Environmental Research 216 (2023) 114700

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

To decipher the phytochemical agent and mechanism for *Urginea indica* mediated green synthesis of Ag nanoparticles and investigation of its antibacterial activity against Methicillin-resistant *Staphylococcus aureus*

Bhumika Jena [a], Swati Sucharita Singh [a], Susanta Kumar Behera [a,b], Smrutirekha Mishra [c], Sankha Chakrabortty [c], Dayanidhi Meher [d], Bansidhar Mulia [d], Suraj K. Tripathy [c], Ramesh Kumar [e], Byong-Hun Jeon [e,**], Cecilia Stålsby Lundborg [f], Amrita Mishra [a,*]

[a] School of Biotechnology, Kalinga Institute of Industrial Technology, Bhubaneswar, 751024, India
[b] IMGENIX India Pvt. Ltd., Bhubaneswar, 751024, India
[c] School of Chemical Technology, Kalinga Institute of Industrial Technology, Bhubaneswar, 751024, India
[d] Kalinga Institute of Medical Sciences, Bhubaneswar, 751024, India
[e] Department of Earth Resources & Environmental Engineering, Hanyang University, Seoul, 04763, Republic of Korea
[f] Department of Public Health Sciences, Karolinska Institutet, Stockholm, 17177, Sweden

ARTICLE INFO

Keywords:
Antibacterial
Biofilm
Green synthesis
Nanoparticles
Silver

ABSTRACT

Globally, Methicillin-Resistant *Staphylococcus aureus* bacteraemia is one of the commonest bloodstream infections associated with clinical complications and high mortality. Thence, devising effective and targeted biogenic silver based strategies are in great demand. However, limited insights regarding the biosynthesis methodologies impedes the possible scale up and commercial potentials. We, hereby demonstrate the biosynthesis of Ag nanoparticles using the phytochemical agent extracted and purified from bulb extract of *Urginea indica*. The chemical structure of the phytochemical agent is investigated by various chromatographic and spectroscopic techniques and was found closely relatable to N-ethylacetamide. Ag nanoparticles synthesis by this agent was found to have a strong Surface Plasmon band at 402 nm. X-ray diffraction and transmission electron microscopy further validated the formation of Ag nanoparticles with face-centred cubic structure with a size range of 20–30 nm. The biogenic metal nanoparticles have shown potential antibacterial activity against *S. aureus* and MRSA (within a range of 10–50 μg/mL). The nanoparticles have also shown promising anti-biofim activity against the above mentioned strains. The nanoparticles were expected to induce ROS mediated bactericidal mechamism. Cell viability and *in-vitro* infection studies advocate noticeable biocompatibility and future clinical potential of the developed nanoparticles against *Staphylococcus* infections.

1. Introduction

Before the use of antibiotics became common practice, bacterial infections have killed millions of people and today, the relative safety afforded to human civilization by these miraculous drugs is at risk as the rapid emergence of resistant bacteria is growing worldwide, endangering the efficacy of conventional antibiotics (Barlow, 2018; Holmes et al., 2016). Among various microorganisms which are listed as Priority Level-2 (High) by WHO, *Staphylococcus aureus* (*S. aureus*) is of particular concern owing to its remarkable ability to acquire resistance to antibiotics, which may seriously undermine the available treatment options (Watkins et al., 2019). *S. aureus* is one of the most prevalent opportunistic human commensal pathogen, infamous not only for its adroitness to deceive the immune syste m to cause numerous infections in both communities and healthcare facilities but also for prolonged morbidity with a high recurrence and mortality rate (Chambers and DeLeo, 2009; Cheung et al., 2021; Turner et al., 2019). Among various antibiotic resistant (ABR) strains, Methicillin-resistant *S. aureus* (MRSA) is endemic in hospitals worldwide, and is also a leading cause of substantial morbidity and mortality. MRSA infections emerge in individuals

* Corresponding author.
** Corresponding author.
E-mail addresses: bhjeon@hanyang.ac.kr (B.-H. Jeon), amrita.mishra@kiitbiotech.ac.in (A. Mishra).

https://doi.org/10.1016/j.envres.2022.114700
Received 19 August 2022; Received in revised form 22 October 2022; Accepted 28 October 2022
Available online 9 November 2022

Environmental Research

Supports *open access*

11
CiteScore

8.3
Impact Factor