

# Antibacterial Effect of Nano Silver on Bacteria Isolated from Human Skin Infections

Suror Abdulhameed Ramadan<sup>1</sup>, Hannaa Abdellatif Yassin<sup>2</sup>

<sup>1,2</sup>Department of Biology Science, College of Females Education, University of Anbar/Iraq

## Abstract

**Background:** Skin infections are one of the important infections in community with low response to antimicrobial agents due to resistant bacteria. **Aims of the study:** This study was devoted to throw light on role of nanosilver on the bacterial isolates and effect of such particles on bacterial antimicrobial resistance. **Patients and methods:** One hundred patients with different skin infections were included in this study, Skin swabs were taken from each patient and bacteriological investigations were done for each swab as soon as possible. Antimicrobial sensitivity diffusion test was done for the isolates pre and post treatment with nanosilver solution. **Results:** Seventy six (76) single and 10 mixed bacterial infections were isolated in this study. *Staphylococcus* took the first rank of isolation (42, 55.26%) followed by *Pseudomonas aeruginosa* (9, 11.8%) isolates while two (2, 2.6%) isolates of *Burkholderia cepacia* were isolated. Other bacterial types were isolated within lower ratios. Majority of isolates were sensitive to ceftriaxone and resistant to other antibiotics. All bacterial isolates were sensitive to nanosilver (100%) except *Pseudomonas aeruginosa* and *Burkholderia cepacia*, they were showing (28.6 %) and (50%) for each respectively. Nanosilver particles showed positive results on gene expression in bacteria resistant to antibiotics leading to shift resistant bacteria to sensitive to antibiotics. **Conclusion:** In conclusion, different bacterial types are imposed in skin infections particularly *Staphylococci*. In spite of majority of bacterial isolates are resistant to antibiotics, ceftriaxone is still effective. Majority of bacterial isolates showed sensitivity to nanosilver particles.

**Keywords:** Nano silver, bacterial infections. Antibiotic resistance

## 1. Introduction

Skin infections are one of the important infections in the community with low response to antimicrobial agents due to resistant bacteria. Scientists in this field started to find an alternative method to combat antibacterial resistance, nanotechnology is one of the tools started to be investigated for this category. Nano silver particles are one of the tested materials to find solution for antibiotic resistance [1, 2]. Nano silver particles are mostly used in the medical field to treat infections because of it is nonpoisonous and effective at lowest particle size and it showed higher antibacterial, antiviral and anti-inflammatory effect than others [3]. Many bacterial types are imposed in skin infections among of them are *Staphylococcus aureus* and *Streptococcus pyogenes* in addition to other types of bacteria isolated from wounds and burns like *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* [4, 5]. Enteric bacteria can be isolated from skin infections in children and aged individuals [6]. Antimicrobial bacterial resistance are one of the most important conflicts facing medical staff for treating infections causing difficulty in treatment and exposing patients life to danger [7]. This study was devoted to:

- 1-Identify the bacterial isolates causing skin infections.
- 2-Study antimicrobial sensitivity of bacterial isolates and the effect of nanosilver particles on bacterial isolates and its effect on antibiotics.

## 2. Patients and Methods

One hundred patients from both genders with

different skin infections were included in this study, their age range was 1-65 years. They were attending Dermatology at Heet General Hospital, Private Clinics in Heet & Ramadi city, Anbar Governorate.

All patients were examined by consultant dermatologist and skin swabs were taken from each patient, a written consent was taken from adult patients and parents of children. Bacteriological investigations were done for each swab as soon as possible following [8] bacterial diagnosis was confirmed by using Vitek 2 system Biomerieux (France). Antimicrobial sensitivity using MIC diffusion test was done for the isolates following Kirby–Bauer technique [7] pre and post treatment with nanosilver solution. The following antibiotics were used in this test, ceftriaxone, Azithromycin, Tetracycline, Erythromycin, Doxycycline, Gentamycin, Lincomycin and Clindamycin. Nano silver solution was prepared following the method of [9]. The effect of nanosilver effect on resistance gene expression was done on tested bacteria *Staphylococcus epidermidis* following [10, 11]. Results were reported and data were analyzed following SPSS Version 2.

## 3. Results and Discussion

Seventy six (76) single and 10 mixed bacterial infections were isolated in this study. *Staphylococcus* took the first rank of isolation (42, 55.26%) followed by *Pseudomonas aeruginosa* (9, 11.8%) isolates while two (2, 2.6%) isolates of *Burkholderia cepacia* were isolated. Other bacterial types were isolated within lower ratios (Fig-1A&B).

This result can be explained due to ability of *Staphylococci* to invade skin and cause infections

due to potency of their pathogenisty factors like toxins and enzymes [12-14]. These findings were in accordance with that of [15, 16]. Isolation of pseudomonas aeruginosa and other enteric bacteria from skin swabs was attributed to the fecal contamination of skin particularly in children and aged individuals [17, 18].

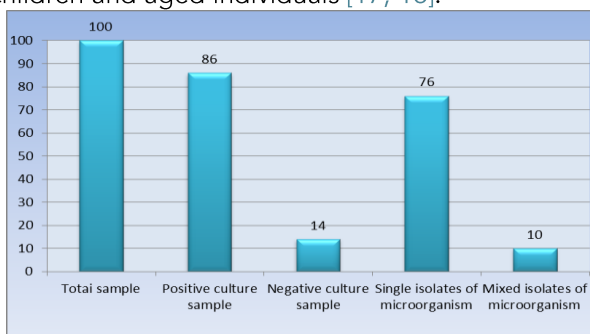


Fig-1-A: Result of bacterial growth of the tested skin swabs

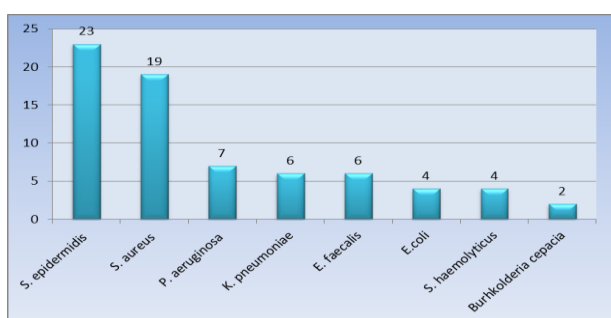


Fig-1-B: Types of bacteria isolates, number and ratios.

Silver nanoparticles were prepared successfully and confirmed by their positive results of identification through gross color change from white to brown and Ultraviolet visible spectroscopy analysis and measurement (Fig-2).the findings were confirmed also by [19, 20].

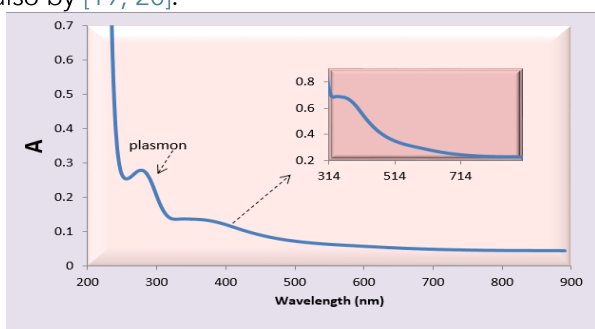


Fig-2: Detection of silver nanoparticles using Ultraviolet visible spectroscopy analysis and measurement.

Majority of isolates were sensitive to Ceftriaxone and resistant to other antibiotics and all bacterial isolates were sensitive to nanosilver (100%) except pseudomonas aeruginosa and Burchkolderia cepacia, they were showing (28.6 %) and (50%) for each respectively (Fig-3-A&B). These findings were in agreement with results of [21], the antimicrobial effect of silver nanoparticles can be explained by the very small size of such particles which enable them to aggregate around bacterial cell wall and membrane leading to interference and reduction of transport and metabolism of metabolites necessary for bacterial cell activity and life [22].

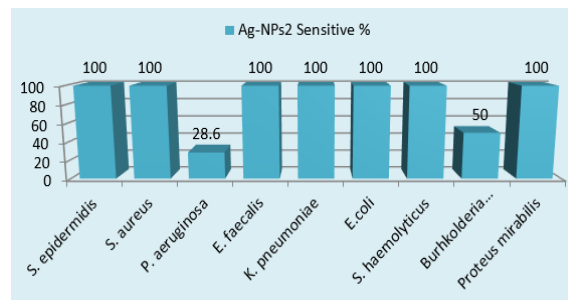


Fig-3-B: Antimicrobial effect of Silver nanoparticles.

We can conclude from this study that silver nanoparticles can be used in future as synergic material for antibacterial agents.

## References

- Singh K, Naidoo Y, Mocktar C, et al. Biosynthesis of silver nanoparticles using Plumbago auriculata leaf and calyx extracts and evaluation of their antimicrobial activities. *Advances in Natural Sciences: Nanoscience and Nanotechnology*. 2018;9(3):035004. Available from: <https://iopscience.iop.org/article/10.1088/2043-6254/aad1a3/meta>
- Suttee A, Singh G, Yadav N, et al. A review on status of nanotechnology in pharmaceutical sciences. *International Journal of Drug Delivery Technology*. 2019;9(1):98-103. Available from: <https://www.researchgate.net/publication/332343582>
- Kapoor RT, Salvadori MR, Rafatullah M, et al. Exploration of microbial factories for synthesis of nanoparticles—a sustainable approach for bioremediation of environmental contaminants. *Frontiers in Microbiology*. 2021;12:658294. <https://doi.org/10.3389/fmicb.2021.658294>
- Forson O, Ayanka E, Olu-Taiwo M, et al. Bacterial infections in burn wound patients at a tertiary teaching hospital in Accra, Ghana. *Annals of burns and fire disasters*. 2017;30(2):116. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5627548/>
- Riedel S, Morse SA, Mietzner TA, et al. *Jawetz Melnick & Adelbergs Medical Microbiology* 28 E. McGraw Hill Professional, 2019.
- Motwani MP, Colas RA, George MJ, et al. Pro-resolving mediators promote resolution in a human skin model of UV-killed Escherichia coli-driven acute inflammation. *JCI insight*. 2018;3(6). <https://doi.org/10.1172%2Fjci.insight.94463>
- Mogasale VV, Saldanha P, Pai V, et al. A descriptive analysis of antimicrobial resistance patterns of WHO priority pathogens isolated in children from a tertiary care hospital in India. *Scientific Reports*. 2021;11(1):1-7. <https://doi.org/10.1038/s41598-021-84293-8>
- Mahon CR, Manuselis G. *Textbook of diagnostic microbiology*. WB Saunders company, 2000.
- Kalpna D, Lee YS. Synthesis and characterization of bactericidal silver nanoparticles using cultural filtrate of simulated microgravity grown Klebsiella pneumoniae. *Enzyme and microbial technology*. 2013;52(3):151-6. <https://doi.org/10.1016/j.enzymictec.2012.12.006>
- Slavin YN, Ivanova K, Hoyo J, et al. Novel lignin-capped silver nanoparticles against multidrug-resistant bacteria. *ACS Applied Materials &*

Interfaces. 2021;13(19):22098-109.

<https://doi.org/10.1021/acsami.0c16921>

11. Herdyastuti N, Fauziah RW, Prabowo YY, et al. Diversity of Chitinolytic Bacteria from Shrimp Farms and Their Antifungal Activity. *J Nat Sci Biol Med*. 2021;12(3):317-26.

<https://doi.org/10.4103/jnsbm.JNSBM.12.3.6>

12. Lacey KA, Mulcahy ME, Towell AM, et al. Clumping factor B is an important virulence factor during *Staphylococcus aureus* skin infection and a promising vaccine target. *PLoS pathogens*. 2019;15(4):e1007713.

<https://doi.org/10.1371/journal.ppat.1007713>

13. Shettigar K, Murali TS. Virulence factors and clonal diversity of *Staphylococcus aureus* in colonization and wound infection with emphasis on diabetic foot infection. *European Journal of Clinical Microbiology & Infectious Diseases*. 2020;39(12):2235-46.

<https://doi.org/10.1007/s10096-020-03984-8>

14. Simeon J, Thrush J, Bailey TA. Angiopoietin-like protein 4 is a chromatin-bound protein that enhances mammosphere formation in vitro and experimental triple-negative breast cancer brain and liver metastases in vivo. *J Carcinog*. 2021;20:8.

<https://doi.org/10.4103/jcar.jcar.20.20>

15. Natsis NE, Cohen PR. Coagulase-negative staphylococcus skin and soft tissue infections. *American journal of clinical dermatology*. 2018;19(5):671-7.

<https://doi.org/10.1007/s40257-018-0362-9>

16. Parlet CP, Brown MM, Horswill AR. Commensal staphylococci influence *Staphylococcus aureus* skin colonization and disease. *Trends in microbiology*. 2019;27(6):497-507.

<https://doi.org/10.1016/j.tim.2019.01.008>

17. Garcia M, Morello E, Garnier J, et al. *Pseudomonas aeruginosa* flagellum is critical for invasion, cutaneous persistence and induction of inflammatory response of skin epidermis. *Virulence*. 2018;9(1):1163-75.

<https://doi.org/10.1080/21505594.2018.1480830>

18. Choby J, Howard-Anderson J, Weiss D. Hypervirulent *Klebsiella pneumoniae*—clinical and molecular perspectives. *Journal of internal medicine*. 2020;287(3):283-300. <https://doi.org/10.1111/joim.13007>

19. Santiago TR, Bonatto CC, Rossato M, et al. Green synthesis of silver nanoparticles using tomato leaf extract and their entrapment in chitosan nanoparticles to control bacterial wilt. *Journal of the Science of Food and Agriculture*. 2019;99(9):4248-59. <https://doi.org/10.1002/jsfa.9656>

20. Qiu X, Gu J, Yang T, et al. Sensitive determination of Norfloxacin in milk based on  $\beta$ -cyclodextrin functionalized silver nanoparticles SERS substrate. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*. 2022;276:121212.

<https://doi.org/10.1016/j.saa.2022.121212>

21. Li X, Robinson SM, Gupta A, et al. Functional gold nanoparticles as potent antimicrobial agents against multi-drug-resistant bacteria. *ACS nano*. 2014;8(10):10682-6. <https://doi.org/10.1021/nn5042625>

22. Dakal TC, Kumar A, Majumdar RS, et al. Mechanistic basis of antimicrobial actions of silver nanoparticles. *Frontiers in microbiology*. 2016;7:1831.

<https://doi.org/10.3389/fmicb.2016.01831>