Demand for fresh fruits and veggies is exploding the fresh-cut produce market.

CUT-UPS!

Fresh-cut produce, such as carrots, cauliflower, and broccoli, has become a hot item with consumers—not just in the United States, but worldwide.

The International Fresh-cut Produce Association claims that fresh-cut produce is the fastest growing segment of the exploding market for fresh fruits and vegetables. Sales of fresh-cuts in the United States are projected to increase from $5.8 billion in 1994 to $19 billion by 1999.

"Fresh-cut products, which we used to call lightly or minimally processed, have been around for many years," says Alley E. Watada, an ARS food technologist. "But the types and quantity have expanded tremendously over the past decade."

This is understandable when you consider that, in 1995, each of us ate close to 28 pounds of fresh lettuce, 10 pounds of fresh carrots, and 28 pounds of melons. John Love, who is with the USDA's Economic Research Service, estimates that each American consumed about 300 pounds of fresh fruits and vegetables in 1996.

Watada believes that quality of fresh-cut produce has a lot to do with the growth of the industry. "This industry is still relatively fragile in some countries, and again, this has to do with product quality."

At the Horticultural Crops Quality Laboratory in Beltsville, Maryland, Watada and his colleagues are developing methods to maintain and improve the quality of fresh-cut fruits and vegetables.

In the United States, most fresh-cut products are prepared by national or regional processors located near the site where the crops are produced, which means that the raw product is at peak quality. Maintaining that quality, Watada says, depends on how processors control the temperature, relative humidity, and sanitation of the product.

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Food technologist Alley Watada (left) and horticulturist Ling Qi, who is visiting from China, prepare shredded carrots and other fresh-cut produce for automated measurement of respiration rate and ethylene production. (K7512-3)

"When you cut produce, you leave a large surface area exposed to air without any skin for protection against loss of water and attack by microorganisms," he says. "The produce must be shipped—sometimes for several days—which makes shelf life vitally important."

Since cut-up produce is much more perishable than the whole product, it must be stored at a lower temperature.

Harvested fruits and vegetables are living tissue still undergoing respiration and with a shelf life of about 7 to 14 days. The rate at which that tissue deteriorates depends on the temperature to which it is subjected. So Watada and colleagues just completed a study of respiration rates of more than a dozen intact and fresh-cut fruits and vegetables.

"We found that to ensure quality, both fresh-cut and intact produce should be handled and stored at or near 32°F—if the product is not sensitive to chilling injury," Watada reports. "And edible coatings and proper packaging will help attain relative humidity close to 100 percent. But we need more research on films or coatings that will adjust gas exchange, or respiration, as the commodity's temperature changes."

Sanitation to control the growth of microorganisms is another very important aspect of fresh-cut produce quality. Currently, processors rinse fresh-cuts in a 50-to-200-parts-per-million chlorine solution. But chlorine doesn't always do the trick, and it has come under scrutiny recently.

"We found several types of bacteria and yeasts on fresh-cut spinach that had been through a chlorine rinse," Watada says. "The organisms were inside broken cells or cells adjacent to broken tissue, where the chlorine solution had not penetrated."

Joe Graziano agrees with Watada. He is president of Graziano Produce in Portland, Oregon, and runs the largest fresh-cut produce company in the northwestern United States.

"Although we use chlorine to sanitize fresh-cuts," says Graziano, "we believe there could be something out there that might be more effective. In the industry, we're always looking for something that will improve the quality of our produce."

In a recent study with Hidemi Izumi of Kinki University in Wakayama, Japan, Watada reduced growth of microorganisms on cut carrots by dipping them in a calcium chloride solution.

"Calcium chloride has been beneficial in maintaining firmness of intact fruit, so we tried it with carrot

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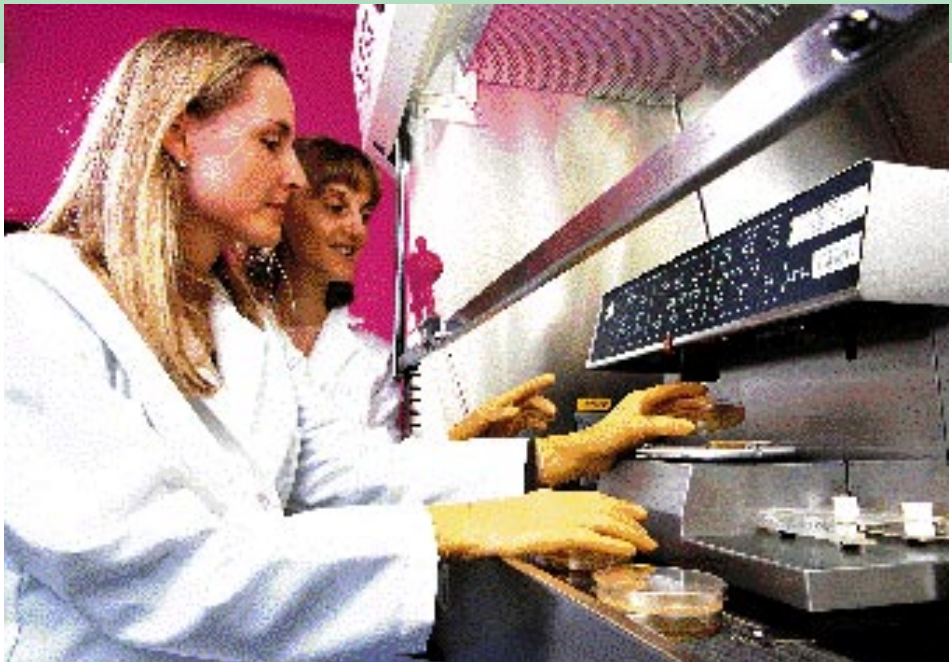

Sanitation to control foodborne microorganisms is important to fresh-cut produce quality. Food microbiologist Isabelle Babic (right) and technician Laurie Gould will check honeydew melon samples applied to agar plates for subsequent growth of disease-causing microbes. (K7512-1)

shreds, sticks, and slices and got excellent results," he says.

In solutions of 0.5 percent and 1 percent calcium, cut carrots stored at 32°F, 41°F, and 50°F remained firm, with minimal increase in growth of microorganisms, he reports. "Although ideal storage temperature is 32°F, we expanded the range because many lightly processed carrots are held commercially at 41°F and sometimes 50°F."

The treatments increased the calcium content slightly in carrot sticks and slices and substantially in the shreds, but the carrots still turned white in storage. Watada and ARS colleagues have used sodium chloride solution on shredded carrots to prevent such discoloration.

One of the problems with some fresh-cut produce is that the areas that have been cut become white and translucent. Consumers associate this with aging and, therefore, think the produce is not fresh. Carrots develop this white appearance within 24 hours after being cut.

"Under a scanning electron microscope, we found that the abrasive action of the knife blade shears, separates, and compresses the cells, causing underlying damage to tissues," Watada explains. "Dehydration of a large mass of cells and tissues causes the whitish color. We dipped shredded carrots in different concentrations of sodium chloride solution, which prevented discoloration and extended shelf life.

"We know that membrane degradation and repair processes are going on in cut carrots, but we don't know anything about how these processes are regulated," says Watada. "More research is needed, particularly at the molecular level, to develop carrot breeding lines with desirable characteristics for the fresh-cut industry."

The team of Watada and Izumi also tried the calcium solution on zucchini squash, which is highly perishable and sensitive to chilling injury. At 32°F, chilling injury occurred, and at 50°F, natural deterioration occurred; but at 41°F, both were minimal.

According to Watada, adding chlorine to the calcium helped bring about the positive results.—By **Doris Stanley,** ARS.

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To provide the proper combination of carbon dioxide and oxygen to fresh-cut vegetable samples at various temperatures, technician Willard Douglas adjusts the valves of a multigas mixture unit. (K7512-4)