Bright pulses of light could make space veggies more nutritious, says study

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Exposing leafy vegetables grown during spaceflight to a few bright pulses of light daily could increase the amount of eye-protecting nutrients produced by the plants, according to a new study by researchers at the University of Colorado Boulder.

One of the concerns for astronauts during future extended spaceflights will be the onslaught of eye-damaging radiation they'll be exposed to. But astronauts should be able to mitigate radiation-induced harm to their eyes by eating plants that contain carotenoids, especially zeaxanthin, which is known to promote eye health.

Zeaxanthin could be ingested as a supplement, but there is evidence that human bodies are better at absorbing carotenoids from whole foods, such as green leafy vegetables.

Already, NASA has been studying ways to grow fresh produce during deep space missions to maintain crew morale and improve overall nutrition. Current research into space gardening tends to focus on getting the plants to grow as large as possible as quickly as possible by providing optimal light, water and fertilizer. But the conditions that are ideal for producing biomass are not necessarily ideal for the production of many nutrients, including zeaxanthin.

"There is a trade-off," said Barbara Demmig-Adams, professor of distinction in the Department of Ecology and Evolutionary Biology and a co-author of the study published in the journal *Acta Astronautica*. "When we pamper plants in the field, they produce a lot of biomass but they aren't very nutritious. If they have to fend for themselves—if they have to defend themselves against pathogens or if there's a little bit of physical stress in the environment—plants make defense compounds that help them survive. And those are the antioxidants that we need."

Plants produce zeaxanthin when their leaves are absorbing more sunlight than they can use, which tends to happen when the plants are stressed. For example, a lack of water might limit the plant's ability to use all the sunlight it's getting for photosynthesis. To keep the excess sunlight from damaging the plant's biochemical pathways, it produces zeaxanthin, a compound that helps safely remove excess light.

Zeaxanthin, which the human body cannot produce on its own, plays a similar protective role in our eyes.

"Our eyes are like a leaf—they are both about collecting light," Demmig-Adams said. "We need the same protection to keep us safe from intense light."

The CU-Boulder research team—which also included undergraduate researcher Elizabeth Lombardi, postdoctoral researcher Christopher Cohu and ecology and evolutionary biology Professor William Adams—set out to determine if they could find a way to "have the cake and eat it too" by simultaneously maximizing plant growth and zeaxanthin production.

Using the model plant species Arabidopsis, the team demonstrated that a few pulses of bright light on a daily basis spurred the plants to begin making zeaxanthin in preparation for an expected excess of sunlight. The pulses were short enough that they didn't interfere with the otherwise optimal growing conditions, but long enough to cause accumulation of zeaxanthin.

"When they get poked a little bit with light that's really not a problem, they get the biomechanical machine ready, and I imagine them saying, 'Tomorrow there may be a huge blast and we don't want to be unprepared,' " Demmig-Adams said.

Arabidopsis is not a crop, but past research has shown that its behavior is a good indicator of what many edible plant species will do under similar circumstances.

The idea for the study came from Lombardi, who began thinking about the challenges of growing plants during long spaceflights while working with CU-Boulder's Exploration Habitat graduate projects team in the Department of Aerospace Engineering Sciences, which built a robotic gardening system that could be used in space.

While the study is published in an astronautics journal, Lombardi says the findings are applicable on Earth as well and could be especially relevant for future research into plant-based human nutrition and urban food production, which must maximize plant growth in small areas. The findings also highlight the potential for investigating how to prod plants to express traits that are already written in their genetic codes either more fully or less fully.

"Learning more about what plants already 'know' how to do and trying to manipulate them through changing their environment rather than their genes could possibly be a really fruitful area of research," Lombardi said.

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