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Climate change will increase Cd accumulation in spinach leaves

Marie Muehe[1,2], Aleksandra Pienkowska[1,2], Alexandra Glöckle[1], Natalia Sánchez[1,2], Shitalben Khadela[1], Paul-Georg Richter[1], Ines Merbach[1], Martin Herzberg[1], and Thomas Reitz[1]
[1]Helmholtz Centre for Environmental Research, Leipzig/Halle/Bad Lauchstädt, Germany (marie.muehe@ufz.de)
[2]University of Tuebingen, Germany (marie.muehe@ufz.de)

Metal contamination in agricultural soils poses a notable environmental and health concern. When available in soils, metals can be assimilated and accumulated by crops, emphasizing the potential for human exposure to elevated metal levels through the consumption of contaminated agricultural produce. Our recent research shows that future climate change conditions of +4°C, doubled atmospheric CO_2, and reduced soil moisture [1] increases the mobility of the heavy metal Cd in agricultural soils [2]. It remains uncertain whether this climate-augmented Cd bioavailability in agricultural soils transfers into the food chain.

To address this gap in knowledge, we cultivated four varieties of spinach (*Spinacia oleracaea*) in four soils with diverse geochemistry and heavy metal contents. Spinach, chosen as a model for leafy crops prone to heavy metal accumulation in edible parts, boasts a global production volume of 63 billion kg in 2021 [3]. Under anticipated climatic conditions with +3°C, +300 ppmv CO_2 and 10% less water [1], three out of four spinach varieties yielded more edible biomass compared to today's climate typical for spring spinach with 20°C daytime temperature and 50% water holding capacity. The non-essential heavy metal Cd and the micronutrient Zn proved most responsive to the imposed future climatic conditions, exhibiting increased accumulation in the edible part. Factors such as soil-root transfer and root to shoot translocation will be discussed to elucidate the climate-induced rise in Cd and Zn contents in spinach leaves beyond soil Cd mobility.

Our findings offer significant insights into forecasting future spinach production and quality, applicable to other leafy vegetables, and underscore the importance of addressing combined climate and heavy metal contamination issues to sustain food quality.

[1] IPCC, 2021. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.*

[2] Drabesch et al., submitted, *Climate induced microbiome alterations increase Cd bioavailability in agricultural soils*.

[3] UN Food and Agriculture Organization, 2023. *Spinach production in 2021; Crops/Regions/World/Production Quantity/Year from pick lists*.