A new concern of nanowaste: A case study of bacterial pathogenic evolution

Chengdong Zhang[1]

[1] School of Environment, Beijing Normal University, Beijing, 100087, China
Keywords: nanowaste, bacteria, pathogenicity, evolution
Presenting author email: zhangchengdong@bnu.edu.cn

Silver nanoparticles (AgNPs), own to its broad spectrum of antibacterial and antifungal activities, has been widely used in many commercial products, ranging from biomedical supplies, textile, to personal-care products (Patchin et al. 2016). It is estimated that over 400 t of AgNPs is produced globally each year (Vila et al. 2017). In general, a 5 to 95% of the total amount of AgNPs in the commercial products will be released into the swage-treatment plant (Syafiuddin et al. 2018). As a result, AgNPs is widely detected in a variety of environmental matrices. Therefore, AgNPs exposures in ecosystems will mostly be chronic exposures to low concentrations, and it is imperative to explore whether bacteria can develop adaptive response/resistance under this circumstance.

The main objective of this study was to elucidate the physiological changes of a model bacteria *E. coli* after chronic exposure to low dose of AgNPs. Additionally, how the capability of AgNPs-resistance/tolerance influenced bacterial sensitivity to various antibiotics was investigated. Our study provides insight into the hitherto little explored phenomenon of bacterial nano-resistance and understands whether the adaptive mechanisms are also relevant for bacteria developing resistance to antibiotics.

The results showed that *E Coli* decreased the susceptibility to AgNPs after 100 generations of exposure as evidenced by the change of minimal inhibition concentration (MIC) from 1.24 to 3.01 mg/L. This tolerance is due to the overexpression of Cu-related efflux pump (i.e., *cusABCF*). Importantly, the developed bacterial resistance also implicates in antibiotic tolerance (i.e., penicillin, ciprofloxacin, kanamycin, gentamicin), due to the adaptation to oxidative stress and associated upregulations of multidrug resistance genes. Together, this outcome will allow us to address the question concerning evolution mechanism of bacteria towards AgNPs, which also poses an important concern about the sustained use of AgNPs as a “miracle” biocide.

Acknowledgements

This project was supported by the National Natural Science Foundation of China (Grants 21777077). Partial support was also provided by the Fundamental Research Funds for the Central Universities and the Interdisciplinary Research Funds of Beijing Normal University.

Reference

Patchin ES, Anderson DS, Silva RM, Uyeminami DL, Scott GM, Guo T, et al. 2016. Size-dependent deposition, translocation, and microglial activation of inhaled silver nanoparticles in the rodent nose and brain. Environ Health Persp 124(12):1870-1875.

Vila L, Marcos R, Hernandez A. 2017. Long-term effects of silver nanoparticles in caco-2 cells. Nanotoxicology 11(6):771-780.

Syafiuddin A, Salmiati S, Hadibarata T, Kueh ABH, Salim MR, Zaini MAA. 2018. Silver nanoparticles in the water environment in Malaysia: inspection, characterization, removal, modelling, and future perspective. Sci Rep 8:1-15.