

**Antibacterial Effects of *Annona muricata* bark and seeds extracts on Coagulase-negative *Staphylococcus* isolates from wounds of patients attending a Tertiary Healthcare Facility in Calabar, Nigeria**Nse O. Umoh^{*1}, Mfoniso Udonkang², Glory Bebia¹, David Umoikot¹ and Solomon A. Ben¹

Department of Medical Bacteriology, Virology, and Mycology, Faculty of Medical Laboratory Science, University of Calabar, Calabar, Nigeria ¹, Department of Histopathology and Cytology, Faculty of Medical Laboratory Science, University of Calabar, Calabar, Nigeria ².

Author for Correspondence*: nsirumoh1611@gmail.com. <https://dx.doi.org/10.4314/sokjmls.v10i2.4>**Abstract**

Annona (A.) muricata bark and seeds extracts were evaluated for antibacterial effects on coagulase-negative *Staphylococcus* (CoNS) isolates from wounds of patients attending University of Calabar Teaching Hospital, Calabar, Nigeria. Ethanolic and aqueous extracts of *A. muricata* bark and seeds were prepared by Soxhlet method and tested for antibacterial activity against 20 isolates of CoNS using agar-well diffusion assay. Minimum Inhibitory Concentration (MIC) of the extracts was determined using broth dilution method. Antibiotic susceptibility of the isolates was determined using Kirby-Bauer disc diffusion method. *A. muricata* bark extracts produced a concentration-dependent antibacterial activity against the CoNS isolates with MIC of 50mg/ml, while the seed extracts showed no antibacterial effect. The ethanolic bark-extract showed a higher efficacy and inhibited more isolates [11(55%)] than the aqueous extract [10(50%)], with a mean inhibition-zone diameter of 17.2 ± 2.2 mm and 14.0 ± 1.8 mm, respectively. The size of the inhibition-zones correlated significantly, in direct proportion, with concentrations of the extracts ($p=0.00012$). Although the antibacterial activity of the bark extracts was lower than that of Ciprofloxacin (90%), Cefuroxime (80%), Meropenem (70%), and Ceftriaxone (60%), the ethanolic extract produced an activity equal to that of Gentamicin (55%). Unlike the seed extract, *A. muricata* bark extracts exhibited promising antibacterial potential that could be optimized, with improvement of the extraction process to include identification and isolation of

the specific antimicrobial substances present in the crude extracts, for maximal activity against multidrug resistant pathogens.

Keywords: Antibacterial effects, *Annona muricata* bark and seeds extracts, Coagulase-negative *Staphylococcus*, wounds, Calabar, Nigeria

Introduction

Coagulase-negative *Staphylococcus* (CoNS) are Gram-positive cocci that are identified by their inability to produce the enzyme coagulase, which distinguishes them from the coagulase producing *Staphylococcus aureus*. While CoNS species, including *Staphylococcus (S.) epidermidis*, *S. saprophyticus* and *S. haemolyticus*, are generally part of the normal skin and mucosal flora, they can become opportunistic pathogens under certain conditions, particularly in healthcare settings (Mon *et al.*, 2024). These organisms have been identified with remarkable ability and ease of developing antibiotic resistance, which complicate treatment strategies (Marincola *et al.*, 2021).

Collectively, CoNS species are frequently associated with severe infections such as sepsis, endocarditis, wounds and urinary tract infections that often require prolonged courses of antibiotics to resolve, particularly in immuno-compromised patients or those with implanted medical devices (Chapeton-Montes *et al.*, 2019; Marincola *et al.*, 2021). The clinical significance of CoNS species, particularly in hospital settings, is rooted in their ability to form biofilms, acquire antibiotic resistance, and persist in medical environments, where they pose serious therapeutic and infection-



control challenges. Due to the high prevalence of multidrug resistant CoNS strains, infections caused by these organisms are potentially liable to treatment difficulties, with prolonged hospital-stay, increased healthcare costs, high morbidity and mortality. Alternative treatment strategies using new antimicrobial agents with novel mechanisms of action would certainly be required to overcome the therapeutic challenges associated with multidrug resistant CoNS infections.

Annona (A.) muricata, a fruit-bearing tropical tree belonging to the Annonaceae family, commonly known as soursop or graviola has emerged as a promising source of bioactive compounds for potential therapeutic applications. Phytochemical analysis of the plant has revealed an array of therapeutically useful bioactive compounds such as acetogenins, alkaloids, and phenolic compounds, which are associated with antimicrobial, anti-inflammatory, and anticancer activities (Moghadamtousi *et al.*, 2021). Although soursop is commonly known and valued for its edible fruits globally, other parts of the plant including leaves, bark and seed, have been found useful in traditional medicine for treatment of various human diseases (Coria-Téllez *et al.*, 2022). In traditional medicine, *A. muricata* extracts have been effectively used for treatment and prevention of arthritis, asthma, bronchitis, biliary disorder, diabetes, heart diseases, hypertension, worm disease, liver disorder, malaria, rheumatism, cancer, and many other diseases caused by bacteria, such as pneumonia, diarrhoea, skin and urinary tract infections (Kamath *et al.*, 2017).

This study investigated the antimicrobial effects of *A. muricata* bark and seeds extracts on CoNS isolates from wounds of patients attending a tertiary-care hospital in Calabar, Nigeria.

Materials and methods

Collection and identification of *A. muricata* plant leaves

Annona muricata plant leaves, barks and fruits, with Voucher number: Bot/Herb/UCC 314, were collected from a home garden in Calabar, and identified by a botanist, Dr. Effah A. Affah, in the Department of Plant and Ecological Science,

University of Calabar, Nigeria. The plant materials were washed and air-dried under shade to prevent degradation of its bioactive compounds.

Preparation of the extracts

The dried barks and seeds of *A. muricata* were ground into a fine powder using a mechanical blender. The powdered plant materials were then subjected to successive ethanol and aqueous extraction using the Soxhlet extraction method as described by Chaaradi *et al.* (2020). The powdered plant material was placed in a thimble, and the solvent was continuously cycled through the sample to maximize the yield of the crude extract.

Collection and identification of bacterial isolates

A total of 20 wound isolates of CoNS was used for the study. The isolates were identified using traditional bacteriological methods, including catalase and coagulase tests, in the Microbiology Laboratory of University of Calabar Teaching Hospital, Calabar.

Preparation of inoculum

The inoculum of each isolate was prepared from fresh pure cultures on Mueller Hinton agar and standardized according to CLSI guidelines (CLSI, 2018). The density of the bacterial suspension was adjusted to match the opacity of 0.5 McFarland standard, corresponding to approximately 1.5×10^8 colony-forming units per milliliter (CFU/mL) (Wiegand *et al.*, 2008). The standardized inoculant was used within an hour after preparation to ensure viability and consistency of the results.

Antibacterial susceptibility testing of CoNS isolates to *A. muricata* barks and seeds extracts

The antibacterial effect of *A. muricata* bark extracts on CoNS isolates was evaluated using the agar-well diffusion method. The standardized inoculum of the test organism was streaked on freshly prepared Mueller Hinton agar, and holes measuring 6mm in diameter were made on the inoculated agar plates using a sterile cork-borer; aliquots (0.5 ml) of each dilution of the extract (200mg/ml, 100mg/ml, 50mg/ml, 25mg/ml, and 12.5mg/ml) were carefully dispensed into the respective agar wells. Meropenem (10 µg) disc placed at center of the plate and 0.5% ethanol in one of the wells were

used as positive and negative controls, respectively. The plates were kept on the bench for 30 minutes to facilitate diffusion of the extracts into the agar before incubation at 37°C for 24 hours. Following overnight incubation, the agar plates were examined for bacterial growth and zones of inhibition around the wells measured in millimeters (mm).

Determination of minimum inhibitory concentration (MIC)

Two-fold serial dilutions of the extracts were prepared by adding 1 ml of the extracts stock solution (400 mg/ml) to 1 ml of freshly prepared Mueller Hinton broth in sterile glass test tubes (13x100 mm), to produce final concentrations of 200, 100, 50, 25, and 12.5 milligrams per milliliters (mg/ml).

Using a sterile 2ml syringe and needle, 1ml of the extract (200mg/ml) was added to the second tube and the contents agitated on a Vortex mixer. 1 ml of the solution in the second tube was transferred to the third tube, and the process continued through the next to the last tube from which 1 ml was removed and discarded. No extract was added to one tube which served as a negative growth control, while Meropenem (10 µg/ml) was used as positive control. An equal volume of a fixed bacterial culture was added to the tubes and incubated at 37 °C for 24 hrs. The tubes were examined for turbidity following incubation. The lowest concentration that shows no visible growth (turbidity) was noted and recorded as the MIC value.

Antibiotic susceptibility testing of CoNS isolates

Antibiotic susceptibility testing of the CoNS isolates was carried out using Kirby-Bauer disc diffusion method, as described by Umoh *et al.* (2024). Even spreads of the isolates were made on Mueller Hinton agar plates using sterile swab sticks followed by aseptic placement of

antibiotics discs, including ciprofloxacin (5 µg), cefuroxime (30 µg), meropenem (10 µg), ceftriaxone (30 µg) and Gentamicin (10 µg). The plates were incubated at 37°C for 24 hours, and after-on examined for clear zones of inhibition of the bacterial growth around the discs. The diameter of the zones of inhibition were measured using a caliper and interpreted according to the Clinical and Laboratory Standard Institute guidelines (CLSI, 2018).

Data analysis

The data obtained from this study were analyzed using Statistical Package for Social Sciences (SPSS) version 25.0 software. The susceptibility of CoNS isolates to the different concentrations of *A. muricata* bark/seed extracts and conventional antibiotics was expressed in percentages. Minimum Inhibitory Concentration (MIC) values were reported in milligrams per milliliter (mg/ml). Chi-square test was used to evaluate the statistical significance of the extract's activity on the isolates in relation to extract-concentrations. The diameter of inhibition zones were measured in millimeters and presented as mean ± standard deviation. A one-way Analysis of Variance (ANOVA) was used for comparing zones of inhibition at different concentrations of the extracts. P-values less than or equal to 0.05 were considered significant.

Results

Antibacterial activity of ethanolic extract of *A. muricata* barks on CoNS isolates of wounds

Table 1 shows the antibacterial activity of ethanolic extract of *A. muricata* bark on CoNS isolates of wounds. The susceptibility of the isolates to the ethanolic extract was 55%, 40%, and 10% at 200 mg/ml, 100 mg/ml, and 50 mg/ml concentrations of the extract, respectively. No isolate was susceptible at concentrations of 25 mg/ml and 12.5 mg/ml.

**Table 1: Antibacterial activity of ethanolic extract of *A. muricata* bark on CoNS isolates of wounds**

Concentration of extract (mg/ml)	No. (%) of isolates (n=20)	p-value
		0.001*
200	11 (55.0)	
100	8 (40.0)	
50	2 (10.0)	
25	0 (0.0)	
12.5	0 (0.0)	

$\chi^2 = 27.3112$; df=3; Significant at $p \leq 0.05$.

The susceptibility of the isolates was significantly associated with the concentrations of the extract (P=0.001).

Antibacterial activity of aqueous extract of *Annona muricata* bark against CoNS isolates of wounds.

Table 2 shows the antibacterial activity of aqueous extract of *Annona muricata* bark against CoNS isolates from the wounds. Only 10(50.0%), 7(35.0%) and 2(10%) of the 20 CoNS isolates showed susceptibility to the aqueous extract of *A. muricata* bark at concentrations of 200 mg/ml, 100 mg/ml and 50 mg/ml, respectively. No isolates were susceptible at concentrations of 25 mg/ml and 12.5 mg/ml. The susceptibility of the isolates correlated significantly the concentrations of the extract was statistically significant (p=0.001).

Antibacterial activity of ethanolic and aqueous extracts of *A. muricata* seeds against CoNS isolates from the wounds.

Table 3 shows the antibacterial effects of ethanolic and aqueous extracts of *A. muricata* seeds on the CoNS isolates. None of the isolates showed susceptibility to both the ethanolic and aqueous extracts of *A. muricata* seeds in this study.

Minimum inhibitory concentration of *A. muricata* bark extracts against CoNS isolates of wounds

An equivalent MIC value of 50 mg/ml for the CoNS isolates was found for both the ethanolic and aqueous extracts *A. muricata* bark (Table 4).

Table 2: Antibacterial activity of aqueous extract of *A. muricata* barks against CoNS isolates of wounds (n=20).

Concentration of extract (mg/ml)	No. (%) of isolates	p-value
		0.001*
200	10(50.0)	
100	6(30.0)	
50	2(10.0)	
25	0(0.0)	
12.5	0(0.0)	

$\chi^2 = 28.5167$; df=3; Significant at $p < 0.05$.



Table 3: Antibacterial activity of ethanolic and aqueous extracts of *A. muricata* seeds against CoNS isolates (n=20).

Concentration of extract (mg/ml)	No. (%) of isolates
200	0(0.0)
100	0(0.0)
50	0(0.0)
25	0(0.0)
12.5	0(0.0)

Table 4: Minimum inhibitory concentration of *A. muricata* bark extract against CoNS isolates

Extracts	Concentration
Ethanolic	50mg/ml
Aqueous	50mg/ml

Comparison of inhibition zones sizes produced by *A. muricata* barks extracts and some conventional antibiotics against CoNS isolates of wounds

The inhibition zones sizes produced by *A. muricata* bark extracts and some conventional antibiotics against CoNS isolates is shown in Table 5. The mean inhibition-zone diameters of the ethanolic extract of *A. muricata* bark for CoNS isolates were 17.5 ± 2.2 mm, 12.0 ± 1.5 mm and 8.5 ± 2.5 mm at 200 mg/ml, 100 mg/ml and 50 mg/ml concentrations of the extract, respectively. No inhibition was observed at concentrations of 25 mg/ml and 12.5 mg/ml.

Comparatively, higher inhibition zone diameters were found for conventional antibiotics including Ciprofloxacin (28.0 ± 2.0 mm), Cefuroxime (27.5 ± 1.5 mm), and Meropenem (25.5 ± 1.0 mm), Ceftriaxone (24.3 ± 2.5 mm) and Gentamicin (25.0 ± 1.5 mm). However, the disparity between inhibition-zones sizes of the extract and conventional antibiotics was not statistically significant ($p=0.301$).

Similarly, the mean inhibition-zone diameters of the aqueous bark-extract for the CoNS isolates were comparatively lower than those of the conventional antibiotics. The mean zone diameters of the aqueous extract were 14.0 ± 1.3 mm, 10.0 ± 1.7 , and 7.5 ± 1.5 mm, at 200 mg/ml, 100 mg/ml and 50 mg/ml concentrations, respectively. No inhibition was observed at concentrations of 25 mg/ml and 12.5 mg/ml. The difference between the inhibition-zone sizes of the aqueous extract and those of the conventional antibiotics was, however, not statistically significant ($p=0.165$).

Susceptibility of CoNS isolates to some conventional antibiotics

Table 6 shows the susceptibility of the CoNS isolates to commonly used antibiotics. The CoNS isolates were highly susceptible to ciprofloxacin (90%) and cefuroxime (80.0%), while sensitivity to Meropenem (70.0%), ceftriaxone (60.0%), and Gentamicin (55.0%) was modest.



Table 5: Inhibition-zones sizes of *A. muricata* bark extracts and some conventional antibiotics for CoNS isolates (n=20)

Antimicrobial agents	Concentration	Mean -Zone of inhibition diameter (mm)	F-value	p-value
Extracts	mg/ml		178.6	0.00012*
Ethanolic	200	17.2 ± 2.2		
	100	12.0 ± 1.5		
	50	7.5 ± 2.5		
	25	0.0		
	12.5	0.0		
Aqueous	200	14.0 ± 1.8		
	100	10.0 ± 1.7		
	50	7.5 ± 1.0		
	25	0.0		
	12.5	0.0		
Antibiotics	µg			
Ciprofloxacin	5	28.0 ± 2.0		
Cefuroxime	30	27.5 ± 1.5		
Meropenem	10	25.5 ± 1.0		
Ceftriaxone	10	24.3 ± 2.5		
Gentamicin	5	25.0 ± 1.5		

Data presented as mean ± standard deviation

*=Significant at p<0.05 (One-way ANOVA)

Table 6: Antibiotics susceptibility pattern of the CoNS isolates (n=20)

Status	No. of isolates (%)				
	*CIP	CXM	CN	MEM	CAZ
Sensitive	18 (90)	16 (80)	11 (55)	14 (70)	12 (60)
Resistant	2 (10)	4 (20)	9 (45)	6 (30)	8 (40)

*CIP- Ciprofloxacin (5µg), CXM- Cefuroxime (30µg), CN- Gentamicin (**10µg**), MEM- Meropenem (**10µg**), CAZ- Ceftriaxone (**30µg**).

Discussion

This study evaluated the antibacterial effects of *A. muricata* bark and seed extracts on CoNS isolates of wounds. Whereas the bark extracts produced a concentration-dependent antibacterial activity against the CoNS isolates, there was no inhibitory effect on the isolates at all concentrations of both ethanolic and aqueous extracts of *A. muricata* seeds utilized in this study. The lack of antibacterial activity for the seeds extracts in this study may be due to absence, or occurrence in very low concentrations, of compounds with antibacterial properties in the plant seeds. Studies on *A. muricata* extracts have revealed that the majority of the plant's phytochemicals which confer antibacterial activity are concentrated in the leaves and are usually found in less quantity or absent in other parts of the plant, including fruits and seeds (Corria-Tellez *et al.*, 2016; Mutakin *et al.*, 2022). Besides, the composition of phytochemicals in different parts of plants has been reported to vary according to factors such as geographical location, growth conditions and extraction method used (George *et al.*, 2017; Adhikari *et al.*, 2020). Regrettably, this study did not evaluate the composition and quantity of phytonutrients in the crude extracts of the plant's materials.

In contrast to the seed extracts, *A. muricata* bark extracts produced significant antibacterial activity against the CoNS isolates, which showed higher susceptibility to the ethanolic extract than the aqueous extract, at all concentrations tested. This finding is consistent with that of previous studies which reported similar activity for ethanolic extracts of *A. muricata* parts, compared with the aqueous extract (Mutakin *et al.*, 2022; Umoh *et al.*, 2025).

However, an equivalent MIC value of 50 mg/ml for the CoNS isolates was found for the ethanolic and aqueous extracts of *Annona muricata* bark in this study. This MIC value was high and suggestive of modest antibacterial potency in comparison with values previously reported for other plant extracts (Palombo, 2011). The high MIC values of the extracts in the present study may be attributed to a mix of interfering substances, which could potentially have undermined the potency of bioactive compounds, in the crude extract. Nevertheless, an equivalent MIC value for the bark extracts, in spite of the higher antibacterial activity found for the ethanolic extract, may suggest a vast phytochemical composition of *A. muricata* barks, comprising of polar and non-polar compounds with antimicrobial properties. MIC values of plants extracts have been reported to vary based on their chemical composition, solubility of the bioactive compounds and the extraction solvent used (Emiru *et al.*, 2024).

The extracts of *A. muricata* bark in this study, however, exhibited a lower antibacterial activity in comparison with the conventional antibiotics, particularly Ciprofloxacin, which showed the highest activity against the CoNS isolates. This finding aligns with that of a previous study, which reported lower antibacterial potency of soursop plant extracts, compared to conventional antibiotics (Abdulsalami *et al.*, 2016). Notwithstanding the lower efficacy of the crude extracts, the ethanolic extract of *A. muricata* bark produced a promising but modest antibacterial activity which corresponded with that of gentamicin in this study.



Conclusion

This study demonstrated a concentration-dependent antibacterial activity of *A. muricata* bark extracts against wounds isolates of CoNS, with a MIC of 50 mg/ml, but found no inhibitory effect of the seed extracts on the isolates. The antibacterial activity of the aqueous bark-extract was lower than that of the ethanolic extract. Although the antibacterial efficacy of both extracts of *A. muricata* bark against the study isolates was generally lower than that of the conventional antibiotics, the activity of the ethanolic extract corresponded with that of the aminoglycoside, gentamicin. Unlike the seed extracts, *A. muricata* bark extracts exhibited promising antibacterial potential that could be optimized, with improvement of the extraction process to include identification and isolation of the specific antimicrobial substances present in the crude extracts, for maximal activity against multidrug resistant bacterial pathogens.

Acknowledgment: The authors are grateful to the staff of Medical Microbiology Laboratory, UCTH, Calabar for their support and cooperation.

Conflict of Interest: None declared by the authors.

References

- Abdulsalami, M.S., Aina, V.O., Ibrahim, M.B. *et al.* (2016). Comparative antibacterial study of aqueous and ethanolic seed extracts of *Annona muricata*. *Journal of Nature Science Research*; **6(3)**: 141-145.
- Adhikari, L., Kotiyal, R., Pandey, M. *et al.* (2020). Effect of geographical location and Type of Extract on Total Phenol/Flavon Contents and Antioxidant Activity of Different Fruits Extracts of *Withania somnifera*. *Current Drug Discovery Technology*; **17(1)**: 92-99.
- Chaaradi, M., Arafa, W. A. and Elkahoui, S. (2020). Antioxidant, anti-inflammatory, and antitumor activities of water-soluble polysaccharide extracted from *Annona muricata* leaves. *International Journal of Biology and Macromolecules*; **165**: 2065-2074.
- Chapeton-Montes, D., Plourde, L., Bouchier, C., Ma, L., Diancourt, L., Criscuolo, A. and Brüggemann, H. (2019). The population structure of *Clostridium tetani* deduced from its pan-genome. *Science Report*; **9(1)**: 11220.
- Clinical and Laboratory Standards Institute (CLSI). (2018). Performance standards for antimicrobial susceptibility testing (28th ed.). CLSI supplement M100. Wayne, PA: Clinical and Laboratory Standards Institute.
- Coria-Téllez, A. V., Montalvo-González, E., Yahia, E. M., and Obledo-Vázquez, E. N. (2018). *Annona muricata*: A comprehensive review on its traditional medicinal uses, phytochemicals, pharmacological activities, mechanisms of action and toxicity. *Arab Journal of Chemistry*; **11(5)**: 662-691.
- Emiru, A.Y., Regassa, F., Endebu Duguma, B. *et al.* (2024). Invitro antibacterial activity of bark, leaf and root extracts of *Combretum molle* plant against *Streptococcus equi* isolated from clinical cases of strangles in donkeys and horses. *BMC Veterinary Research*; **20**:102. <https://doi.org/10.1186/s12917-024-03954-8>.
- George, U.E., Mboto, C.I., Mbim, U.O. *et al.* (2017). Comparative evaluation of the effect of *Annona muricata* (Graviola) leaves extracts and Cefoxitin on *Staphylococcus aureus*. *Asian Journal of Biology*; **3(3)**:1-7.
- Kamath, N., Rita Swaminathan and Neetin Desai (2017). Phytochemical analysis and antibacterial activity of *Annona muricata* (Laxman phal) against ESBLs producers (*Escherichia coli* and *Klebsiella pneumoniae*). *International Journal of Current Microbiology and Applied Science*; **6(3)**: 1339-1344 doi: <https://doi.org/10.20546/ijcmas.2017.603.155>.
- Marincola, G., Liong, O., Schoen, C. *et al.* (2021). Antimicrobial Resistance Profiles of Coagulase-Negative Staphylococci in Community-Based Healthy Individuals in Germany. *Frontiers of Public Health*; **9**: 684456. <https://doi.org/10.3389/fpubh.2021.684456>.
- Moghadamtousi, S. Z., Fadaeinasab, M., Nikzad, S., Mohan, G., Ali, H. M. & Kadir, H. A. (2021). *Annona muricata* (Annonaceae): A review of its traditional uses, isolated acetogenins and biological



- activities. *International Journal of Molecular Science*; **16(7)**: 15625-15658.
- Mon, W. L. Y., Khin May, O. O., AYE, M., and Thida, N. A. N. A. Y. E. (2024). Coagulase negative staphylococci from clinical isolates at tertiary care hospital, Myanmar. *Journal of Advanced Microbiology*; **5(1)**: 171-177.
- Mutakin, M., Fauziati, R., Fadhillah, F. N. *et al.* (2022). Pharmacological activities of soursop (*Annona muricata* Lin.). *Molecules*; **27(4)**: 1201.
- Palombo, E.A. (2011). In vitro activity of plant extracts against *Enterococcus faecalis*. *Journal of Ethnopharmacology*; **137(3)**: 791-796.
- Umoh, N. O., Udonkang, M., Akpan, S. *et al.* (2024) Antibiotic Resistance Indices of Methicillin-Resistant *Staphylococcus aureus* isolates at a Tertiary Healthcare Hospital in Calabar, Nigeria. *Sokoto Journal of Medical Laboratory Science*; **9(1)**: 150-158.
- Umoh, N., Udonkang, M., and Uloaku, P. (2025). Antibacterial activity of *Annona muricata* (Soursop) leaves extract on Urogenital Isolates of *Enterococcus faecalis* from Patients Attending a Tertiary Hospital in Calabar, Nigeria. *Global Journal of Pure and Applied Sciences*; **31**: 451-457.
- Wiegand, I., Hilpert, K. and Hancock, R. E. (2008). Agar and broth dilution methods to determine the minimal inhibitory concentration (MIC) of antimicrobial substances. *Nature Protocols*; **3(2)**: 163-175.

Citation: Nse O. Umoh, Mfoniso Udonkang, Glory Bebia, David Umoikot and Solomon A. Ben. Antibacterial Effects of *Annona muricata* bark and seeds extracts on Coagulase-negative *Staphylococcus* isolates from wounds of patients attending a Tertiary Healthcare Facility in Calabar, Nigeria. *Sokoto Journal of Medical Laboratory Science*; **10(2)**: 36. <https://dx.doi.org/10.4314/sokjmls.v10i2.4>

Copyright: This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.