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Features

Cover Photos:

1. Postharvest biologist Adel Kader at his retirement dinner
2. One of the department's many excellent graduate students found the gene that presumably controls the determinate growth habit in beans.
3. Herder gathering yaks, sheep and goats in the grasslands of Mongolia

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UC Davis: Postharvest Powerhouse

"UC Davis is a powerhouse in postharvest technology."

You hear that often from growers, breeders, scientists, consultants and educators here and abroad. Some speak of the university's long, productive history in postharvest science. Some cite its landmark discoveries. Still others point to the impact UC Davis continues to have on postharvest technology and research throughout the state, the nation and the world.

"The postharvest research and technology at UC Davis provides serious relevance to the real world business it serves," says Art Dawson, owner and CEO of The Dawson Company, specializing in market intelligence for agriculture. "That's why it's such a powerhouse. When it comes to postharvest technology, UC Davis has been an industry leader for years."

Some 100 years, by most accouns—dating back to the days when what is now UC Davis was still the 776-acre "University Farm." The roots of UC Davis go back to 1906 when the University of California "farm" was established as a research facility and farm school offering primarily short courses. The first short course for farmers was offered in 1908. By 1925, UC researchers had discovered the use of sulfur dioxide gas to control *Botrytis cinerea* on table grapes. In 1960, a year after UC Davis became an independent UC campus, researchers released sulfur dioxide-generating pads, a still more effective means for controlling *Botrytis cinerea* on table grapes.

It was also in 1960 when UC Davis provided producers the means for pressure cooling fresh produce. Five years later, in 1965, UC Davis researchers developed and perfected tight-fill packing so produce wouldn't vibrate and bruise as it traveled in cartons on trucks from packinghouses to market.

"Since its earliest days, postharvest technology at UC Davis has worked to reduce postharvest losses and improve the safety, quality and marketability of horticulture crops," says Jim Gorny, executive director of the Postharvest Technology Research and Information Center. "Our research is designed to help everyone in the produce supply chain—the farmers, the packing houses, the shippers, the markets and the consumer."

The list of UC Davis accomplishments in postharvest technology goes on and on. (Various milestones are listed on Page 13.) One monumental breakthrough arrived in the late 1970s when Doug Adams and the late Shang Fa Yang identified the precursor ethylene and its biosynthetic pathway, unlocking one of the keys to prolonged freshness in fruits, vegetables and flowers. During his 40-year career at UC Davis, Yang's research focused on how plants produce ethylene, important to regulating a host of plant functions, from seed germination to fruit ripening and senescence.

"In terms of ripening, ethylene triggers it all—turning the starch to sugar, the green to red, the firm to soft," says Gorny, who received a doctorate in plant biology from UC Davis in 1995. "So Dr. Yang's research was revolutionary,

paving the way for technologies that control a plant's perception and therefore the timing of when ripening and senescence occurs."

Reducing postharvest losses

UC Davis plant scientists contribute to the breeding and cultivation of many of the 370 different crops grown in California. Their research helps growers increase quality and yield, fight pests and disease and continually adapt to changing conditions.

"All that time and hard work invested in developing varieties and cultivating crops can be lost very quickly without good postharvest handling," says Marita Cantwell, Cooperative Extension postharvest specialist. "When you look at food availability, it's not just the quality and quantity of food grown, but how much of that food is actually consumed with its flavor and nourishment intact."

Postharvest losses are estimated at 25 percent in the U.S. and other developed nations and as high as 40 percent in less developed areas of the globe. Reducing food losses with improved postharvest handling has important implications for fighting world hunger, improving economies and enhancing agricultural sustainability.

"When it comes to sustainability, good postharvest handling is the low-hanging fruit," Gorny says. "By reducing postharvest losses, you save in so many areas such as water use, synthetic fertilizer use, transportation—just to name a few."

Improved postharvest handling can also alleviate world hunger by assuring more crops reach more people and by helping farmers in remote regions earn more for their goods.

"There's an economic component to postharvest technology for growers everywhere," Gorny says. "You can increase market access when you can keep produce fresher longer."

Farmers now face what Gorny calls a "perverse marketplace." The market price for their product is at its lowest when its quality is at its peak.

"Sellers have no control over the price—unless they can improve storage or invest in other technologies that can spread the availability of their product," he says.

Improving postharvest handling

Quality, safety and marketability—those are the three main areas of focus for the multidisciplinary team in the Postharvest Technology Research and Information Center. A wide range of experts—food scientists, plant biologists, engineers, economists, consumer behaviorists and sensory scientists—come together to tackle the full spectrum of complex questions affecting everyone in the produce supply chain, such as: How can I be sure my food is safe? What can I do when the crop I produce is wrongly linked to a food scare? How can I find a greener way to protect my crops from pests during transport? How long can I store my bounty crop and at what temperature so it will still be marketable next month? My fruit looks beautiful but tastes like cardboard. What's being done to improve the flavor of fresh fruit?

A lot is being done. Here's a sampling of the wide-ranging work underway by postharvest plant scientists.

Professor Mike Reid's research is aimed at improving the postharvest life of ornamental plants and cut flowers. Reid and his team have been working with the shipping industry to improve temperature management during marketing of cut flowers, and are poised to expand that effort to potted and bedding plants.

"We have also been testing new fungicides as possible tools for preventing *Botrytis*, or grey mold, a common cause of postharvest loss in ornamentals," he says. "In the laboratory we are testing an artificial cytokinin, thidiazuron (TDZ), as a tool for delaying leaf and plant death. We are also using a range of techniques to study and manipulate the genes that are responsible for flower senescence and leaf fall."

Cooperative Extension (CE) Specialist Beth Mitcham focuses on the postharvest physiology and handling of apples, pears, cherries, apricots, cling peaches, prunes, bushberries, strawberries, almonds and walnuts. Her program studies harvest maturity, storage conditions and quality measurements as well as developing alternatives to chemicals used in postharvest for control of decay, physiological disorders, and insect quarantine treatments.

Current projects include prestorage heat treatments (hot air or water) as a replacement for diphenylamine in control of apple storage scald; heat treatments as a possible alternative to methyl bromide for quarantine treatment of temperate fruit crops against codling moth; controlled atmospheres as a possible quarantine treatment against several insect pests for table grape export to Australia; controlled atmospheres in combination with warm temperatures as a possible alternative to methyl bromide for quarantine treatment of various temperate fruit crops; and controlled atmospheres with high carbon dioxide for control of postharvest decay during domestic and export shipments of various fruit crops.

CE Specialist Marita Cantwell and her team identify and solve problems related to the postharvest physiology, handling and storage of fresh vegetables. Current efforts include postharvest physiology and handling of specialty vegetables, including fresh culinary herbs, Asian leafy vegetables, and jicama; alternatives to postharvest fungicides and fumigants on selected vegetables; short-term heat treatments and controlled atmospheres to control decay organisms and insects; and physiology, shelf-life and quality of fresh-cut vegetables, including lettuces, melons, peppers, onions and garlic.

If it tastes good, they will eat it.

Flavor is the focus of several postharvest specialists.

"My main goal is fruit consumption, and flavor has a lot to do with that," says Carlos Crisosto, a CE specialist based at the ANR Kearney Research Center. "It's not enough to deliver fruit that looks good and holds up well. If it doesn't taste good, people aren't going to eat it."

But when a consumer says "this tastes good," what does that mean? How do you quantify flavor?

Carlos and his wife and colleague, Associate CE Specialist Gale Crisosto, conduct research on cherries, figs, kiwifruit, tree fruit (nectarines, peaches, plums), and table grapes to understand orchard factors, genotypes and fruit quality to answer those questions and more. They use different sensory evaluation techniques such as the use of trained panels or "in store" consumer tests according to the objectives of the specific commodity.

"In the case of tree fruit," Carlos says, "we conducted fruit quality surveys, which indicated the potential fruit quality range within the industry reality. We then investigated the potential role of cultivars and orchards on these quality attributes. Third, we used a trained panel to select the most important sensory quality attributes in the perception of fruit flavor. At the same time, we segregated cultivars according to our trained panel's perception of the predominant sensory attributes such as sweetness, sourness, and fruit flavor and aroma intensity."

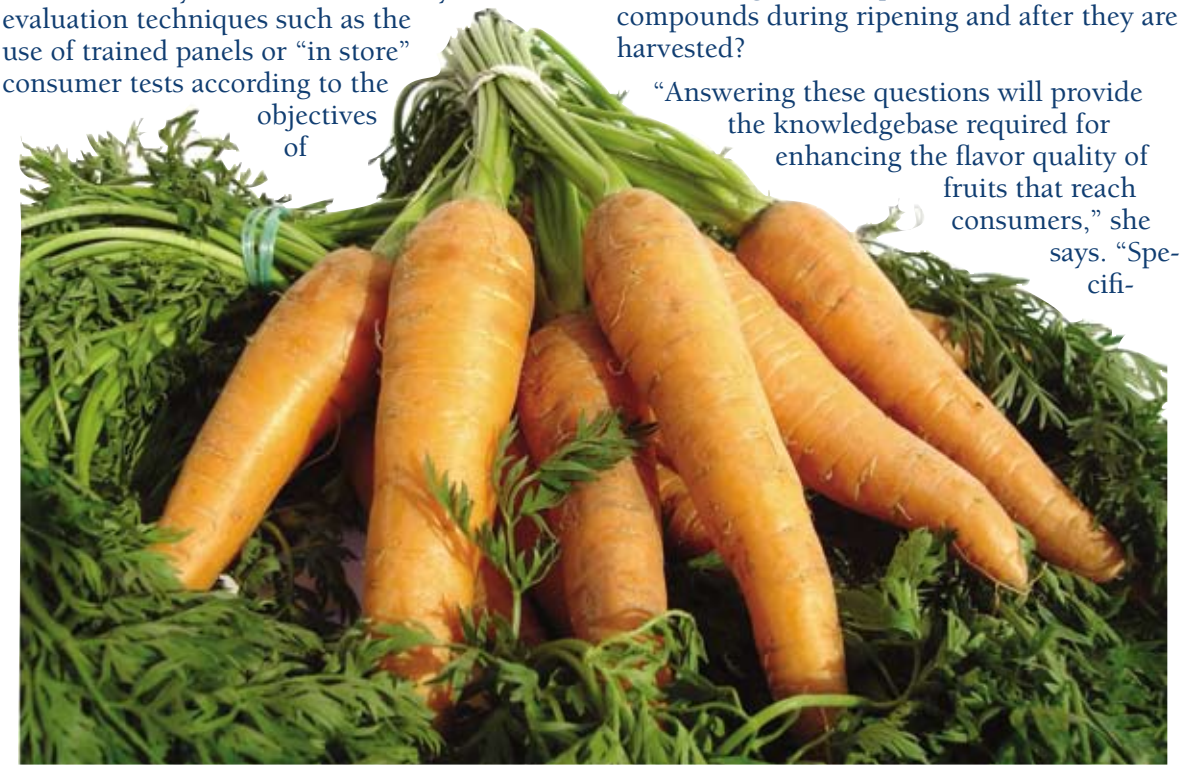
The Crisostos used that data to design large "in store" consumer tests within each sensory classification group. The final results provide industry with the information it needs to propose a flavor code classification with quality index standards specific for each sensory classification group.

Flavor is central, too, to the research of Assistant Professor Florence Zakarhov.

"The flavor of fresh produce is one of the most important characteristics determining their quality," she says. "Volatile compounds produced by fruits determine the aroma properties that we perceive when we eat. Although the importance of aroma in fruit quality is well recognized, little is known about the process of aroma synthesis."

How do fruits make aroma compounds? How do fruits regulate the production of these compounds during ripening and after they are harvested?

"Answering these questions will provide the knowledgebase required for enhancing the flavor quality of fruits that reach consumers," she says. "Specifi-



(continued on page 11)

'Retirement' Won't Slow Adel Kader

About 150 colleagues, former students, family and friends gathered on June 21, 2008, to toast Adel Kader, the UC Davis postharvest physiology professor and UC Cooperative Extension specialist who retired July 2007 after 35 years of service.

They spoke of his passion, his integrity, his extraordinary accomplishments and his generosity of spirit. And they heard from Adel what folks in the industry most wanted to hear.

"This is a transition, not a retirement," Adel told the crowd of well-wishers. "I definitely won't disappear from the postharvest technology world."

Adel Kader is a world leader in postharvest biology. His research focuses on preserving the flavor and nutritional quality of whole and fresh-cut fruit and his findings help guide everyone in the food chain—from farmers to shippers to merchants to consumers—to this day. He has published more than 230 technical publications and edited and co-authored "Postharvest Technology of Horticultural Crops," considered the definitive industry manual worldwide.

Adel Kader and his daughter, Soad Kader, enjoy a well deserved toast at his retirement celebration.

Adel advanced our understanding of phytonutrients in fruits, controlled atmosphere storage and biological responses of fruits stored in atmospheres with reduced oxygen and elevated carbon dioxide concentrations. He mentored 37 graduate students and 63 researchers, many of whom have become leaders in the field in their own right. He led the UC Postharvest Biology and Technology Program by coordinating teaching, research and extension activities. He took his teachings abroad, to countries where—in many cases—40 percent of the produce rots before it reaches hungry mouths due to poor postharvest handling.

Behind all his work is Adel's over-riding goal: To help people eat better food and live better lives.

A native of Cairo, Egypt, Kader earned his bachelor's degree in horticulture from Ain Shams University in Cairo, then came to the United States in 1961 to pursue graduate studies. After earning his master's in vegetable crops and Ph.D. in plant physiology from UC Davis, he returned to Cairo and joined the faculty of the College of Agriculture at Ain Shams University, where he taught courses and conducted research for six years. In 1972 he joined the UC Davis faculty and became a U.S. citizen in 1976.

Adel entered the university as a premedical student, but became more interested in plant biology and transferred to the College of Agriculture. "By my second year, I became very interested in postharvest biology and the potential for increasing food availability by reducing postharvest losses," he recalled. "That is why I have spent most of my adult life learning and teaching about postharvest biology and technology of horticultural crops."

In 1979, Adel and his colleagues began offering the annual two-week Postharvest Technology Short Course, which has been attended by

about 2,500 people from all over the world. The course includes a week-long field tour from Davis to Bakersfield and back via the coast, providing students a front-row seat to some 20 postharvest handling operations for fruits, vegetables and ornamental horticulture.

In 1998, Adel launched the postharvest Web site (http://postharvest.ucdavis.edu), which has become the premier source of postharvest information worldwide, averaging nearly 250,000 views per month. Though he has retired from the university, he volunteers as technical editor for the site.

He serves on the editorial boards of two scientific journals. He served on the Scientific Advisory Council of the World Food Logistics Organization and the Research Advisory Board of the Produce for Better Health Foundation.

Adel received awards for outstanding teaching in 1989 and for distinguished graduate mentoring in 2003 from UC Davis and for best research publications in 1978 and 1980 from the American Society for Horticultural Science (ASHS). He was elected a fellow of ASHS in 1986, and served as president-elect in 1995, president in 1996, and chairman of the board of directors in 1997. He was selected as the Outstanding Horticulturist of 1997 by the Horticultural Research Center at Laval University, Quebec, Canada. In 2000 Kader received the Award of Distinction from the UC Davis College of Agricultural and Environmental Sciences, and the Alumni Citation for Excellence from the Cal Aggie Alumni Association.

During his so-called retirement, Kader and his wife, Aileen, plan to spend more time with their two grandchildren, who live in Redding, and travel the United States and other countries. He also intends to do some consulting to raise funds for the UC Davis postharvest endowment.

Already, the calls are coming in, from the Citrus Industry, from the National Mango Board, from the Bill and Melinda Gates Foundation (just to name a few).

"I see opportunities on the horizon," Adel told the group gathered for his retirement dinner in June. "I will continue to do as much as I can to contribute to postharvest technology."

(continued from "Postharvest..." page 9)

cally, we are using melons as a model to study aroma formation. Melon aroma is composed of tens of volatile compounds which are produced when fruits are ripe. In this fruit, the aroma formation process is linked to the production of the fruit ripening hormone ethylene, which also regulates other physiological processes in fruits such as softening and senescence. Our goal is to investigate the possibility of uncoupling aroma formation from ethylene action, in order to prolong shelf-life without compromising flavor quality. "

Assuring our food is safe

Food safety is vital to our nation and a cornerstone to postharvest science at UC Davis. Perhaps Jim Gorny explained it best in July when he testified as an expert witness before a U.S. congressional hearing to explore the legal and technological capacity for traceability in fresh produce.

"We can never forget the real human impact when something goes wrong in our food supply," he said. "I'm here to assist in developing solutions to enhance consumer and marketplace confidence in our nation's food supply."

Before taking the helm of the Postharvest Technology Research and Information Center last year, Gorny had been senior vice president of food safety and technology for the United Fresh Produce Association for two years and had previously served as vice president of technical and regulatory affairs for the International Fresh-cut Produce Association. Food safety is his specialty and he works diligently to establish ways in which industry, academia and government can better coordinate efforts to enhance public heath and produce food safety.

Food safety is also the expertise of Cooperative Extension Specialist Trevor Suslow whose research explores the effects of bacterial microflora on the postharvest quality of perishable produce. His research falls within three broad areas of postharvest pathology: Creating integrated systems for the control of postharvest decay and spoilage microbes in whole produce and in fresh-cut applications; integrating basic and practical applications of cultural, genetic, and energetic technologies to achieve and maintain postharvest quality through transportation and distribution; and developing diagnostic tools and methods that are predictive of predisposition to loss of postharvest quality or spoilage.

(continued on page 13)