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COMPARATIVE EFFICACY OF MEDICATED SOAPS ON *STAPHYLOCOCCUS AUREUS* ASSOCIATED WITH WOUNDS AND POST-OPERATIVE WOUNDS FROM HOSPITALS IN ONDO STATE, NIGERIA

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ABSTRACT

Introduction: *Staphylococcus aureus* remains one of the leading causes of wound infection and medicated soaps have antimicrobial substances which when applied on living tissues, reduces the possibility of *S. aureus* wound infection, sepsis or putrefaction.
Aim: Therefore, this study is aimed at determining the antibacterial activities of 6 medicated soaps on *S. aureus* isolated from wounds.
Methodology: One hundred and eight (108) wound samples were collected from patients with wound infection found in the orthopedic and surgical wards of selected hospitals in Ondo State. The antibacterial activity of medicated soaps on *S. aureus* isolated from wound infection was determined using agar well diffusion technique and the antibiogram profile was determined using disc diffusion technique.
Results: Of the 108 wound samples tested, 64 (59.3%) were infected with *S. aureus.* Tetmosol soap recorded the highest zone of inhibition against all *S. aureus* strains with (24.3 mm) at 200 mg/ml and (20.3 mm) at 100 mg concentrations. Carat soap had the least antibacterial activity against all staphylococcus strains with (6.0 mm) for both concentrations. Over 70% of the isolates were resistant to amoxicillin, rocephine, gentamycin, zinnacef, ampiclox and septrin; whereas, ≤ 50% were susceptible to ciprofloxacin, streptomycin, erythromycin and perfloxacin. Medicated soaps had a better activity on *S. aureus* compared to conventional antibiotics.
Conclusion: Therefore, antiseptic soaps could be used in the cleaning of wounds and cuts during time of hurts to prevent infection and the transmission of wound pathogens. However, this should be used moderately by patients in order to avoid irritation and development of microbial resistance in the future.

Keywords: *Staphylococcus aureus*, medicated soaps, antibacterial activity

INTRODUCTION

Antibacterial soaps otherwise called medicated or antiseptic soaps contain chemical ingredients that purportedly assist in killing bacteria **(Aiello *et al.*, 2007).** The earliest antibacterial soap was carbolic soap, which used up to 5% phenols (carbolic acid). Fears about the safety of carbolic soaps chemical components on the skin brought about a ban on some of these chemical components **(Oboh and Aluyor, 2011).** The majority of antibacterial soaps contain triclosan, though other chemical additives are also common. Triclosan and other antibacterial agents have long been used in commercial cleaning products for hospitals and other healthcare settings, however their use in home products began in the 1990s **(Kodjak, 2016).**
Antibacterial activity is the ability to either annihilate or inhibit the growth of microorganisms. This can be referred to as either cidal or static effects respectively. This is significant with respects to the human body in preventing sepsis and skin infections **(Higaki *et al.*, 2000).** Soaps are classified into either non-bacterial or bacterial agents, also known as antiseptic or medicated soaps, based on their formulation and functional chemical constituents. The antiseptic or medicated soaps are made to fight pathogenic microbes and other germs due to special chemical additives in them while the non-antiseptic soaps are made for conventional cleaning purposes **(Ogunnowo *et al.*, 2010).**
Wound is a breach on the skin and the exposure of subcutaneous tissue following loss of the skin integrity which provides a moist, warm and nutritive environment that is conducive to microbial colonization and proliferation **(Brölmann *et al.*, 2013).** Wound infections are mainly of two types i.e. open wounds and closed wounds. Open wounds are caused by external damage to intact skin whereas closed wound is infection to tissues below the skin **(Smith, 2006).** Post-operative wound infection is the commonest wound infection and recognized as having a poly-microbial etiology, involving both aerobic and anaerobic microorganisms **(Lilani *et al.*, 2005).** Post-operative/surgical site infections are acquired in hospitals, a leading cause of nosocomial infection, a common complication of operative procedures, associated with prolong stay in hospital and lack of antisepsis measures **(***Pahys et al., 2013).*
The most common pathogenic bacteria indulged in wound infection is *Staphylococcus aureus*, it is a commensal flora in nose and transmitted due to hand hygiene, clothes of staff and other health care tools **(Masalha, 2001).** Although *S. aureus* usually acts as a commensal of the human microbiota it can also become an opportunistic pathogen, being a common cause of skin infections including abscesses, respiratory infections such as sinusitis, and food poisoning. Pathogenic strains *S. aureus* often promote infections by producing virulence factors such as potent protein toxins, and the expression of a cell-surface protein that binds and inactivates antibodies **(Masalha, 2001).**

MATERIALS AND METHODS

Study area

Ondo State is in the South-West Geopolitical zone of Nigeria. It is one of most productive states in Nigeria with great business opportunities; it is endowed with great natural resources and holds a rich cultural heritage. The ethnic composition of Ondo State is largely from the Yoruba sub-groups of the Akoko, Akure, Ikare, Ilaje, Ondo and Owo. The geographical coordinates are 7º10'N, and 5º05'E. Ondo state has a tropical wet and dry climate with an average annual temperature ranging between 20°C - 34°C as lowest and highest values, respectively. This study therefore covers selected hospitals in Ondo state found in Ondo Central and Ondo South.

Ethical Consideration and Approval

An ethical clearance was sought and obtained from Ondo State Health Research Ethics Committee (OSHREC 5/4/2021/308), Ministry of Health, Akure, Nigeria.

Wound Sample Collection

A total of 108 wound samples were collected from patients who consented in the surgical wards and orthopedic units of University of Medical Teaching Hospital, Akure, State General Hospital, Okittipupa and State General Hospital, Ore, Ondo State. Structured questionnaires which covered respondents' demographic information, respondents' knowledge about medicated soaps and the history of wound infection were administered. The wound samples were collected using sterile swab sticks and transported in cold chain to the Microbiology Laboratory of the Federal University of Technology, Akure for further analysis.

Isolation and Identification of *Staphylococcus aureus*

Following guidelines of Clinical and Laboratory Standard Institute (CLSI), the wound swabs were inoculated directly on Mannitol salt agar (Oxoid) and sub cultured to Nutrient agar (Oxoid) for purification. The cultured plates were then incubated at 37°C for 18 hours. Biochemical characterization and identification of the test organisms were carried out using standard identification manual **(Cheesbrough, 2006).** The isolates were then stored in nutrient agar slant and preserved in the refrigerator at 4ºC for further use.

Antibacterial activity of medicated soaps on *Staphylococcus aureus*

Preparation/Dissolution of Soap Samples

A sterile blade was used to scrap a portion of the soap samples. Two hundred milligram per millimeter (200 mg/ml) and 100 mg/ml concentrations were prepared according to **Saba *et al.* (2009).** Each of the isolate was standardized using colony suspension method **(Cheesbrough, 2002).** The susceptibility of the test organisms to the different soap sample concentration was assayed using agar-well diffusion method **(Ndukwe *et al.*, 2005).** The plates were allowed to stand on the laboratory bench for 30 minutes and were then incubated at 37°C for 24 hours in an upright position. They were then examined for zones of inhibition which indicated the degree of susceptibility or resistance of the test organism to the antibacterial soaps **(Obi, 2014).** A vernier caliper was used to measure the diameter of the clear zones of inhibition (mm) on the plates. The test was carried out in triplicate.

Antibacterial susceptibility test against Staphylococcus aureus

Susceptibility testing using antibiotic disc was performed by Kirby–Bauer disc diffusion technique according to criteria set by Clinical Laboratory Standard Institute **(CLSI), 2016**. Standardized culture of test organism was uniformly seeded over the Mueller-Hinton agar (Oxoid) surface and exposed to the concentration gradient of the antibiotic followed by incubation at 37°C for 16 - 18 hours. Diameters of the zone of inhibition around the discs were measured to the nearest millimeter using a vernier caliper and classified as sensitive, intermediate, and resistant according to the standardized table supplied by CLSI, 2016. The antibiotics tested were pefloxacin (10 μg), gentamycin (10 μg), ampiclox (30 μg), zinnacef (20 μg), amoxacillin (30 μg), rocphin (25 μg), ciprofloxacin (10 μg), streptomycin (30 μg), septrin (30 μg), erythromycin (10 μg).

Statistical analysis

Data are presented as mean ± standard error (SE). Significance of difference between different treatment groups was tested using one-way analysis of variance (ANOVA) and significant results were compared with Duncan's multiple range tests using IBM SPSS version 20 software. For all the tests, the significance was determined at the level of p <0.05.

RESULTS

Out of 108 patients with wound infection that were recruited for the study, 59.3% (64/108) were positive for *Staphylococcus aureus* (Figure 1). Table 1 shows the result of the biochemical test to confirm the *S. aureus* isolated from wound samples. Table 2 shows the active ingredients present in the assayed soaps as listed on soaps leaflet. Based on gender, 50% (24/48) of the male participants and 67% (40/60) of the females were positive for *S. aureus* wound infection (Table 3, p = 0.034). The age group of 41-50 years had the highest percentage positivity with 100%, which was followed by age group 31- 40 years with 80% and the least was age group 61 years and above with 0% (Table 3, p = 0.028). Furthermore, this study showed that the Married participants had a high rate of positivity to *S. aureus* wound infection with 68.3% (43/63), followed by the Singles with 48.8% (20/41), while the divorced had the least positivity rate with 25% (1/4). From the study, the religious group; Christianity had the highest percentage of positivity with 65.8% (50/76), followed by the Traditional group with 50% (2/4), and the least was the Islam with 42.9% (12/28). Significant association was found (p = 0.012) in the group of patients with underlying sickness with 67.6% (44/68) while those without underlying illness recorded low rate of positivity with 55% (22/40) (Table 3). Also, the study showed that the Artisans had the highest positivity for *S. aurues* wound infection with 75% (6/8), followed by self-employed with 65.9% (29/44), the least in this class was the students with 45.8% (11/24) (Table 3, p = 0.051). Furthermore, patients with old wounds had the highest positivity with 95% (38/40), and very old wounds with 75% (3/4), while new wounds had the least percentage of positivity with 35.9% (23/64). Significant association was found (p = 0.016) in the Duration of wound infection with 59.4% (38/64) in those that had wounds within 1-2months, followed by those who had wounds within 3-4months, with 58.3% (21/36) and then those with wounds above 5months with 65.5% (5/8) (Table 3). Also, from the study, patients who seldom dressed their wounds had the highest positivity to *S. aureus* wound infection with 100% (40/40) while the least positivity was observed in patients who dressed their wounds often 35.3% (24/68). This study showed that patients who had no knowledge about medicated soaps had the highest percentage of positivity 65.6% (42/64), followed by those who had knowledge about medicated soaps with 50% (22/44) (p=0.013). Furthermore, the patients that were on antibiotics as at the time of sampling had the highest percentage of positivity with 60.6% (63/104), while those who weren't on antibiotics had the least percentage of positivity with 25% (1/4) (Table 3). Table 4 and 5 shows the zones of inhibition (in millimeters) of the isolated S*taphylococcus aureus* using different antiseptic soaps at 200mg/ml and 100mg/ml. At 200 mg/ml concentration, Tetmosol had the highest zone of inhibition (24 mm), followed by Delta with (18.3 mm). At 100 mg/ml, Tetmosol also exhibited a great antibacterial activity against all *S. aureus* with (20.3 mm) followed by Safeguard with (13.2 mm). Antibiogram by disc diffusion technique carried out on isolated bacteria showed that majority of the isolates were resistant to most of the antimicrobial agents employed for this study. Over 70% of the isolates were resistant to amoxicillin, rocephine, gentamycin, zinnacef, ampiclox and septrin; whereas ≤ 50% were susceptible to ciprofloxacin, streptomycin, erythromycin and perflocxacin. (Table 6).

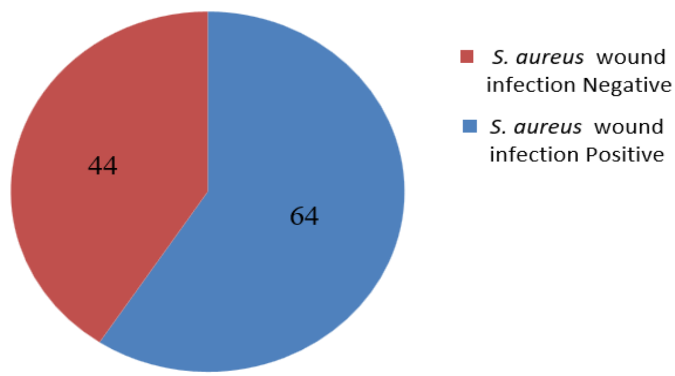

Figure 1 Prevalence of *S. aureus* in infected wounds of patients attending selected Hospitals in Ondo state

Table 1 Morphological and biochemical characteristics of *Staphylococcus aureus*

Isolate	**Colony description**	**Gram stain**	**Cell shape**	**Coagulase**	**Catalase**	**Oxidase**	**Indole**	**Citrate**	**Urease**	**manitol**	**sucrose**	**galactose**	**glucose**	**Fructose**	**lactosae**	**Presumptive isolate**
x	Small smooth yellow colonies with glistering surface	+	Cocci	+	+	-	-	-	-	+	+	+	+	+	+	*Staphylococcus aureus*

Table 2 Assayed soaps and their active ingredients

S/N	Soap brand	Active ingredients
1.	Dettol	Chloroxylenol 4.8%
2.	Tetmosol	Monosulfiram 5%
3.	Safeguard	Triclocarban 0.75%
4.	Carat	Chloroxylenol 0.5%; Triclosan 0.1%
5.	Crusader	Hydroquinone 2%; Lanolin 1%; Ethylhexyl Methoxycinnamate 0.5%
6.	Delta	Trichlorocarbanilide 0.5%; Triclosan 0.05%
7.	Black Soap	Not indicated
8.	Soda	Not indicated

Table 3 Demographic data of patients with wound infection recruited for the study/assessment of patient's knowledge about medicated soap

Variables	Frequency	Percentage (%)	*S. aurues* wound infection positivity (%)	p-values
Gender				
Male	48	44.4	24 (50)	pv = 0.034
Female	60	44.6	40 (66.7)	
Age Range (Years)				
10 – 20	8	7.4	0 (0)	pv = 0.028
21 – 30	32	29.6	20 (62.5)	
31 – 40	40	37.0	32 (80)	
41 – 50	12	11.1	12 (100)	
51 – 60	12	11.1	0 (0)	
≥ 61	4	3.7	0 (0)	
Marital Status				
Single	41	38	20 (48.8)	
Married	63	58.3	43(68.3)	
Divorced	4	3.7	1 (25)	
Religion				
Christianity	76	70.4	50 (65.8)	
Islam	28	25.9	12 (42.9)	
Traditional	4	3.7	2 (50)	
Occupation				
Artisan	8	7.4	6 (75)	pv = 0.051
Public servant	32	29.6	18 (56.3)	
Self employed	44	40.7	29 (65.9)	
Student	24	22.2	11 (45.8)	
History of wound				
New	64	59.3	23 (35.9)	
Old	40	37	38 (95)	
Very old	4	3.7	3 (75)	
Duration of wound				
1 - 2months	64	59.3	38 (59.4)	pv = 0.016
3 - 4 months	36	33.3	21 (58.3)	
≥ 5 month	8	7.4	5 (62.5)	
Knowledge of medicated soap				
Yes	44	40.7	22 (50)	pv = 0.013
No	64	59.3	42 (65.6)	
How often do you dress wound				
Often	68	63	24 (35.3)	
Not often	40	37	40 (100)	
Do you have an underlying illness				
Yes	68	63	46 (67.6)	pv = 0.012
No	40	37	22 (55)	
Are you taking antibiotics presently				
Yes	104	96.3	63 (60.6)	
No	4	3.7	1 (25)	

Table 4 Effect of 200 mg medicated soaps on the various strains of *Staphylococcus aureus*

Isolates	Dettol (mm)	Tetmosol (mm)	Safeguard (mm)	Carat (mm)	Crusader (mm)	Delta (mm)	Black soap (mm)	Soda (mm)
Staphylococcus aureus	7.2 ± 0.2^{bc}	16.1 ± 0.2^{b}	10.2 ± 0.2^{b}	6 ± 0^{e}	8.1 ± 0.1^{e}	11.1 ± 0.1^{f}	11.2 ± 0.2^{e}	6±0
”	7.4 ± 0.5^{b}	16.1 ± 0.2^{b}	10.1 ± 0.1^{b}	6 ± 0^{e}	11.1 ± 0.1^{c}	15.1 ± 0.2^{d}	10.1 ± 0.2^{f}	6±0
”	7.2 ± 0.2^{bc}	11.1 ± 0.2^{d}	12.1 ± 0.2^{a}	12.1 ± 0.2^{a}	16.1 ± 0.2^{a}	11.1 ± 0.2^{f}	18.2 ± 0.2^{a}	6±0
”	6 ± 0^{c}	24.3 ± 0.3^{a}	6 ± 0^{d}	6 ± 0^{e}	8.1 ± 0.2^{e}	7.3 ± 0.3^{h}	9.2 ± 0.2^{g}	6±0
”	13.1 ± 0.1^{a}	6 ± 0^{e}	12.1 ± 0.2^{a}	12.1 ± 0.2^{a}	13.2 ± 0.2^{b}	18.3 ± 0.3^{b}	11.1 ± 0.2^{e}	6±0
”	6 ± 0^{c}	12.1 ± 0.2^{c}	7.2 ± 0.2^{c}	7.2 ± 0.2^{d}	7.1 ± 0.2^{f}	14.2 ± 0.2^{d}	10.1 ± 0.1^{f}	6±0

Key: Values represents mean ± standard error of triplicate readings. Superscript of the same letter in a row are not significantly different at P>0.05.

Table 5 Effect of 100 mg medicated soaps on the various strains of *Staphylococcus aureus*

Isolates	Dettol (mm)	Tetmosol (mm)	Safeguard (mm)	Carat (mm)	Crusader (mm)	Delta (mm)	Black soap (mm)	Soda (mm)
Staphylococcus Aureus	6 ± 0^{d}	16.3 ± 0.3^{d}	11.5 ± 0.4^{b}	10.1 ± 0.2^{a}	6 ± 0^{c}	11.2 ± 0.2^{b}	6 ± 0^{e}	6±0
”	7.3 ± 0.3^{c}	16.3 ± 0.3^{d}	9.4 ± 0.4^{c}	6 ± 0^{c}	6 ± 0^{c}	9.3 ± 0.3^{d}	11.3 ± 0.3^{a}	6±0
”	6 ± 0^{d}	18.3 ± 0.3^{b}	11.3 ± 0.3^{b}	6 ± 0^{c}	6 ± 0^{c}	10.4 ± 0.4^{c}	6 ± 0^{e}	6±0
”	9.3 ± 0.3^{b}	20.3 ± 0.3^{a}	13.2 ± 0.3^{a}	6 ± 0^{c}	7.2 ± 0.2^{b}	6 ± 0^{f}	6 ± 0^{e}	6±0
”	12.1 ± 0.1^{a}	17.4 ± 0.4^{c}	9.1 ± 7^{c}	6 ± 0^{c}	10.4 ± 0.4^{a}	8.3 ± 0.3^{e}	9.5 ± 0.4^{b}	6±0
”	7.3 ± 0.3^{c}	16.4 ± 0.4^{d}	11.3 ± 0.3^{b}	7.4 ± 0.4^{b}	7.4 ± 0.4^{b}	12.4 ± 0.4^{a}	8.2 ± 0.2^{c}	6±0

Key: Values represents mean ± standard error of triplicate readings. Superscript of the same letter in a row are not significantly different at P>0.05.

Table 6 Effect of conventional antibiotics on the various strains of *Staphylococcus aureus*

Isolate	PEF	CN	APX	Z	AM	R	CPX	S	SXT	E
Staphylococcus aureus	16.1 ± 0.1^{c}	8 ± 0.1^{b}	8.1 ± 0.1^{a}	10 ± 0.1^{a}	7.1 ± 0.1^{b}	9.1 ± 0.1^{b}	9.9 ± 0.1^{e}	6 ± 0^{f}	7.1 ± 0.1^{e}	12.9 ± 0.1^{d}
”	12.1 ± 0.1^{e}	8 ± 0.2^{b}	8.1 ± 0.1^{a}	9 ± 0.2^{b}	7.2 ± 0.2^{b}	9.1 ± 0.1^{b}	10 ± 0.2^{d}	10.1 ± 0.1^{c}	8.1 ± 0.1^{d}	15.9 ± 0.1^{b}
”	10.1 ± 0.1^{f}	11.1 ± 0.2^{a}	8.1 ± 0.2^{a}	9.2 ± 0.2^{b}	8.1 ± 0.1^{a}	9 ± 0.2^{b}	14.2 ± 0.2^{b}	7.1 ± 0.1^{e}	15.2 ± 0.2^{a}	14.2 ± 0.2^{c}
”	18 ± 0.1^{a}	11.1 ± 0.1^{a}	6 ± 0^{b}	6 ± 0^{c}	6 ± 0^{c}	6 ± 0^{c}	6 ± 0^{f}	18.2 ± 0.3^{b}	7.3 ± 0.3^{e}	21.2 ± 0.3^{a}
”	17.2 ± 0.3^{b}	11.1 ± 0.2^{a}	6 ± 0^{b}	6 ± 0^{c}	6 ± 0^{c}	10.3 ± 0.3^{a}	19.3 ± 0.3^{a}	19.1 ± 0.1^{a}	9.4 ± 0.3^{c}	11.4 ± 0.3^{e}
”	13.1 ± 0.2^{d}	6 ± 0^{c}	6 ± 0^{b}	6 ± 0^{c}	6 ± 0^{c}	6 ± 0^{c}	11.2 ± 0.2^{c}	9.1 ± 0.1^{d}	12.1 ± 0.1^{b}	14.2 ± 0.2^{c}

Values represent mean ± standard error of triplicate readings. Superscript of the same letter in a row are not significantly different at P>0.05.
KEY: S = Sensitive, R = Resistant, I = Intermediate. PEF = Perfloxacin, CN = Gentamycin, APX = Ampiclox, Z = Zinnacef, AM = Amoxicillin, R = Rocephin, CPX = Ciprofloxacin, S = Streptomycin, SXT = Septrin,
E = Erythromycin.

DISCUSSION

Staphylococcus aureus is an important human pathogen that is implicated in a wide variety of wound infections and sepsis. The cause of transmission could be as a result of direct contact with infected patient, colonized object or contaminated environment **(David and Daum, 2010).** In this study, the clinical characterization for the positive cases of *S. aureus* in wound infection was observed. All patients recruited for this study were from the OPD and surgical wards of selected hospitals in Ondo State.

The frequency of wound colonized by *S. aureus* (59%) is a little lower in the present study than the frequency of ≥ 80% in the majority of previously reported studies, **(Lipsky *et al.*, 2007, Feleke *et al.*, 2007, Lima *et al.*, 2011 and Almeida *et al.*, 2014).** This can be attributed to the fact that 100% of the wound samples recruited for the present study were from in-patients, with at least ≥ 70% on prior antibiotic use. Maximum *S. aureus* wound infection cases were seen within the age group 31-40 years, 32 (80%) in both male and female, followed by the age group 21-30years, 20 (62.5%) and 41-50years, 12 (100%). This was relatively in accordance with the findings of **Anima *et al.* (2018)** who reported that people within this age ranges were more susceptible to *S. aureus* wound infection. His studies identified risk factors like; sex, pus, consistency, age, duration of operation, type of surgery, ward and hospital stay as possible factors that augments the patient's chances to developing *S. aureus* wound infection, and these factors are also applicable in the present studies.

Of the 108 wound samples analyzed, 64 (59.3%) were positive, while 44 (40.7%) were negative. The high percentage of positivity justifies the fact that *Staphylococcus aureus* is an important etiologic agent which contributes to the establishment of wound infection. This is in line with the work of **Gaurav *et al.* (2015)** who discovered *S. aureus* as the most important pathogen associated with wound infection after analyzing 171 wound samples and obtaining 57 (33.3%) of positivity, they therefore concluded that *S. aureus* is the most common cause of wound infection. This same result was reported by **Keith *et al.* (2009)** who observed a high predominance of *S. aureus* (51.6%) from operative patients with wound infection. **Ike, (2016)** who analyzed 50 clinical (wound) samples and had a 50 percent positive result also reported *S. aureus* as the most prominent cause of wound infection.

The studies revealed that majority of the isolates were resistant to the 10 antimicrobial agents employed for this study. Greater than seventy percent (≥70%) of the isolates were resistant to amoxicillin, rocephine, gentamycin, zinnacef, ampiclox and septrin; whereas ≤ 50% were susceptible to ciprofloxacin, streptomycin, erythromycin and peflocxacin. These finding was similar to that of **Kahsay *et al.* (2014)** who reported the antimicrobial activity of 10 antibiotics including amoxicillin, erythromycin, gentamycin, septrin and so on, on *S. aureus* from wound infection and had a 50% resistance. **Anima *et al.* (2018)** also reported a high resistance to *S. aureus* isolated from wound and sepsis to several antibiotics tested. These included; gentamycin, ciprofloxacin, erythromycin, amoxicillin and so on, which is in line with the current study, except for ciprofloxacin which had high susceptibility pattern. This however, can be attributed to the staphylococcus strain tested in the current study, and also the concentration of the antimicrobial agents used.

Soaps are generally used for cleaning purposes and for removing dust and microbes present on the surface of skin **(Chaudhari, 2016).** Six (6) medicated soaps; Dettol, Crusader, Safeguard, Tetmosol, Delta, and Carat were investigated for their antimicrobial activity against *S. aureus* and the result obtained showed that the conventional customized medicated soaps had antimicrobial activities against *S. aureus* although to a certain identifiable position as showed by the inhibition of the growth pattern of the isolates. The study revealed that the zone of inhibition exhibited by test organism's depicted significance difference (P>0.05) increase with an increase in the concentration of the soaps. When the efficacy of the antibacterial soaps were compared at 200 mg/ml concentration, Tetmosol was found to be most effective against all *Staphylococcus aureus* strains tested having the highest zone of inhibition (24 mm), followed by Delta with (18.3 mm). At 100 mg/ml, Tetmosol also exhibited a great antibacterial activity against all *S. aureus* strain tested with the highest zone of inhibition (20.3 mm) followed by Safeguard with (13.2 mm). This result is in agreement with the research conducted by **Wemedo *et al.*, (2018),** who compared the antimicrobial activity of locally produced soaps with that of the conventional customized antiseptic soaps on bacterial isolates from skin and wound and had Safeguard as one of the soaps with the highest activity on the isolates including *S. aureus*. The percentage of activity of the soaps on the test organism showed that *S. aureus* displayed higher susceptibility to some of the antiseptic soaps analyzed, even at a lower concentration and the observable variability in the antimicrobial activity was due to the difference in the antibacterial active ingredients and type of formulation. In a similar work, **Mwambete and Lyombe, (2011)** reported that Safeguard, Dettol and Tetmosol had inhibitory activities against *S. aureus* even at lower concentrations than that tested in this work. Apparently, the observed variability in the efficacy of the soaps is due to the active ingredient, type of formulations, type of organism and so on. The great efficacy of Tetmosol soap as observed in this study could be attributed to the type and concentration of the active ingredient (monosulfiram 5%).

Of the two locally made soaps used as control in this study, soda had no observable inhibition against the test pathogen whereas; black soap had apparent and measureable antibacterial activity against the test pathogen with the highest zone of inhibition (18.2 mm) at 200 mg/ml and (11.3 mg/ml) at 100 mg/ml, these was found to be of better activity on *S. aureus* than some of the customized medicated soaps. This according to **Oluranti *et al.* (2012)** could be attributed to the presence of some antimicrobial phytochemicals such as flavonoids, alkanoids, and so on, which may account for its antibacterial efficacy against *S. aureus.* Also one of the major components of black soap according to **Ikotun *et al.* (2018)** is palm kernel oil which is found to cause distortion in the peptidoglycan layer of Gram positive organisms due to its long fatty acid chain. The susceptibility of these *S. aureus* strains to black soap therefore indicates the therapeutic potentials of the black soap in treatment of such infections. The antibacterial activity exhibited by black soap suggests it as a potential candidate of bio-prospecting for antibacterials according to **Smith, *et al.* (2018).** Therefore, the isolation and identification of the antibacterial active ingredients of the black soap will be a step forward in medication discovery.

CONCLUSION

The antiseptic soaps tested in this present research portrayed varied levels of activity against the various *S. aureus* strains. This study also revealed that antiseptic soaps and black soap have a better activity on *S. aureus* even more than the conventional antibiotics. Therefore, Tetmosol among others that showed antibacterial activity could be used in washing and cleaning wounds. However this should be used moderately by consumers in order to avoid irritation and development of microbial resistance in the future.

Authors' contribution: This study has established that Tetmosol soap has a great antibacterial activity which at different concentrations can be used in the management of *Staphylococcus aureus* wound infection.

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