Biofortification of microgreens with zinc could mitigate global 'hidden hunger'

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Pradip Poudel, the doctoral student in the Department of Plant Science who spearheaded the research, with pea and sunflower plants shortly after seeds germinated, growing in trays filled with peat-perlite mix. Credit: Penn State, Creative Commons

When the seeds of plants such as pea and sunflower are biofortified with zinc, the seedlings they quickly produce—harvested as microgreens—could both help to mitigate global malnutrition and boost the odds of people surviving a catastrophe.

That's the conclusion of a Penn State research team that experimented with several biofortification methods to determine the most effective way to incorporate a mineral essential to human health into the young plants while not diminishing the amounts of other essential nutrients they produce. Microgreens biofortified with zinc offer people a lifeline in the face of starvation risk, according to team leader Francesco Di Gioia, assistant professor of vegetable crop science.

"This study has demonstrated that zinc biofortification through seed nutri-priming achieves needed levels of zinc in the young pea and sunflower plants we focused our experiments on," he said. "These results have implications for both global 'hidden hunger' and emergency or catastrophe preparedness."

The work is another development in the ongoing project Food Resilience in the Face of Catastrophic Global Events. In Di Gioia's work, an international team of researchers found that microgreens can be grown in a variety of soilless production systems in small spaces indoors, with or without artificial lighting. The zinc biofortification component is an important new innovation.

Biofortification is the process of growing crops to increase nutritional value from the seed on, Di Gioia explained. It is different from food fortification, which involves adding nutrients to foods during post-harvest processing. In poor regions of the world, or under post-catastrophic conditions, simply soaking seeds in a zinc solution is a practical and effective strategy for producing nutrient-dense microgreens, he pointed out.

"Starting decades ago as fashionable, high-value gourmet greens, microgreens today have gained popularity among consumers for their nutritional profile and high content of antioxidant compounds," he said. "Our work shows microgreens can help people to survive a global catastrophe such as all-out nuclear war, a large asteroid strike or supervolcano eruption in the short term, but additional nutritional resources may be needed in the longer term."

Such a cataclysmic event would endanger agricultural productivity by reducing sunlight and temperature, disrupting rainfall patterns, and contaminating water supplies, thus threatening starvation for survivors of the initial event. Early on, biofortified microgreen production could improve the probability of human survival under these conditions.

The prospect of also being able to expeditiously mitigate hidden hunger excites Pradip Poudel, the second-year doctoral degree student in the College of Agricultural Sciences who spearheaded the research. He suggested that production of nutrient-dense crops using agronomic biofortification techniques is a sustainable strategy that is badly needed to address malnutrition.

The World Health Organization defines "hidden hunger" as a lack of vitamins and minerals that occurs when the quality of food people eat does not meet the nutrient requirements they need for their growth and development, Poudel noted. Two billion people suffer from vitamin and mineral deficiencies, according to the WHO.

"We were thinking, how can we increase the content of zinc in microgreens, developing a very simple way that people could use at home in a 'microgreens growing kit' that could be delivered in an emergency situation," he said. "And we know it will be important to include a fertilizer source for zinc so people will just have to soak the seeds before putting them in germination—a very simple process that anyone can do to enrich their microgreens with zinc."

In their findings, recently published in *Frontiers in Plant Science*, the researchers reported that zinc sulfate, which is sometimes taken as a dietary supplement to treat a zinc deficiency or to promote wellness, was the most effective zinc source. Seeds soaked in a 200 parts per million solution of zinc sulfate resulted in higher zinc accumulation in both peas (126%) and sunflower microgreens (230%).

Researchers examined the effect of different zinc sources and soaking concentrations on microgreen-yield components such as mineral content; phytochemical constituents such as total chlorophyll, carotenoids, flavonoids, anthocyanin and total phenolic compounds; antioxidant activity; and antinutrient factors such as phytic acid.

Seed soaking in zinc sulfate and zinc oxide solutions at higher concentrations reduced phytic acid in both pea and sunflower microgreens—a positive development—the researchers pointed out. Because phytic acid is known to be an "anti-nutrient," its lower level suggests the zinc might be more bioaccessible, or nutritionally available, to consumers.

While microgreens and sprouts are similar, they are not the same thing, Poudel noted. Both are baby plants; both can be grown indoors; and both can be grown from the same types of seeds. But that is where the similarities end.

A sprout is the first stage in a plant's life cycle after the seed germinates. When the baby plant grows beyond its first shoot and root, it transitions to the microgreen stage. Microgreens are essentially the mature plant in miniature, with leaves, stems and roots. They are typically harvested after the stem has grown 3 to 5 inches tall and its first set of leaves appear.

"The reason microgreens are so rich in nutrients, vitamins, minerals and antioxidants," he added, "is that they all soon would be spread throughout the maturing plants' leaves, flowers and fruit."

More information: Pradip Poudel et al, Zinc biofortification through seed nutri-priming using alternative zinc sources and concentration levels in pea and sunflower microgreens, *Frontiers in Plant Science* (2023). DOI: 10.3389/fpls.2023.1177844

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