IAF/IAA SPACE LIFE SCIENCES SYMPOSIUM (A1)
Medicine in Space and Extreme Environments (4)

Author: Prof. Omer Aydin
Erciyes University, Türkiye

Mr. Zakarya Al-Shaebi
Türkiye
Ms. Münevver Akdeniz
Erciyes University, Türkiye
Mrs. Serra Ilayda Yerlitas
Türkiye
Mrs. Ruveyda Benk
Erciyes University, Türkiye
Mr. Ahmet Sezgin
Erciyes University, Türkiye
Prof. Pinar Sagiroglu
Türkiye
Prof. Mustafa Altay Atalay
Türkiye
Prof. Gokmen Zararsiz
Türkiye

ANTIMICROBIAL RESISTANCE: THE LESSON FROM WORD AND ITS APPLICATION IN SPACE

Abstract

Antibiotic resistance is a significant health challenge globally and in space, posing risks to public health and astronaut safety. Space's unique conditions, such as altered gravity and increased radiation, can accelerate antimicrobial resistance (AMR), complicating health management for astronauts. This urgency is echoed by the World Health Organization (WHO), highlighting the need for addressing AMR as a potential global health crisis. Traditional detection methods like Polymerase Chain Reaction (PCR) and Enzyme-Linked Immunosorbent Assays (ELISA) are limited by high costs, lengthy processes, and the need for specialized expertise. Thus, there's a critical demand for rapid, reliable, and cost-effective methods to distinguish between antibiotic-resistant and susceptible bacterial strains.

Our study introduces an innovative approach combining Surface-Enhanced Raman Spectroscopy (SERS) with Artificial Intelligence (AI) to address AMR. SERS, leveraging inelastic scattering of laser light by noble metal nanostructures, offers label-free detection and direct identification of bacterial pathogens. However, distinguishing between antibiotic-resistant and susceptible strains is challenging due to their molecular similarities. Machine learning algorithms, including deep learning and traditional models, are essential for detecting subtle spectral differences indiscernible to the human eye, allowing for precise bacterial strain discrimination.

We utilized AI and SERS to explore bacterial resistance mechanisms under simulated space conditions, developing a specialized SERS library for cataloging antibiotic resistance profiles. This method provides a rapid, non-invasive tool for astronaut health monitoring, microbial contaminant detection on spacecraft, and enhancing our understanding of extraterrestrial microbial life. Promising to revolutionize antibiotic resistance detection and profiling, this approach offers a critical tool for maintaining sterile conditions in

space missions and developing strategies against antibiotic-resistant pathogens that threaten astronaut health and potential extraterrestrial sample contamination.

The integration of AI-enhanced SERS into AMR research opens new avenues in the search for microbial life beyond Earth, providing a crucial tool for space exploration. This methodology supports rapid AMR detection and effective infection treatment and prevention, safeguarding astronaut and global health. In our study, we applied SERS to identify methicillin-resistant and susceptible S. aureus strains, employing machine learning for differentiation. The U-Net model demonstrated high accuracy (99.04 0.003Supported by Erciyes University Scientific Research Projects Coordination Unit under grant FBAÜ-2023-12265.