Selenium enrichment of tomato plants with nanoparticles: improved fruit quality, physiological performance and increased nutraceutical value.

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Selenium (Se) has several important functions for both humans and plants. At proper concentrations, Se positively affects DNA synthesis, fertility, reproduction, muscle function and immunity response in humans. One billion people on the Earth are having insufficient Se dietary uptake, therefore strategies to improve Se uptake are needed. In plant tissue, Se is well known to increase antioxidant capacity, to affect titratable acidity, weight loss, to delay fruit senescence and loss of firmness. However, the physiological explanations of such effects are still poorly described. As a second most important vegetable crop and well-studied model plant, tomato appears to be the best commodity for producing a Se biofortified fruit for dietary supplementation and for investigating fruit physiological responses of Se enrichment.

In this study, traditional approach to provide Se to plants in form of sodium selenate was compared with innovative use of chemically synthetized nanoparticles (SeNPs), that harbor elemental Se, safer and more bioavailable than Se (IV) and (VI). Tomato plants were hydroponically grown in a greenhouse and sprayed with sodium selenate and SeNPs solution at dose of 0, 5 and 10 mg Se L^{-1} before fruit entered the mature green stage. Fruit ethylene production, qualitative and visual parameters were monitored during fruit ripening and post-harvest. Volatile organic profiling and NMR analysis were used as non-targeted tools for detecting metabolome changes. Carotenoid content in fruit, and expression of the genes involved in carotenoid biosynthesis were measured.

Se was absorbed by aerial plant organs and re-allocated in different organs, including fruit, where it accumulated. The lowest dose of Se (5 mg L^{-1}) did not affect fruit physiology, whereas spraying plants with 10 mg Se L^{-1} influenced the accumulation of amino acids, terpenoids, aldehydes, alcohols, carotenoids and their metabolites. Se also affected taste index and titratable acidity. Eight genes involved in carotenoid biosynthesis were downregulated in fruit biofortificated with the highest Se concentration. Moreover, Se has impacted synthesis of signaling molecules, odor-related and ripening related compounds in fruit.

Both Se nanoparticles and sodium selenate have been found applicable for the biofortification of tomato. These Se delivering methods increased the nutraceutical properties of tomato fruit, without exceeding the recommended dose for human diet. Additionally, biofortification of tomato fruit with Se improves fruits physiological properties and increased nutraceutical value.

Keywords: selenium, tomato, postharvest, nanoparticles, nutraceuticals.