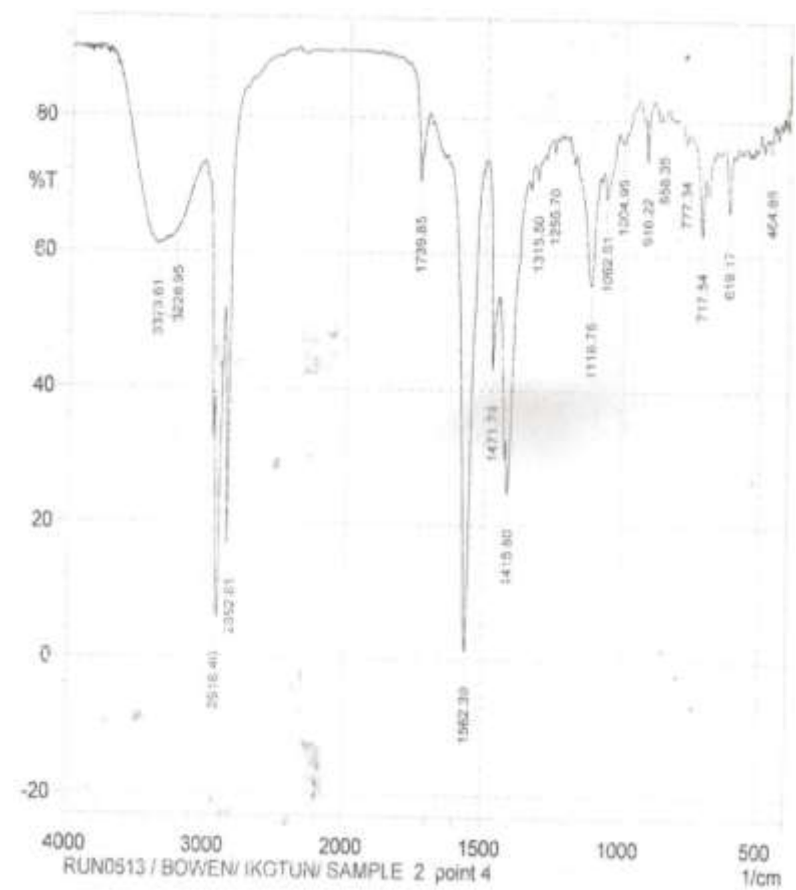


Figure 3. FTIR spectrum of B (Black soap with aloe vera).

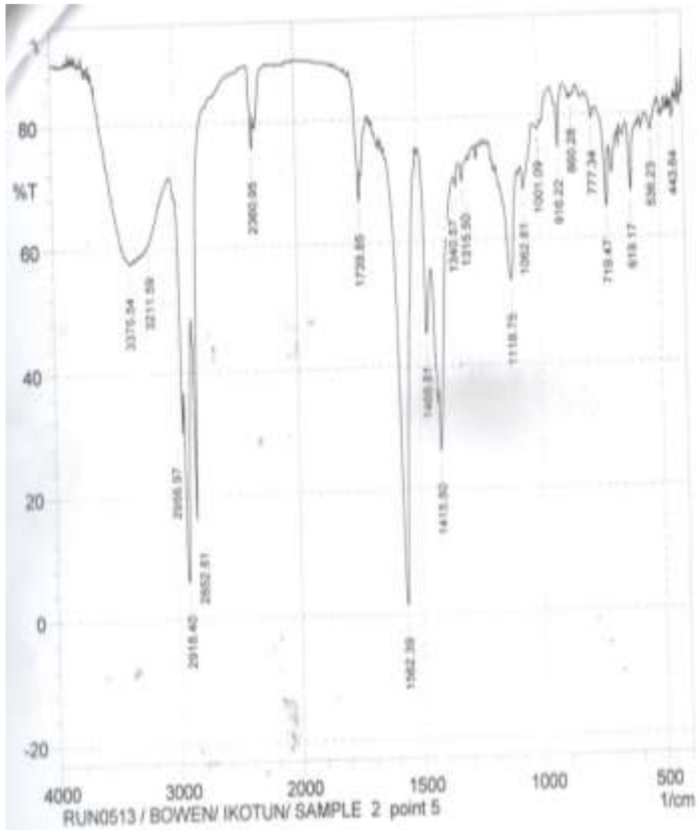


Figure 4. FTIR spectrum of C (black soap pounded with camwood).

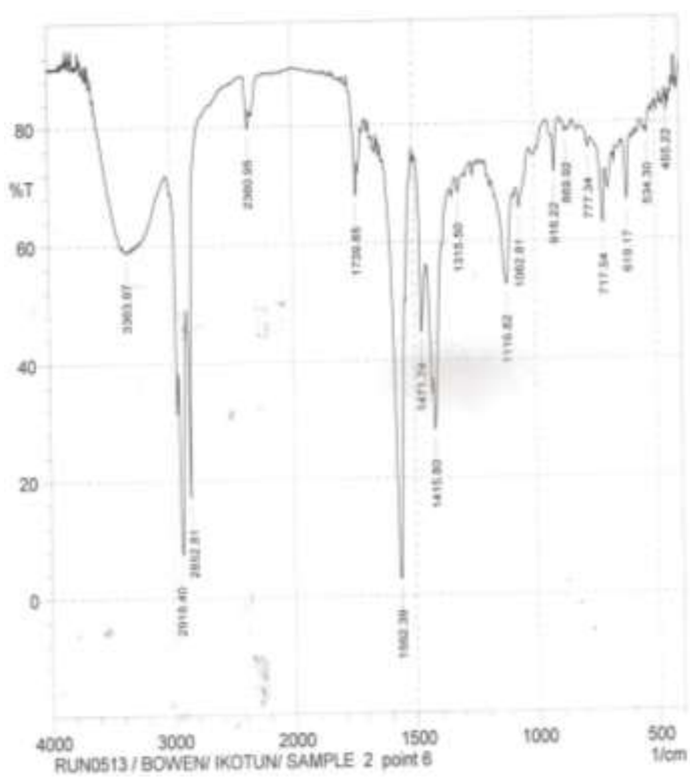


Figure 5. FTIR spectrum of D (black soap with lime).

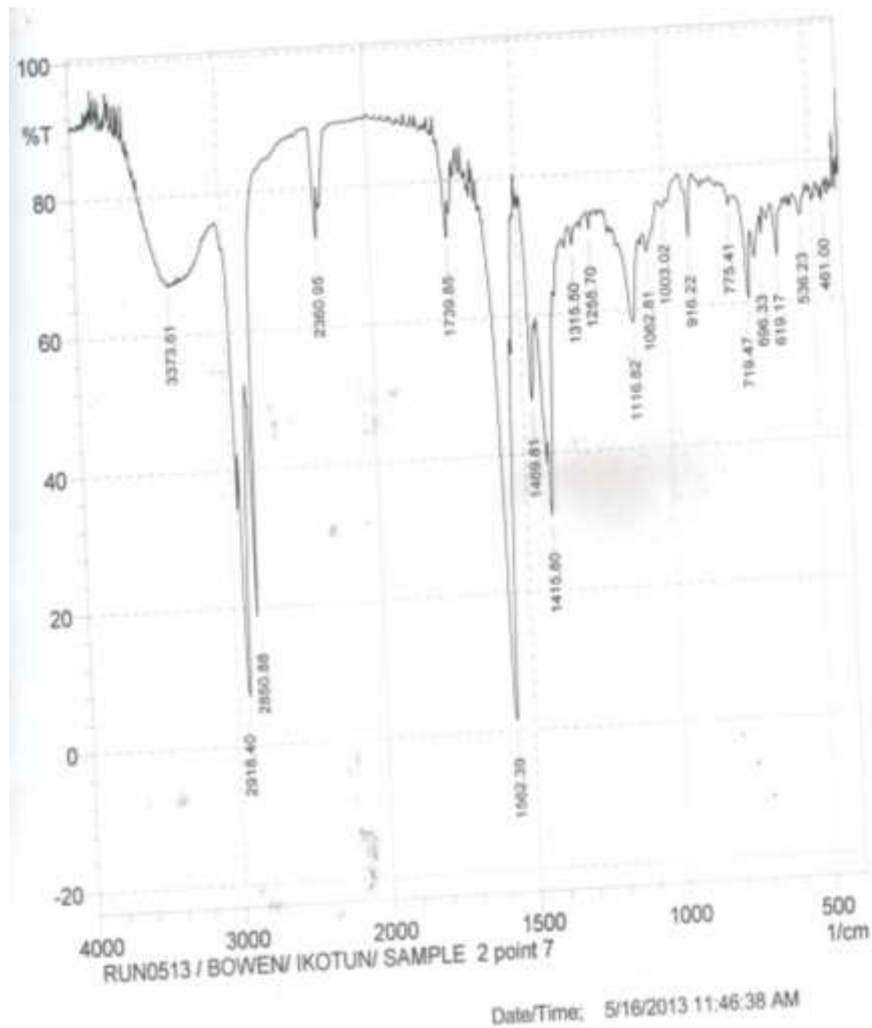


Figure 6. FTIR spectrum of E (black soap with shea butter and camwood).

Table 2. FTIR spectra analyses of black soap and its enhanced samples.

Sample	υ (OH) (cm^{-1})	υ (C-H) (cm^{-1})	υ (C=O) (cm^{-1})	υ (C-O) (cm^{-1})	Others
A	3381 bm	2920 s 2957 sh 2863 s	1740 m 1562 s	1119 m	1416s
B	3374 bm	2918 s 2853 s	1740 m 1562 s	1119 m	1416 s
C	3376 bm	2918 s 2957sh 2853 s	1740 s 1562 s	1119 m	1416 s
D	3364 bm	2918 s 2853 s	1740 m 1562 s	1117 m	1416 s
E	3374 bm	2918 s 2851 s	1740 m 1562 s	1117 m	1416 s

s, Strong; m, medium; b, broad; bs, broad strong; bm, broad medium; sh, shoulder.

Table 3. Phytochemical screenings of the black soap samples.

Sample	Tannins	Saponins	Flavonoids	Steroids	Terpenoids
A	-	+	+	-	+
B	-	-	-	-	+
C	-	-	+	-	+
D	-	+	+	-	+
E	-	-	-	-	+

+, Present; - , Absent.

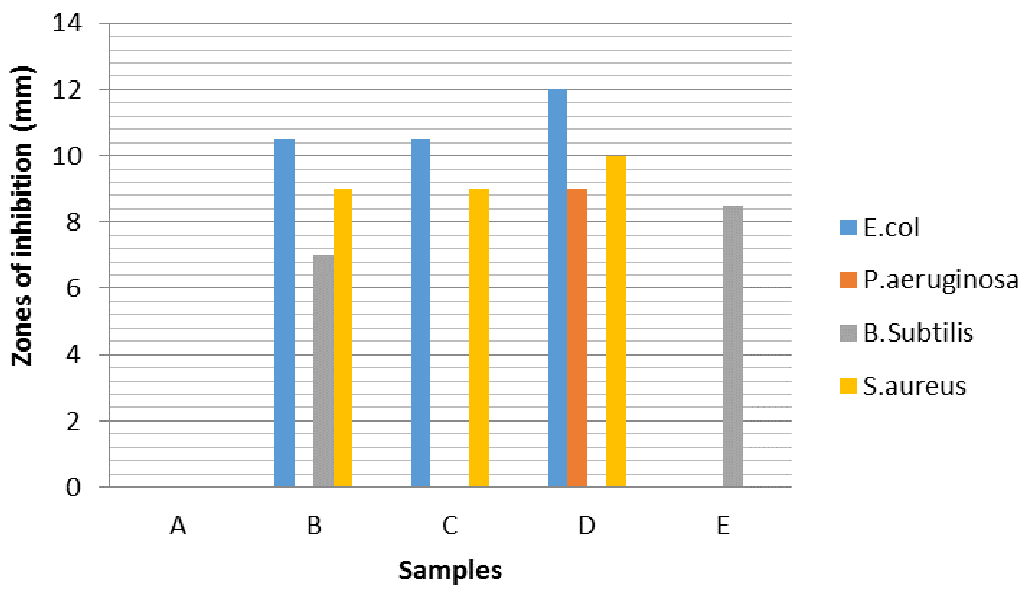


Figure 7. Antibacterial activities of black soap and its enhanced samples. *E. col = Escherichia coli; P. aeruginosa = Pseudomonas aeruginosa; B. subtilis = Bacillus subtilis ; S. aureus = Staphylococcus aureus.*

REFERENCES

Balogun OS, Owoseni AA (2013) Phytochemical and antimicrobial investigation of *Dissotis rotundifolia* (sm) Triana. Natural Products 9(2):77-80.

Bauer AW, Kirby WM, Sherris JC, Turck M (1996). Antibiotic susceptibility testing by a standardized single disk method. American Journal of Clinical Pathology 45:439-496.

Bella O (2008). African Black Soap, http://www.bellaonline.com/articles/art26846.asp.

Cheesbrough M (2002). Biochemical tests to identify bacteria. In. Laboratory practice in tropical countries. Cheesbrough M (ed.). Cambridge Edition pp. 63-87.

Dunn KM (2010). Scientific Soap making: The Chemistry of Cold Process. Clavicula Press.

Emeruwa KC (1982). Antimicrobial substances from Cacaya papaya fruit extracts. Journal of Natural Products 45:123-127.

Getradeghana BT (2000). Evaluation of African traditional soap. Global Journal of Pure and Applied Sciences 6:174-179.

Ikotun AA, Awosika OO, Oladipupo MA (2017a). The African Black soap from *Elaeis guinensis* (Palm Kernel Oil) and *Theobroma cacao* (Cocoa) and its transition metal complexes. African Journal of Biotechnology 16(18):1042-1047.

Ikotun AA, Olalere CA, Adekunle DO, Dawodu MO (2017b). Phytochemistry and Antimicrobial Studies of African Black Soap and its Modified Samples. Journal of Chemical and Pharmaceutical Research 9(5):354-359.

Tarun J, Susan J, Suria J, Susan VJ, Criton S (2014). Evaluation of pH of Bathing Soaps and Shampoos for Skin and Hair Care. Indian Journal of Dermatology 59(5):442-444.