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Producing Better Produce

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How researchers are maintaining the quality and extending the shelf life of fresh fruits and vegetables

By Greg Tammen

ELENI PLIAKONI AND COLLEAGUES have an appetite for fresh produce production and storage research.

An assistant professor of horticulture and natural resources at the Kansas State University Olathe campus, Pliakoni specializes in urban food production and postharvest handling, or how the handling procedures of fresh fruits and vegetables affect these foods and what techniques safeguard their quality and extend their shelf life.

"Fresh fruits and vegetables are very diverse, so there is not one postharvest-handling approach that will work for all," Pliakoni said. "For example, tomatoes and broccoli cannot be stored at the same temperature. Because of the differences between fresh fruits and vegetables, we are required to use multiple techniques to develop different handling methods for every type of produce."

Pliakoni collaborates with Cary Rivard, assistant professor of horticulture and natural resources, extension specialist and director of the Horticultural Research and Extension Center in Olathe, Kansas, and Helena Pontes Chiebao, postdoctoral research associate in Pliakoni's lab. Pliaknoni also leads a team of three graduate students who conduct research on various fruits and vegetables.

The researchers are focusing on a combination of tools and techniques, ranging from temperature control to low-cost greenhouse alternatives, to maintain taste and nutrition while extending the shelf life of fresh produce grown by smallholder Kansas farmers. These small-acreage farmers have fewer than 10 acres of land and represent more than half of the vegetable producers in the Midwest.

Helping smallholder farmers increase the

availability of locally grown, fresh fruits and vegetables in metropolitan areas is important for several reasons, Pliakoni said. Urban populations are continuing to grow. Also growing is consumer interest in locally produced food and farmers markets, which account for more than $6 billion in annual sales. Even more pressure will be placed on local food systems as the world's population balloons to a projected 9.6 billion people by 2050.

No 'one size fits all'

The Kansas State University researchers work with Kansas-grown broccoli, asparagus, beets, spinach, tomatoes, strawberries, melons and sweet potato slips.

Produce is grown on a university research farm, then harvested and transported to the lab for study in KoolKat, a trailer turned into a mobile refrigeration unit. The trailer can keep food cooled to as low as 35 degrees Fahrenheit, which reduces losses of temperature-dependent foods.

Because there is no "one-size-fits-all" approach to produce handling, projects often involve multiple tools and techniques, Pliakoni said.

For example, a completed Kansas Department of Agriculture-funded project had researchers looking at how a combination of an ozonated water wash and modified atmosphere packaging — packaging that substitutes atmospheric air inside it with a mixture of oxygen, carbon dioxide and nitrogen to lower the product's respiration rate and prolong its shelf life — could help Kansas farmers maintain the quality of vegetables while ensuring food safety even if storage conditions aren't perfect.

"Washing vegetables with ozonated water decreases the natural microbes that are on the surface of the produce, while the modified atmosphere packaging was used as a replacement for cold storage," Pliakoni said. "In the conditions we used it, we found that the ozonated water didn't have any effect on the natural microflora, while the modified atmosphere packaging extended the shelf life of broccoli, spinach and asparagus in non-optimum storage temperatures."

High tunnels

Under Rivard, one of the team's main research focuses is high tunnels, which are long, semicircular structures made of polyethylene that serve as a low-cost alternative to greenhouses. High tunnels protect crops from high winds, heavy rains and damaging storms, and they create a beneficial microclimate for the crop.

As part of an ongoing collaboration with the University of Florida, researchers have been able to prove that high tunnels boost fresh produce production. Chiebao's part of this project is to investigate the effect of growing in high tunnels on the quality of produce. She has found that produce grown in high tunnels has a longer shelf life, which makes fruits and vegetables more marketable and adds to growers' profits.

"As much as 40 percent of fresh fruits and vegetables are lost from harvest to market because of spillage, rot and other causes," Pliakoni said. "We're seeing that produce grown in high tunnels have better quality and are more marketable than produce grown in the open field. Fruits, such as tomatoes, have fewer cracks, splotches and other aesthetic defects."

Pliakoni, Rivard and Chiebao's high tunnel project involves several graduate students. They are conducting the research on tomatoes and spinach with Kostas Batziakas, graduate research assistant and doctoral student in horticulture with an emphasis in postharvest physiology. The project is in its third year and is funded by the National Institute of Food and Agriculture through the Agriculture and Food Research Initiative.

Graduate students also are using high tunnels for projects on strawberries and sweet potato slips. Kelly Gude, master's student in horticulture, found that strawberries can be grown in Kansas under high tunnels. She taste-tested the berries with consumers. Riley Sunday, master's student in horticulture, and Rivard are using high tunnels to grow sweet potato slips — shoots that grow into mature sweet potatoes — in an effort to find better storage and shipment solutions for the slips. Kansas producers ship the slips to growers across the state, and their main challenge is quality loss during shipment. Zach Hoppenstedt, master's student in horticulture, and Rivard also are using high tunnels to examine the possibility of growing sweet potato slips earlier in the season. Slips typically originate in the South early in the season and then are produced in Kansas as the weather warms in spring.

Hot water treatment

One of the objectives of the Agriculture and Food Research Initiative project with the University of Florida is using hot water treatments and acetic acid to reduce microbial rot on tomatoes and spinach. Produce is dipped into water heated to 131 degrees Fahrenheit. The temperature, which researchers are tweaking for optimal results, controls the natural microbes on the surface of the produce. Microbes cause decay, particularly if they enter a crack in the skin of the produce.

Agricultural engineering students at the University of Florida are developing a prototype hot water treatment device that farmers can use on spinach and tomatoes in the field. Once developed, it will be reproduced at Kansas State University and used for research as well as for demonstrations. As part of the project, Rivard is working with a consultant and software developer to make a smartphone app that will help growers and extension agents keep track of locally grown crops, identify what is causing a crop loss, and adjust what crop is planted and when so that growers can maximize their food production.

Modified atmosphere packaging

Batziakas also is working with modified atmosphere packaging. Modified atmosphere is the practice of changing the composition of the internal atmosphere of a produce bag to maintain the quality of the produce inside and extend its shelf life. Typically the bags are flushed with a gas mixture that has decreased oxygen and elevated carbon dioxide content. Bags are produce-specific and designed for a specific optimum temperature.

"The problem with this type of packaging is that it is designed only for a certain temperature," Pliakoni said. "If leafy greens are processed and packaged at 40 degrees Fahrenheit, they then travel in a refrigerated truck to a distribution center, then to a grocery store and then onto the store display. The cold chain is disrupted in many of those steps, and you can imagine how big the temperature fluctuation is throughout its journey. That makes it challenging to design a singular package that adjusts to the different temperatures and remains beneficial."

Researchers on the Agriculture and Food Research Initiative project are working on a possible solution: improving the storage efficiency of this packaging by determining proper atmospheric conditions for bags kept in ambient temperatures. They are storing spinach in commercial bags in above-optimum temperatures to identify possible improvements. The researchers then plan to collaborate with a packaging company to manufacture a better packaging solution for spinach kept at ambient temperatures. k