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# Mineral nutrients in soil and pea plants after exposition to $TiO_2$ nanoparticles through a biosolid-amended soil

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In addition to the benefits derived from nanotechnology, there is also concern about the potential risks of engineered nanoparticles (ENPs) when released into the environment. Their possible accumulation and effects in agricultural soils and crops are closely linked to food and agriculture safety. Particular attention has been focused on the reuse of biosolids from wastewater treatment plants that are considered a cost-effective practice for the improvement of nutrients and organic matter in agricultural soils and, but also a sink of contaminants such as nanoparticles (NPs). $TiO_2$NPs have a global production of about 10.000 tons/year and it are among the most extensively used ENPs. Moreover, dissimilar or inconclusive results have been reported concerning the impact of $TiO_2$ NPs on the soil-crop system, thus more information regarding their behavior are necessary.
This study aimed to evaluate the potential effects of $TiO_2$ NPs (anatase and rutile) and larger particles (bulk) on the availability of soil nutrients and on the nutritional status of *Pisum sativum* plants, simulating low (80 mg/kg) and high load of $TiO_2$ (800 mg/kg ) in a biosolid-amended soil. Treated soils were analyzed for N, P, K, Ca, Mg, Mn, Fe, Cu, Zn, soil microbial community, and plants grown in laboratory for 30d were analyzed for growth, pigments and mineral nutrition.
Results showed that the treatment with $TiO_2$ at macro- and nano-scale significantly reduced the availability of Mn, Fe and P in soils, this last more evident for the NPs treatments. Indeed, the soil bacterial diversity was reduced when the mixture of anatase and rutile were spiked in the biosolid-amended soil at high concentration. Moreover, the pea plants from treated soils showed an imbalance in the mineral nutrition, with reduction in the plant tissues of Mn and K and increase of N. This study pose a reflection on the use of biosolid, which could act as a vehicle for the spread and accumulation of ENPs in agro-ecosystems.