> Sci Total Environ. 2023 Feb 10;859(Pt 1):160032. doi: 10.1016/j.scitotenv.2022.160032. Epub 2022 Nov 10.

Metagenomics indicates abundance of biofilm related genes and horizontal transfer of multidrug resistant genes among bacterial communities in nano zinc oxide polluted soil

R Dinesh [1], C P Sreena [1], T E Sheeja [2], Sona Charles [1], V Srinivasan [1], V Sajith [3], K P Subila [1], P Haritha [1]

Affiliations + expand

PMID: 36370776 DOI: 10.1016/j.scitotenv.2022.160032

Abstract

The unsafe and reckless disposal of metal oxide nanoparticles like ZnO (nZnO) into the soil could seriously impact bacterial behavioural responses and functions. Under such stress, biofilm formation is considered to be a robust mechanism for bacterial survival in soil. We examined the response of bacterial metagenomes in soils exposed to varying levels of Zn (50, 200, 500 and 1000 mg kg^{-1}) as nano Zn oxide (nZnO) in terms of biofilm genesis and regulation and their co-occurrences with multidrug resistance genes (MDRGs) and mobile genetic elements (MGEs). The size-specific effects of nZnO were verified using its bulk counterpart (bZnO). Both nZnO and bZnO facilitated profusion of biofilm related genes (BGs) especially at higher Zn levels (500 and 1000 mg kg^{-1} Zn), though maximum abundance was registered at a comparatively lower level under nZnO. In general, nZnO favoured an enhancement of genes involved in exopolysaccharide biosynthesis and attachment, while bZnO favoured genes related to capsule formation, chemotaxis and biofilm dispersion. Co-occurrence network analysis revealed significant positive correlations between abundances of BGs, MDRGs and MGEs, indicating an enhanced probability for horizontal gene transfer of MDRGs in nZnO polluted soils.

Keywords: Biofilm genesis; Co-variance network; Horizontal gene transfer; Metal oxide nanoparticles; Mobile genetic elements; Soil pollution.

Conflict of interest statement

Declaration of competing interest The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Similar articles

New insights into bacterial Zn homeostasis and molecular architecture of the metal resistome in soil polluted with nano zinc oxide.
Raghavan D, Patinharekkara SC, Elampilay ST, Payatatti VKI, Charles S, Veeraraghavan S, Kadiyalath J, Vandana S, Purayil SK, Prasadam H, Anitha SJ.
Ecotoxicol Environ Saf. 2023 Sep 15;263:115222. doi: 10.1016/j.ecoenv.2023.115222. Epub 2023 Jul 6.
PMID: 37418939

Soil polluted with nano ZnO reveals unstable bacterial communities and decoupling of taxonomic and functional diversities.
Dinesh R, Sreena CP, Sheeja TE, Kumar IPV, Praveena R, Charles S, Srinivasan V, Jayarajan K, Sajith V, Subila KP, Haritha P.
Sci Total Environ. 2023 Sep 1;889:164285. doi: 10.1016/j.scitotenv.2023.164285. Epub 2023 May 19.
PMID: 37209750

Exploring the impact of Mg-doped ZnO nanoparticles on a model soil microorganism Bacillus subtilis.
Auger S, Henry C, Péchaux C, Lejal N, Zanet V, Nikolic MV, Manzano M, Vidic J.
Ecotoxicol Environ Saf. 2019 Oct 30;182:109421. doi: 10.1016/j.ecoenv.2019.109421. Epub 2019 Jul 10.
PMID: 31301592

Synergistic Effects Between Dietary Zinc Form Supplementation and Dietary Protein Levels on Performance, Intestinal Functional Topography, Hemato-biochemical Indices, Immune, Oxidative Response, and Associated Gene Expression of Nile Tilapia Oreochromis niloticus.
El-Badawy AS, Hassaan MS, Abdel-Hameid NH, El-Ezaby MM, El-Serafy S.
Biol Trace Elem Res. 2022 Jul;200(7):3412-3428. doi: 10.1007/s12011-021-02911-y. Epub 2021 Sep 6.
PMID: 34487300

Comparative toxicity of nano-ZnO and bulk ZnO suspensions to zebrafish and the effects of sedimentation, ˙OH production and particle dissolution in distilled water.