NANO HIGHLIGHT
Accumulation of Engineered Nanoparticles in Belowground Vegetables: Nutritional Bioaccessibility and Dietary Exposure Risks

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Project overview and objectives:

The release of engineered nanoparticles (ENPs) into the environment has raised concerns about their potential risks to food safety and human health. There is a particular need to determine the extent of ENP uptake into plant foods. Belowground (i.e., root) vegetables that grow in direct contact with the soil are the foods which will likely accumulate the highest concentration of ENPs and present the most significant risk to human health. This four year project is evaluating the accumulation of six different metal ENPs into the tissues of ten common belowground vegetables, including carrot, parsnip, turnip, beet, radish, and sweet potato, to identify the plant foods from those examined with the greatest potential for accumulation of individual ENPs. Project efforts are also examining the penetration of the ENPs into the edible plant tissues and how basic food preparation steps may remove the tissues with the greatest density of ENPs and thereby reduce dietary exposure. The cornerstone of the project is the inclusion of a physiologically-based extraction test (i.e., an "artificial stomach" system) to provide data on the extent to which ENPs in those plant foods are released in the gastrointestinal tract. Data from these extraction tests will be used to produce models of dietary exposure to help estimate dietary risks of ENP exposure.

NANO HIGHLIGHTS:

In the 15 months since the project began, work has focused on largely on the accumulation of metal oxide ENPs such as ZnO, CuO, or CeO_2 in the edible tissues of carrot. Each experiment has also included treatments with the free metal ion of each ENP (e.g., Zn^{2+} v. ZnO) for comparison since the ions are the form normally found in soils. There have been three consistent results from each of the studies. First, compared to the more common ionic form, the ENPs are found at lower concentrations in edible flesh of carrots. This is because most of the ENP was trapped in the carrot peel (which is typically removed prior to consumption). Second, of the three ENPs tested, CuO and CeO_2 accumulated more readily in the edible flesh of carrot than ZnO. These results indicate that ENPs behave differently and results from one ENP do not necessarily predict how other ENPs will behave in the same crop or other crops. Third, when mathematical models were used to estimate the exposure to metal ions or the metal ENPs that adults or children might receive from eating these raw carrots, the estimates suggested that if the carrots were peeled prior to eating, the exposure from consumption would fall below the threshold for toxic effects. However, according to the models the toxic threshold for Zn would be exceeded if children were to consume the unpeeled carrots or if adults consumed raw, unpeeled carrots grown in high concentrations of ZnO. The extent to which cooking these carrots alters the possible exposure will be examined in future studies. The results of this work and from other experiments are being prepared for publication in prominent scientific journals.

References (10 point font)

[1] For further information about this project contact Stephen Ebbs, sebbs@plant.siu.edu