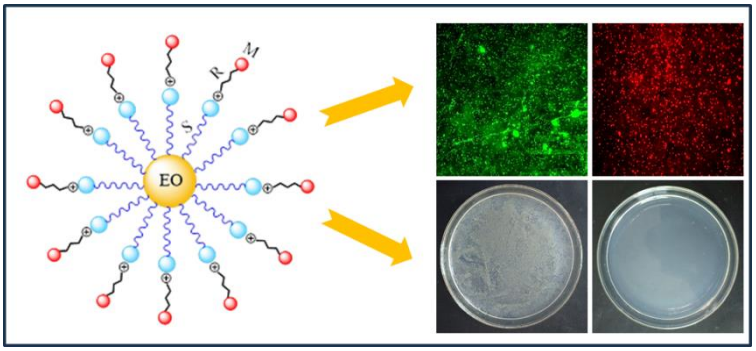
Membrane Selective Cationic Metal Nanoparticles Conjugated Nanoemulsion for the Augmentation of Antibacterial Efficacy by Membrane Depolarization and Lipid Solubilization of *Staphylococcus aureus*

Somashree Bose, PhD Scholar, CSIR-Indian Institute of Chemical Biology, Kolkata, India

Sujoy K Das, Principal Scientist, CSIR-Indian Institute of Chemical Biology, Kolkata, India

Abstract

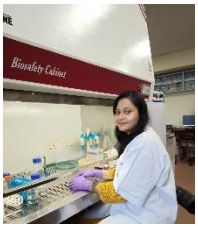


Bacteria associated infections are one of the growing global concerns for human health care management. Different treatment strategies to combat such problems are of at most importance. The emergence of nanoemulsion based therapy has potential role in the eradication of bacterial infestation. In this research work, we detailed the synthesis and functionalization of an essential oil based nanoemulsion (NE) with cationic metal nanoparticles (CNP) for the treatment against *Staphylococcus aureus* infection. The NE was functionalized with CNP to form cationic nanoparticles conjugated nanoemulsion. (designated as NECNP). NECNP was further characterized by UV-Vis spectroscopy, FTIR spectroscopy, Atomic Force microscopy (AFM), field emission scanning electron microscopy (FESEM), high resolution transmission electron microscopy (HRTEM), nuclear magnetic resonance (NMR), dynamic light scattering (DLS) and ζ-potential analysis. NECNP exhibited magnified antibacterial efficacy as compared to their individual constituents due to the synergistic activity of NE and CNP. There was 5 log reduction in the bacterial cells following the treatment with NECNP. The strong bactericidal efficacy by NECNP was due to the cell membrane lipid solubilization mode of action. The negatively charged bacterial cell membrane following contact with positively charged NECNP led to the membrane depolarization, causing lipid solubilization, membrane damage and finally cell death. The penetration of NECNP into the cellular cytoplasm leads to the release of its intracellular proteins and nucleic acid into the extracellular region. The fluorescence and confocal microscopic images of the bacterial cells following the treatment with NECNP exhibited the membrane

depolarization, membrane lipid solubilization, an effective bactericidal property for *S. aureus*. NECNP also possesses least *in-vitro* cytotoxicity to the fibroblast cell line (L929) and human red blood cells. Further the *ex-vivo* study on porcine skin also supported the *in –vitro* antibacterial potency of NECNP. The procured results stipulated the potential utilization of the as synthesized NECNP constructing them as a promising candidate for the bactericidal therapeutics.

Recent Publications

1. Vijaya Gowri Ayyappan [a,b] , Shashikant Shivaji Vhatkar [a] , **Somashree Bose** [b,c] , Srinivasan Sampath d , Sujoy K. Das [b,c] , Debasis Samanta [a,b],* , Asit Baran Mandal [a,b,e],**Journal of the Indian Chemical Society 99 (2022) 100278.
2. Arpita Mukherjee,[ab] **Somashree Bose**,[ab] Anirban Shaoo[a] and Sujoy K. Das [*ab] *Mater. Adv.*, 2023,4, 2544-2572.
3. S. K. Das, D. Kumar, S. Swarnakar, **S. Bose** and Y. Dahat, India Pat., 202111045225, 2021.
4. P. Choudhary, T. Parandhaman, B. Ramalingam, N. Duraipandi, M. S. Kiran and S. K. Das, *ACS Appl. Mater. Interfaces*, 2017, **9**, 38255-38269.
5. T. Parandhaman and S. K. Das, *Biomater. Sci*., 2018, **6**, 3356-3372.
6. S. K. Das, T. Parandhaman, N. Pentela, A. K. M. M. Islam, A. B. Mandal and M. Mukherjee, *J. Phys. Chem. C*, 2014, 118, 24623−24632.



Somashree Bose received her BSc degree from Acharya Prafulla Chandra Roy Government College, University of North Bengal in 2015, majoring in Zoology. Then, she completed her MSc studies from Ranchi University in 2017, majoring in Zoology. She is currently pursuing her PhD degree at the Infectious Diseases and Immunology Division, CSIR-IICB, Kolkata, India under the supervision of Dr Sujoy K. Das. Her research focus is on the development and application of smart transdermal scaffolds as novel drug delivery systems to combat bacterial infections and accelerate wound healing. She is a coauthor of one research paper and one review article in an international journal of high repute, and has also filed a patent from India.

Email: somashree.21bose@gmail.com