"Terrestrial trophic transfer of bulk and nanoparticle $La_2O_3$ does not depend on particle size"

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Pages- 6

Figures- 5

Tables- 0

## S1.Method

S1.1.Nanoparticle characterization

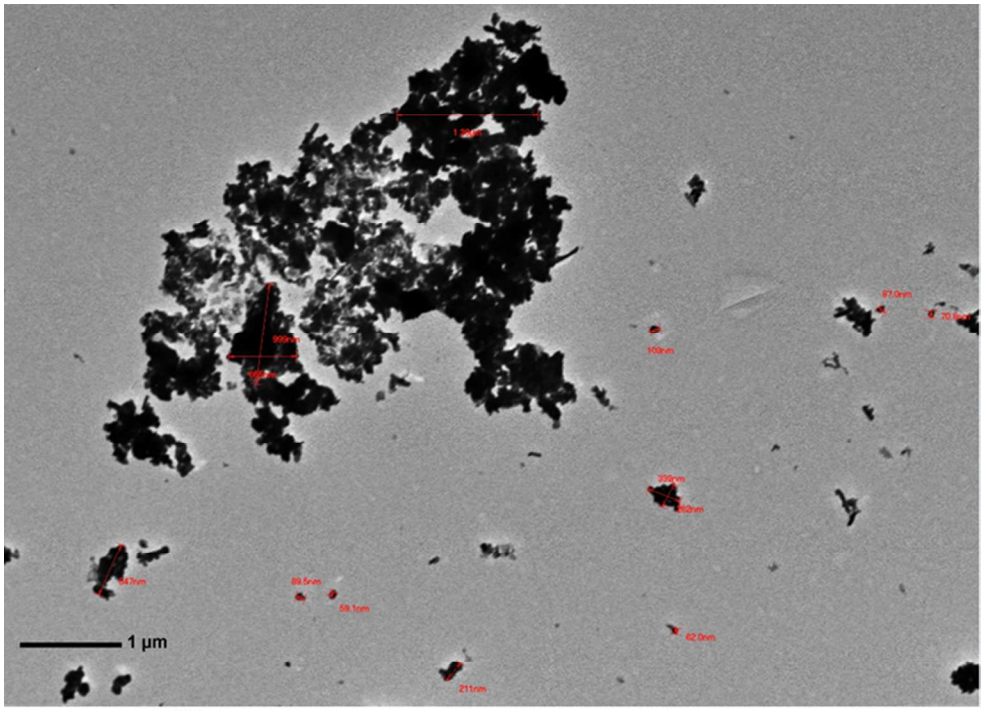
To provide an initial characterization of the La particles, 100 mg/L $La_2O_3$ NP solutions were prepared, probe-ultrasonicated for 3 min, and left on the bench overnight. The solutions were then centrifuged at 2110g for 10 min and a portion of the supernatant was removed for particle size and zeta potential determination. In summary, the average hydrodynamic particle diameters ($d_h$) and zeta potentials (ζ) for bulk and NP $La_2O_3$ in tap water were 439.6 nm and 166.7 nm, and -47.4mV and 47.8 mV, respectively. In Hoagland's solution significant aggregation occurred and values for bulk and NP were 2374 nm and 1220 nm, respectively. The zeta potential values were -3.72 mV and 15.2 mV for bulk and NP, respectively.

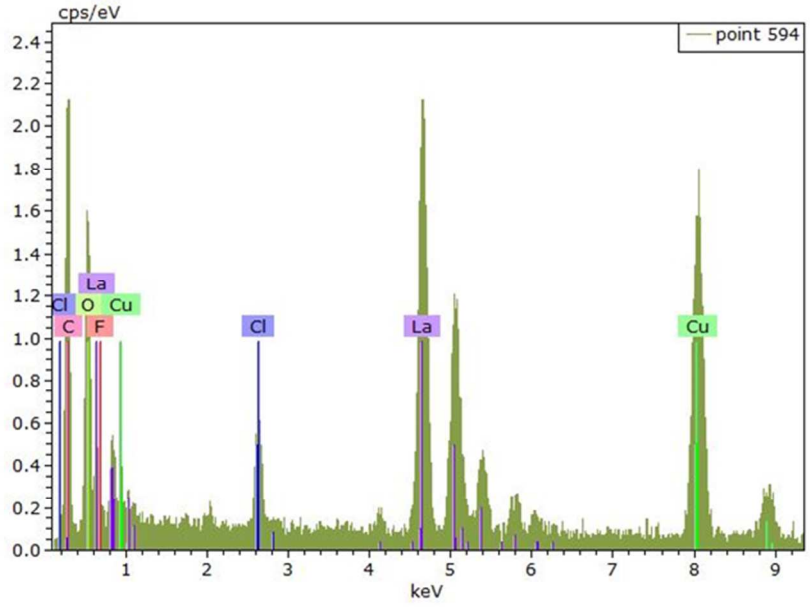
To characterize the particles under conditions that better approximate that of addition to the soil, 700 mg of bulk or NP $La_2O_3$ was added to 500 mL of tap water or 10% Hoagland's solution. The solution were ultrasonicated with a probe sonicator for 5 minutes prior to immediate analysis for size and zeta potential determination. In addition, 1 drop of each solution was transferred to a Cu grid, allowed to air day and then was analyzed by scanning/transmission electron microscopy with energy-dispersive X-ray spectroscopy (S/TEM-EDS; Hitachi High Technologies America, Pleasanton CA). Notably, significantly greater NP aggregation was observed under these conditions (Figure S1). In summary, the average hydrodynamic particle diameters ($d_h$) and zeta potentials (ζ) for bulk and NP $La_2O_3$ in tap water were 834.1 nm and 906.2 nm, and -21.8 mV and 2.67 mV, respectively. In Hoagland's solution significant aggregation occurred and values for bulk and NP were 1175 nm and 1254 nm, respectively. The zeta potential values were -9.94 mV and 5.86 mV for bulk and NP, respectively.

S1.2 Matrix digestion

Crickets were generally not composited prior to analysis; individual replicate pots or insects containers served as sources for replicate tissues. Similarly, mantises were not composited and each individual served as a single replicate. Darkling beetles were separated into 4 separate replicates per treatment. To determine La content, samples tissues (root, leaf, cricket, darkling beetles, and mantis), as well as the vermiculite and soil, were oven-dried at 100 °C for at least 72 h and were digested on a hot block digester (SCP Science, Champlain NY) in concentrated $HNO_3$ for 30 min. After 30 min, 1 mL of 30% hydrogen peroxide (Fisher Scientific, Pittsburgh PA) was added to each sample matrix to complete the digestion and the samples were again heated on the hot block for an additional 25 min. The digests were analyzed by ICP-MS (Agilent 7500ce)(Santa Clara, CA) for La content (139 amu) which was quantified against a five-point calibration curve that had been previously evaluated for linearity and accuracy. Analytical blanks, matrix blanks, and calibration verification samples were included in each sequence.

Figure S1. S/TEM-EDS of NP $La_2O_3$ in tap water; significant NP aggregation is evident.



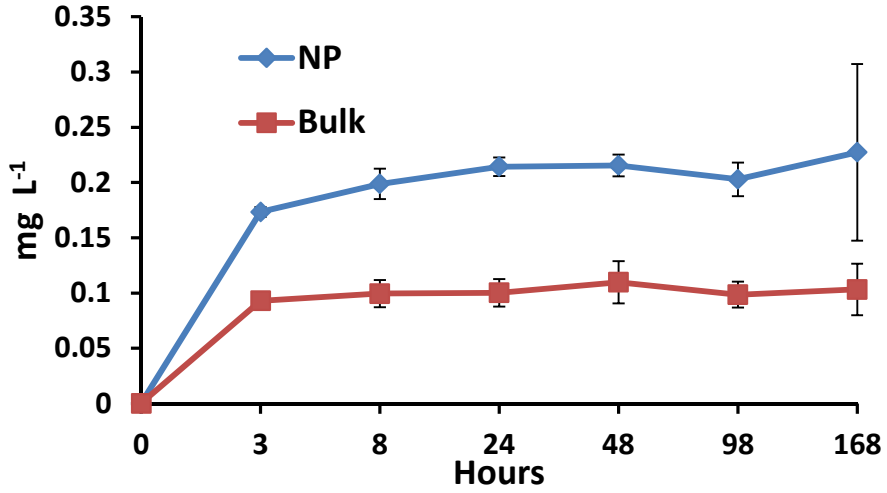



Figure S2. Time-dependent dissolution of 100 mg $L^{-1}$ $La_2O_3$ bulk and NP in tap water. The concentration of released La reached a maximum (about 0.21 mg $L^{-1}$ and 0.09 mg $L^{-1}$ respectively) at 24 h and kept basically constant for 6 days.

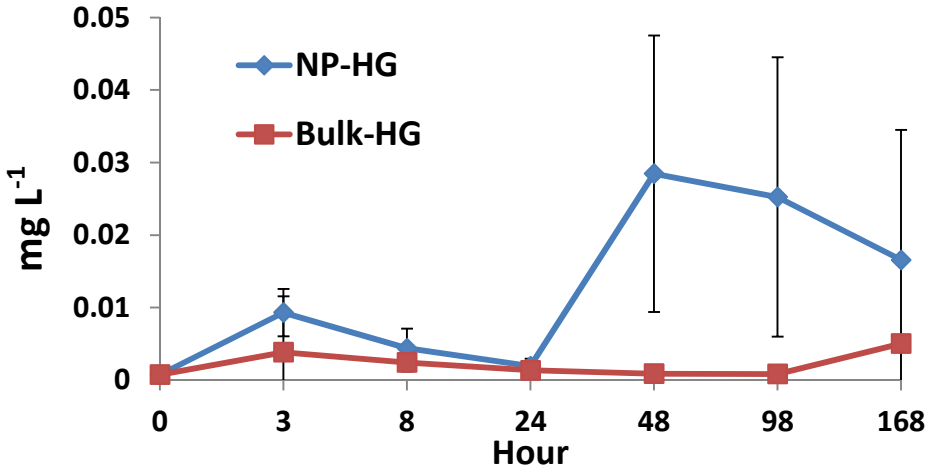



Figure S3. Time-dependent dissolution of 100 mg $L^{-1}$ $La_2O_3$ bulk and NP in 10% Hoagland's solution.

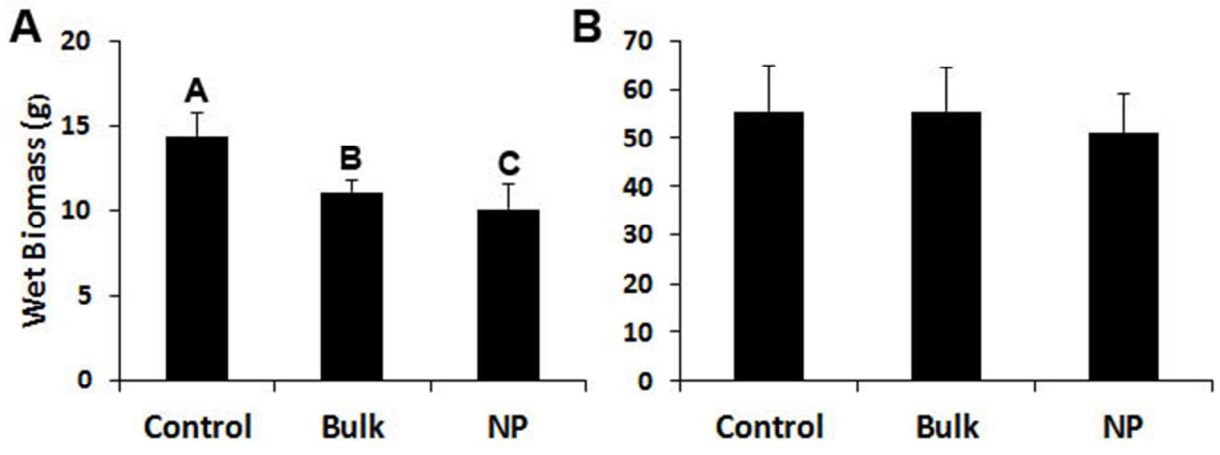



Figure S4: Wet biomass (g) of lettuce leaves from plants grown in soil amended with 0 or 500 mg $kg^{-1}$ bulk or nanoparticle (NP) $La_2O_3$.A: Plants grown in 350 g of soil. B: Plants grown in 1200 g of soil. Within treatments, bars with different letters are significantly different. Error bars represent standard deviation.

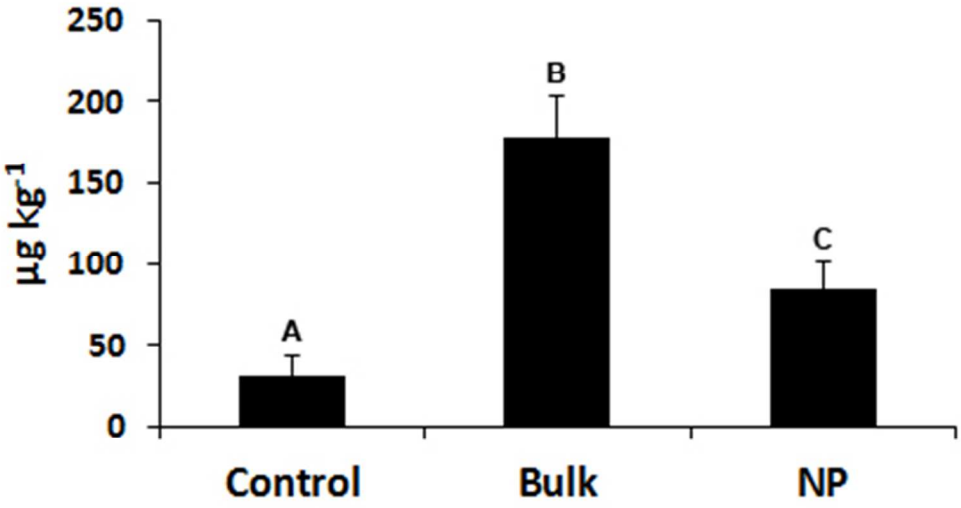



Figure S5: A: La content of darkling beetles that consumed lettuce leaves from plants grown in soil amended with 0 or 500 mg kg bulk or nanoparticle (NP) $La_2O_3$. Within treatments, bars with different letters are significantly different. Error bars represent standard deviation.