



## ORIGINAL RESEARCH

### Antimicrobial Activity of Commonly Used Medicated Soaps on Multi-Drug Resistant *Staphylococcus aureus* and *Escherichia coli* in Maiduguri, Nigeria

Kaigama ZB<sup>1\*</sup>, Stephen CM<sup>1</sup>, Hamza JA<sup>2</sup> and Onanuga A<sup>1,2</sup>

<sup>1</sup>Department of Pharmaceutical Microbiology & Biotechnology, Faculty of Pharmacy, University of Maiduguri, Maiduguri, Borno State, Nigeria; <sup>2</sup>Department of Pharmaceutical Microbiology & Biotechnology, Faculty of Pharmaceutical Sciences, Gombe State University, Tudun-Wada, Gombe State, Nigeria.

#### Address for correspondence:

Miss. Zara Bukar Kaigama  
Department of Pharmaceutical Microbiology & Biotechnology, Faculty of Pharmacy, University of Maiduguri, Borno State, Nigeria.  
Email: kaigamazarah@gmail.com

**To cite this article:** Kaigama ZB, Stephen CM, Hamza JA and Onanuga A. Antimicrobial Activity of Commonly Used Medicated Soaps on Multi-Drug Resistant *Staphylococcus aureus* and *Escherichia coli* in Maiduguri, Nigeria. Journal of Basic and Social Pharmacy Research, 2022;2(3):13-21  
ISSN: 2705-3245

## ABSTRACT

**Background:** The spread of antibiotic resistant infections in both hospital and community settings is a global public health problem. Proper hand washing with soaps has been described as a simple means of preventing disease transmission.

**Objectives:** The antimicrobial activities of six commonly used medicated soaps - Safeguard<sup>®</sup>, Dettol<sup>®</sup>, Crusader<sup>®</sup>, Septol<sup>®</sup>, Tetmosol<sup>®</sup> and Sabulun salo (Local black soap) against multi-drug resistant pathogenic *Staphylococcus aureus* and *Escherichia coli* isolates were investigated in Maiduguri metropolis.

**Methods:** Two isolates each of *Staphylococcus aureus* and *Escherichia coli* were collected from laboratory unit of the University of Maiduguri Teaching Hospital and confirmed using standard microbiological procedures. Antibiotic susceptibility testing was determined using standard disc assay method. The effectiveness of the soaps against these organisms was determined using agar well diffusion and broth dilution methods.

**Results:** The *E. coli* and *S. aureus* isolates were multi-drug resistant to the tested antimicrobials. Only one of the *S. aureus* isolates was susceptible to Safeguard<sup>®</sup>, Dettol<sup>®</sup>, Tetmosol<sup>®</sup> and Sabulun salo, while the other three isolates were resistant using the agar well diffusion method. Dettol<sup>®</sup>, Tetmosol<sup>®</sup> and Sabulun salo had the highest activity against all the isolates. One of the *S. aureus* isolates exhibited the highest susceptibility at MIC 1.56mg/ml and MBC 3.175mg/ml of the soaps' concentrations.

**Conclusion:** This study showed that Dettol<sup>®</sup>, Tetmosol<sup>®</sup> and Sabulun salo are the most effective soaps against antibiotic resistant bacteria and thus can be used to control the spread of pathogenic microorganisms in hospitals and communities through proper hand hygiene.

**Keywords:** Medicated soaps, MDR, *Staphylococcus aureus*, *Escherichia coli*, MIC, MBC

## INTRODUCTION

Soaps are the products of the saponification of alkaline substances with free fatty acids in fats and oils<sup>1</sup>. They have been used for extensively long time in many generations

as cleansing agents and means of achieving personal hygiene in many households and hospitals<sup>2-4</sup>. The antimicrobial soaps otherwise known as medicated soaps containing some antiseptic chemicals like Triclosan, Triclocarban, Chlorhexidine,

Hexachlorophene and Iodine<sup>2,3</sup>. They have been reported to remove 65 - 85% bacteria from human skin due to their washing and killing effects, thereby continue to reduce microbial flora on the skin after washing hands<sup>2,5-8</sup>.

Micro-organisms are ubiquitous having their habitats everywhere and in some parts of human body where they exist as microbiota rendering one benefit or the other to the host<sup>9</sup>. However, they are a major aetiologic agents of human diseases and infections in the community, and their effects can be more severe in people with breakdown of immune status depending on the loads of the infectious agents in the carrier individuals<sup>10</sup>. Person to person contact has been attributed as one of the major means of transmission of these infections in the community and the commonly implicated bacteria in the community associated infections are being described as *Staphylococcus aureus*<sup>11</sup>, *Escherichia coli*<sup>12</sup> and *Pseudomonas aeruginosa*<sup>13</sup>.

The human skin is the largest organ in the body which is the first line of defence that serves as a protective waterproof layer that blocks the entry of bacteria, viruses, fungi and parasites into the body thereby keeping the internal tissues free from infections<sup>9</sup>. Hence, regular hand washing is therefore very crucial to the wholesome health of the individuals in community and hospitals when it is targeted at the reduction of possible cross transmission of pathogenic or opportunistic bacteria especially when the cleansing agent contains chemicals that have antimicrobial property<sup>14</sup>.

Although some researchers have described excessive use of medicated soaps as a possible rid-off of skin microbiota and exposure to opportunistic skin infections<sup>4</sup>. This study therefore seeks to evaluate the antimicrobial activities of different kinds of medicated soaps available in Maiduguri metropolis, Borno state against clinical isolates of multi-drug resistant *Staphylococcus aureus* and *Escherichia coli*.

## MATERIALS AND METHODS

### Study Area

Maiduguri is capital city of Borno State in North-eastern Nigeria, and it is the largest city in the Northern Nigeria with 543 km<sup>2</sup> and it lies between latitudes 11° 49' 59.9988" N and longitude 13° 9' 0.0000" E<sup>15</sup>. Its residents are mostly Muslims including Kanuri, Hausa, Shuwa, Marghi and Fulani ethnic groups. There are also a considerable Christian population and people from Southern States of Nigeria such as the Igbo, Ijaw and Yoruba. Their major occupations are trading, farming and education<sup>15</sup>.

### Ethical Clearance

Ethical approval was obtained from the Ethics and Research committee of University of Maiduguri, Maiduguri, Nigeria, before the commencement of the study in April 2021.

### Sample Collection

The bacterial cultures of *Staphylococcus aureus* and *Escherichia coli* which were obtained from patients with wound and urinary tract infections respectively, were collected from the Microbiology laboratory unit of University of Maiduguri Teaching Hospital (UMTH), and transported to the Department of Pharmaceutical Microbiology laboratory, Faculty of Pharmacy, University of Maiduguri, Borno State. They were inoculated on already prepared sterilized nutrient agar for purification and identification of the discrete bacterial colonies after incubation at 37°C for 24 hours.

### Collection of soap samples and preparation of soap solutions

The medicated soap samples used for the study were purchased from market in Maiduguri, Borno State. The batch numbers, expiry dates and the presence or absence of the manufacturers seal were noted. The soap samples were Safeguard®, Dettol®,

Crusader®, Septol®, Tetmosol® and Sabulun salo (local black soap).

Six different concentrations of each of the soap samples were prepared for the susceptibility testing. An initial stock concentration of 100mg/ml of each of the soaps was first prepared by scrapping 1 gram of each of the soaps into each of a sterilized 9 ml of distilled water and the other concentrations of 50mg/ml, 25mg/ml, 12.5mg/ml, 6.25mg/ml and 3.125mg/ml were prepared from the initial stock concentration of 100mg/ml solution of each of the soaps.

#### **Preparation of standardized bacterial suspension**

The bacterial isolates that gave the characteristic golden yellow colour on Mannitol Salt agar and greenish metallic sheen on Eosin Methylene Blue agar were confirmed as *Staphylococcus aureus* and *Escherichia coli* respectively. Each of the overnight culture of the selected *S. aureus* and *E. coli* was standardized by dispensing colonies from it into sterilized 5ml normal saline until the turbidity matched that of 0.5McFarland standard suspension corresponding to  $1.5 \times 10^8$  CFU/mL of the isolate in the suspension.

#### **Antimicrobial susceptibility testing of the bacteria**

The susceptibility pattern of each of the selected *S. aureus* and *E. coli* isolates against some antibiotics was determined using the modified Kirby-Bauer agar diffusion method by inoculating each of the Mueller Hinton agar plates with each of the standardized bacterial suspension using sterile cotton swab sticks. Then the eight antibiotic discs (Gentamicin 10 µg, Chloramphenicol 30 µg, Levofloxacin 5 µg, Cefotaxime 30 µg, Imipenem 10 µg, Ceftaxidime 30 µg, Nitrofurantoin 300 µg and Cotrimoxazole 25 µg) were placed at equidistance on the surface of the agar and incubated at 37°C for 24 hours. The zone of inhibition of each of the antibiotic discs against the test organism was measured and

interpreted using the Clinical Laboratory Standard Institute<sup>16</sup> test chart. The antimicrobial susceptibility test results were interpreted based on the different zones of inhibition produced on the Mueller Hinton agar plates by the different concentrations of the antibiotic discs<sup>17</sup>.

#### **Determination of the antimicrobial activities of the soaps**

The susceptibility pattern of each of the selected *S. aureus* and *E. coli* isolates to the various concentrations of the soaps was determined using agar well diffusion method. Each of the Mueller Hinton agar plates were swabbed with each of the standardized bacteria suspension using sterile cotton swab sticks and a sterile cork-borer of 10 mm diameter was used to make six wells in the agar plates and sealed with few drops of molten agar before adding 100 µl (0.1 ml) of each of the six concentrations (100mg/ml, 50mg/ml, 25mg/ml, 12.5mg/ml, 6.25mg/ml and 3.125mg/ml) of a particular soap to the labelled wells using 100 µl micropipette. The plates were then incubated at 37°C for 24 hr, after which the zone diameters of inhibition were measured and interpreted<sup>16</sup>.

#### **Determination of minimum inhibitory concentration and minimum bactericidal concentration of the soaps**

The Minimum Inhibitory Concentration (MIC) of each of the selected soaps were determined by the standard macro broth dilution method in Mueller–Hinton broth using a 100mg/ml stock solution of the soap and a serial dilution was performed by taking 5 mL from the stock solution (100 mg/mL) and successively pipetting the same volume into the test tubes containing 5 mL of sterile Muller Hinton broth each serially, starting with the first tube to obtain the following concentrations: 50mg/mL in the first tube, 25mg/mL in the second tube, 12.5mg/mL in the third tube, 6.25mg/mL in the fourth tube, 3.125mg/mL in the fifth tube, and 1.5625mg/mL in the sixth tube. The tubes were then inoculated with 100 µL

of each of the standardized test bacterial isolates. All the tube cultures including the experimental controls were incubated at 37 °C for 24 hours and were observed for turbidity as evidence of bacterial growth. The lowest concentration of the soap that prevented the bacterial growth is taken as its minimum inhibitory concentration (MIC). The minimum bactericidal concentrations (MBC) assay was determined by inoculating fresh nutrient agar plates with one loop-full of culture taken from each of the broth cultures that showed no growth including the MIC tubes. The plates were incubated at 37 °C for 24 hr. After the incubation period, the lowest concentration of the soap that killed the bacteria on the solid medium was

established as MBC values for each soap sample<sup>17</sup>.

## RESULTS

### Susceptibility of bacteria to selected antibiotics

The four different pathogenic bacteria isolates obtained from the hospital were confirmed to be two *S. aureus* and two *E. coli*. The results of their susceptibility to the selected antibiotics revealed *S. aureus* isolates to be resistant to all the antibiotics belonging to seven classes of antimicrobial agents while *E. coli* isolates were only resistant to three antibiotics belonging to two classes of the agents as shown in Table 1.

**Table 1: Antimicrobial Susceptibility Pattern of the bacterial isolates**

AGENTS	<i>S. aureus</i> 1	<i>S. aureus</i> 2	<i>E. coli</i> 1	<i>E. coli</i> 2
Cefotaxime	R	R	R	R
Ceftazidime	R	R	R	R
Gentamicin	R	R	S	S
Chloramphenicol	R	R	S	S
Cotrimoxazole	R	R	R	R
Nitrofurantoin	R	R	S	S
Levofloxacin	R	R	S	S
Imipenem	R	R	S	S

**Note:** *S. aureus* 1, *S. aureus* 2, *E. coli* 1 and *E. coli* 2 are four different strains of two bacteria

### Antimicrobial activity of the soaps

The determination of the antimicrobial activities of the various concentrations of the six selected soaps using agar well diffusion method revealed *E. coli* 1, *E. coli* 2 and *S. aureus* 2 to be completely resistant to all the different soaps' concentrations while *S. aureus* 1 was found to be susceptible to increasing concentrations of Tetmosol®, Dettol®, Safeguard® and local soap as shown in Table 2.

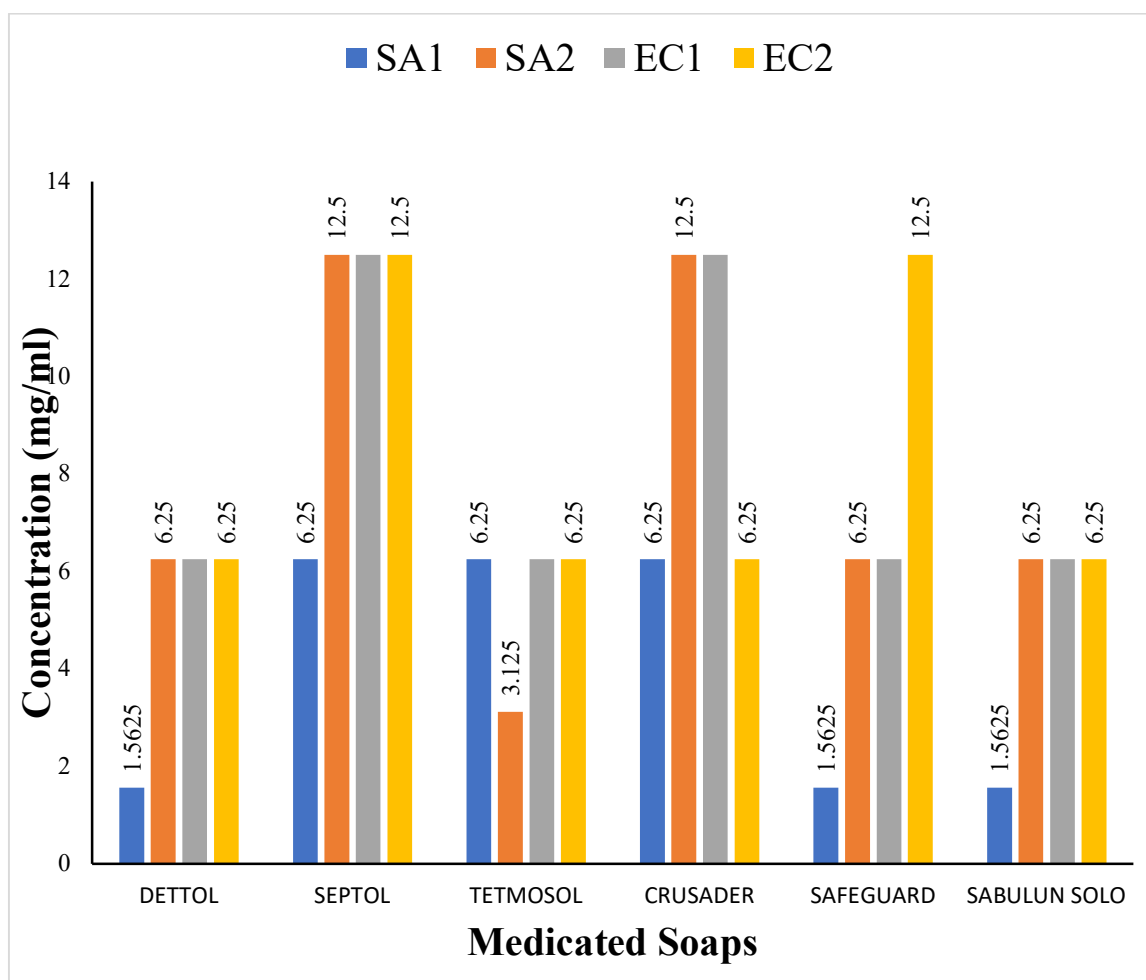
### Minimum inhibitory concentration and minimum bactericidal concentration of the soaps

The MIC and MBC determination of the soaps revealed the *S. aureus* 1 to be the most susceptible isolate showing highest susceptibility to Dettol®, Safeguard® and Local soap at MIC 1.56mg/ml and MBC 3.175mg/ml. However, Dettol®, Tetmosol® and local soap exhibited the highest antimicrobial activity against the *E. coli* isolates at MIC 6.25mg/ml and MBC 12.5 mg/ml as shown in Figures 1 and 2.

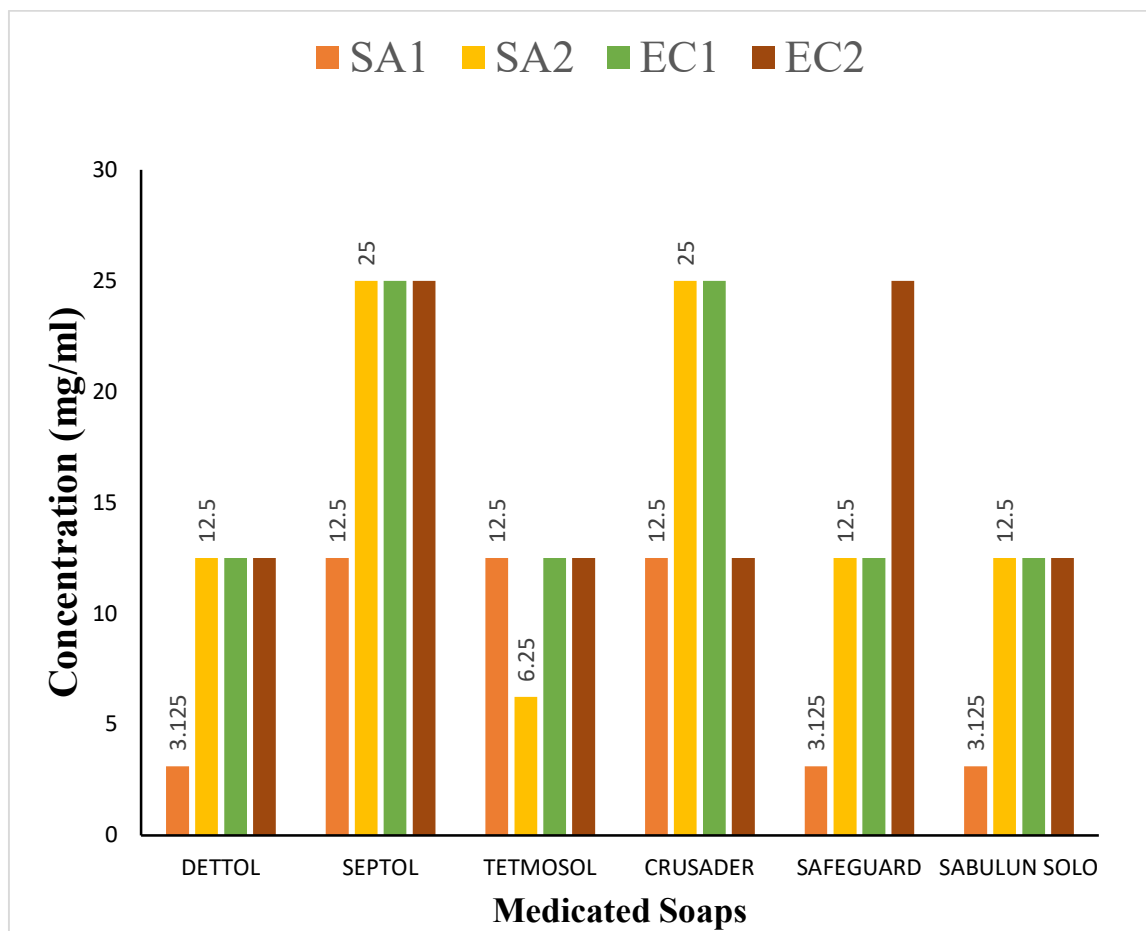
**Table 2: Susceptibility pattern of *S. aureus* 1 to the selected medicated soaps**

Soaps (mg/ml)	Zone diameter of inhibition (mm)					
	3.125	6.25	12.5	25	50	100
Tetmosol®	0	14	15	17	16	18
Dettol®	0	0	0	13	11	13
Septol®	0	0	0	0	0	0
Crusader®	0	0	0	0	0	0
Safeguard®	0	12	14	14	12	0
Local soap	0	0	12	14	19	21

**Note:** A 100 $\mu$ L of each of the soaps' solutions was used and the cork borer diameter was 10 mm.

**Figure 1: Minimum Inhibitory Concentrations of the Soaps**

**Key:** SA1 = *S. aureus* 1, SA2 = *S. aureus* 2, EC1 = *E. coli* 1 and EC2 = *E. coli* 2



**Figure 2: Minimum Bactericidal Concentrations of the Soaps**

**Key:** SA1 = *S. aureus* 1, SA2 = *S. aureus* 2, EC1 = *E. coli* 1 and EC2 = *E. coli* 2

## DISCUSSION

Medicated soaps have been reported to have killing effects on common antibiotic resistant pathogenic organisms and thus, has been recommended for regular use for the prevention of skin infections and the transmission of other diseases by direct or indirect contacts<sup>1, 18</sup>.

The susceptibility patterns of the isolates of the pathogenic bacteria in this study revealed that *S. aureus* isolates were all resistant to all the seven classes of antimicrobials used while the *E. coli* isolates were only resistant to two classes. This therefore implies that these pathogenic bacteria have been widely exposed to many antibiotics and their infections might have very limited treatment options posing the challenges of transmission to vulnerable

populations in the society leading to a serious a public health problem<sup>19-21</sup>.

The susceptibility pattern of the four bacterial isolates to the studied medicated soaps using agar well diffusion method revealed that only Safeguard®, Dettol®, Tetmosol® and local soap showed increasing varied activities to only one of the two *S. aureus* isolates at increasing concentrations while Septol® and Crusader® showed no activity to this isolate. However, the other three isolates were all resistant to all the tested soaps. This observation might be due to the molecular weights of the soap ingredients and their varying dissolutions which affect their diffusion within the agar<sup>16,17</sup>. The susceptibility of *S. aureus* isolates to the local soap using agar well diffusion method in this study is in agreement with the

findings of the studies from Bauchi State<sup>22</sup>, Zaria<sup>23</sup>, Birnin Kebbi<sup>24</sup>, Gombe State<sup>14</sup> and Akure<sup>25</sup>.

The *Escherichia coli* isolates in this study were not inhibited by any of the tested medicated soaps which agree with a similar study in Rawalpindi, Pakistan<sup>4</sup>. However, our finding is in contrary to a similar study in India where *E. coli* was inhibited by both herbal soap and medicated soap<sup>1</sup>. These observed variations might be due to the differences in the active ingredients of the soaps and the resistant profile of the strains of *E. coli* in the different centres.

The MIC and MBC determination of the medicated soaps revealed that *S. aureus* 1 was the most susceptible isolate showing the highest susceptibility to Dettol®, Safeguard® and local black soap at MIC 1.56mg/ml and MBC 3.175mg/ml. However, Dettol®, Tetmosol® and Local black soaps had the highest activity (MIC 6.25mg/ml and MBC 12.5 mg/ml) against the *E. coli* isolates. This therefore suggests that Dettol®, Tetmosol® and local black soap might be the most effective soaps for the reduction of antibiotic resistant bacteria through hand hygiene in both hospitals and communities in this locality. These results of the MIC and MBC against different concentrations of the selected medicated soaps concurred with a study which reported varied MBC and MIC results against isolates of *S. aureus* and *E. coli* showing *S. aureus* isolates to be more susceptible than *E. coli* isolates<sup>26,27</sup>.

## CONCLUSION

This study has shown the various levels of effectiveness of the selected medicated soaps against common human pathogens. Tetmosol®, Dettol® and local black (Sabulun salo) soaps showed the highest antimicrobial activity against the pathogens and can therefore be used to prevent skin infections and its transmission by hand washing, cleaning and bathing.

## ACKNOWLEDGEMENTS

The authors are thankful to Management and Laboratory staff of the participating hospitals and also wish to thank all our Technologists for their assistance during the various laboratory investigations for this study.

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. The authors declare no conflict of interest.

## REFERENCES

1. Chaudhari VM. Studies on antimicrobial activity of antiseptic soaps and herbal soaps against selected human pathogens. *Journal of Scientific and Innovative Research*, 2016;5(6):201-204.
2. Mwambete KD and Lyombe F. Antimicrobial activity of medicated soaps commonly used by Dar-es Salaam residents in Tanzania. *Indian Journal of Pharmaceutical Science*, 2011;73:92-98.
3. Obi CN. Antibacterial activities of some medicated soaps on selected human pathogens. *American Journal of Microbiological Research*, 2014;2(6):178-181.
4. Abbas SZ, Hussain K, Hussain Z, Ali R and Abbas T. Antibacterial activity of different soaps available in local market of Rawalpindi (Pakistan) against daily encountered bacteria. *Pharmaceutical Analytica Acta*, 2016;7(11):1-3.
5. Osborne RC and Grube J. Hand disinfection in dental practice. *Journal of Clinical Preview*, 1982;4:11-15.
6. Larson E. Hygiene of the Skin: When is clean too clean? *Emerging Infectious Diseases*, 2001;7(2):225-230.
7. Below H, Assadian O, Baguhl R, Hildebrandt U, Jäger B, Meissner K, *et al.* Measurements of chlorhexidine, p-chloroaniline, and p-chloronitrobenzene in saliva after mouth wash before and after operation

- with 0.2% chlorhexidine digluconate in maxillofacial surgery: a randomized controlled trial. *British Journal of Oral and Maxillofacial Surgery*, 2017;55(2): 150–155.
8. Painter J and Hoekstra RM. Effect of intensive hand washing promotion on childhood diarrhoea in high risk communities in Pakistan. *JAMA*, 2017;291(21):2547-2554.
  9. Teniola OD, Folounsho VT, Ogunlusi PS, Aderounmu AE and Omemu AM. Antimicrobial activities of different soaps on selected human skin pathogens. *Journal of Advances in Microbiology*, 2019;17(2):1-10.
  10. Garcia SL. Mixed cultures as model communities: Hunting for ubiquitous microorganisms, their partners and interactions, *Aquatic Microbial Ecology*, 2016;77(2):79-85.
  11. Higaki S, Kitagawa T, Kagoura M, Morohashi M and Yamagishi T. Predominant *Staphylococcus aureus* isolated from various skin diseases. *Journal of International Medical Research*, 2000;28(4):187- 190.
  12. Russell JB and Jarvis GN. Practical mechanisms for interrupting the oral-foecal lifecycle of *Escherichia coli*. *Journal of Molecular Microbiology and Biotechnology*, 2001;3(2):265-272.
  13. Fluit AC, Schmitz FJ and Verhoef, J. Frequency and isolation of pathogens from bloodstream, nosocomial pneumonia, skin and soft tissue, and urinary tract infections occurring in European patients. *European Journal of Clinical Microbiology and Infection*, 2001;20:188-191.
  14. Oladosu PO, Umar YA, Salawudeen A, Izebe K, Adamu MT and Aboh M. Antibacterial activity of soaps indigenously made in Gombe metropolis, Nigeria. *Journal of Natural Remedies*, 2018; 18(4):122-130.
  15. Mayomi I and Mohammed JA. A decade assessment of Maiduguri urban expansion (2002-2012): Geospatial approach, *Global Journal of Human Science*, 2014;B14(2):1. Available at: [https://globaljournals.org/GJHSS\\_Volume14/1-A-Decade-Assessments-of-Maiduguri-Urban.pdf](https://globaljournals.org/GJHSS_Volume14/1-A-Decade-Assessments-of-Maiduguri-Urban.pdf)
  16. Clinical and Laboratory Standards Institute. Performance Standards for Antimicrobial Susceptibility Testing. Twenty-Eighth Edition. Clinical and Laboratory Standards Institute, 950 West Valley Road, Suite 2500, Wayne, Pennsylvania 19087 USA, 2018.
  17. Cheesbrough M. Summary of the clinical and laboratory features of microorganisms: Bacterial pathogens. District laboratory practice in tropical countries, part 2 Cambridge University Press. 2006.
  18. Olajuyigbe OO, Morenike OA and Otunola A. Synergistic potentials of benzylpenicillin, amoxicillin and streptomycin antibiotics against selected bacterial species. *Life Science Journal*, 2016;13(8):37-44.
  19. Gupta M, Malhatra S, Chandra KK, Sharma N and Pandhi P. Utilization of parenteral anti-infective agents in the medical emergency unit of tertiary care hospital; an observational study. *Journal of Pharmacoepidemiol. Drug Saf.*, 2004;13(9):653-657.
  20. Johnson J, Kuskowski M, Menard M, Gajewski A, Xercavins M and Garau J. Similarity between human and chicken *Escherichia coli* isolates in relation to ciprofloxacin resistance status. *Journal of Infectious Diseases*, 2006;194(1): 71-78.
  21. Krivoy N, Ahal WAE, Lavie YB and Hadded S. Antibiotic prescription and cost pattern in a general intensive care unit. *Journal of Pharmacy of Practice*, 2007;5:67-73.
  22. Samaila AB, Yarma AA and Oshomoh EO. Antifungal and antibacterial activities of Sabulun salo local soap in Bauchi metropolis, Bauchi State, Nigeria. *Special Fungal Pathogens Journal*, 2016;1(1):0014-0018.
  23. Aliyu MS, Tijjani MB, Doko MHI, Garba I, Ibrahim MM, Absulkadir SM,

- et al.* Antimicrobial activity of Sabulun salo a local traditional medicated soap. Nigerian Journal of Basic and Applied Science, 2012;20(1):35-38.
24. Mondagi AG, Imonikhe MA and Oyinbo K. Analysis of antibacterial activity of African black soap on some selected pathogens. APRN Journal of Science and Technology, 2012; 2:358-364.
25. Adebayo OC, Afolami OI, Oladunmoye MK and Bolaniran T. Comparative antimicrobial efficacy of locally made African black soaps produced in Akure, Nigeria and medicated soaps against selected clinical skin pathogens. ACTA Scientific Microbiology, 2018;1(3):33-37. DOI: 10.31080/ASMI.2018.01.0026
26. AL-Saadi` ZN. Estimation of Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC) of Cell-Free Extracts of Bifidobacterium Species against Methicillin-Resistant *Staphylococcus aureus*. American Journal of Biomedical and Life Sciences, 2016;4(5):75-80.
27. Kingsley TU, Kelechi EE and Chukwudi UA. Antibacterial activities of medicated soaps on selected clinical bacterial isolates. Journal of Basic Pharmacology and Toxicology, 2019;3(2):17-20.