



Fresh-Cut Goes to War

Military research points to the future of fresh-cut

By Scott Christie
Managing Editor



The United States military has soldiers across the country, and each branch is tasked with feeding them healthy meals. Because fruits and vegetables are important to a healthy diet, researchers at the U.S. Army Natick Soldier Research, Development and Engineering Center's Combat Feeding Directorate are finding new ways to get fresh produce to soldiers in the field or at sea.

The United States military is an advanced fighting machine and the soldiers running it have to be mentally and physically fit to keep it at its best. The food they eat can have a profound impact on both mental and physical health, so the researchers in the Combat Feeding Directorate take their jobs seriously.

Top, supplies to U.S. troops in remote locations are airlifted by helicopter. Troops in the field rarely get fresh produce from home. By Tech. Sgt. Joseph McLean, courtesy of U.S. Army. Left, a U.S. soldier prepares a Meal Ready to Eat (MRE). Produce in MRE packages is usually canned. Courtesy of Combat Feeding Directorate

MAP Extension Times

The researchers at the Army's Natick research facility are using fresh-cut technology to extend the shelf life of fresh produce. The researchers are working with Apio's polymer packaging material to store bulk produce in a modified atmosphere.



Tomato
25 days



Cantaloupe
25 days



Banana
15 days



Melon
30 days



Broccoli
45 days



Lettuce
30 days

"Our job is to fuel that warfighter and enhance those cognitive and physical abilities," said Gerry Darsch, director of the Combat Feeding Directorate in Natick, Mass.

Modified Atmosphere

The U.S. Navy spent \$26 million on fresh fruits and vegetables in 2005. The service also reported that about \$3 million worth of produce was lost to spoilage.

"The actual number is probably greater because no one wants to report those types of losses," said Deborah Sisson, a food technologist in the Combat Feeding Directorate.

Navy ships at sea are resupplied every two weeks by the Military Sea Command, which airlifts the supplies to the vessels. The command is responsible for supplying nearly 300 ships under the Navy command, so airlifts can be 30 days apart or more, Sisson said. After two weeks, the galley staff has to use spoiling produce to feed the crew.

"With a head of lettuce, you're going to keep peeling away until you get to the core to find something good to eat," Sisson said.

Sisson is working with Apio Inc. to develop modified atmosphere packaging (MAP) for the Navy that can extend the shelf life of produce in case-size quantities. The researchers identified the top 16 fruit and vegetable items purchased by the Navy and used research by the University of California, Davis, to determine the respiration rate of each item.

Those respiration rates are matched to Apio's

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U.S. Navy ships are resupplied every 14 to 30 days. Fresh produce that isn't used creates waste for the galley crew. Photo courtesy of Combat Feeding Directorate

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polymer packaging material. The package's membrane closely regulates how much oxygen the produce receives and restricts how much carbon dioxide it's giving off.

"What you're basically doing is putting the produce to sleep," Sisson said.

The research has significantly reduced spoilage, Sisson said. The shelf life of bananas more than doubled to 15 days. Broccoli's shelf life was extended to 45 days, cantaloupe to 30, tomatoes to 25, honeydew melon to 30 and iceberg lettuce lasted 30 days in the modified atmosphere packaging.

A recent Naval Supply Systems Command test on the USS Reagan was a great success, Sisson said. Navy officials and crew wanted to know about the technology, and more importantly, when they could get it.

Navy ships will likely see the packaging within the next two years. Sisson's program received funding from the Navy under a Technology Insertion Program for Savings to transition the entire fleet to modified atmosphere packaging in 18 to 24 months. She said it would take that entire time to make the switch, because the program affects every naval supplier of produce.

"We're affecting the supply chain and asking them to change the way they package things," she said.

There has been interest from other services to implement produce shipped with MAP. The Army is looking at MAP technology to resupply troops in remote locations, such as Afghanistan, Sisson said.

Gene Tilling

Getting fresh produce to soldiers is "extremely difficult, if not impossible," Darsch said. Trying to ship 6,000 heads of lettuce to a forward operating base

like Iraq or Afghanistan will more than likely result in 6,000 gallons of lettuce juice after sitting under the sun in 120° F temperatures.

"It's not exactly what a warfighter expects when he opens up that container," Darsch said.

Soldiers don't see fresh fruit or vegetables during their operations. They will most likely see canned produce, but Darsch said providing fresh items would be an incredible morale boost.

The Department of Defense partnered with Arcadia Biosciences in 2005 to explore ways to extend the shelf life of fruits and vegetables by letting nature take its course. The Tilling Program uses non-transgenic methods to find genes that are beneficial to extending shelf life, such as a plant with lower respiration rate, thicker texture and better color and firmness.

"We let Mother Nature play her trump cards to develop those genes," Darsch said.

The goal of the program is to extend the shelf life of produce by a minimum of 25 percent. The first items under scrutiny are iceberg lettuce and tomatoes, although the program is still in its infancy. Lettuce has a shelf life of about 20 days from the time of harvest and the goal is to extend that by at least seven days – but Darsch said he hoped to extend it by 14 days.

With a week or two added on to an item's shelf life, it may be possible to send fresh produce to combat troops or isolated bases.

Gene identification and shelf life extension could benefit the commercial system as well. The retail supply chain is more efficient, and produce developed by the project would be able to reach their longest shelf life.

"The military system will never have the luxury of the commercial system," Darsch said.

He said another leafy green is next – romaine lettuce. Romaine is more nutritious than iceberg lettuce, so the military would get more bang for its buck.

Ethylene Control

Shipments to troops can take days or weeks, and that opens the door for ethylene gas to spoil a whole load. Ethylene concentrations as low as 1 part per million can spoil an entire shipment and rotten produce can lead enemy combatants to soldiers' locations, in addition to generating more waste for the military.

"The challenge is getting it there at its optimum freshness – and 'there' these days is far, far away," said Paul Lavigne, a chemical engineer in the Combat Feeding Directorate.

Apples and bananas, for example, give off high levels of ethylene, and some vegetables are extremely susceptible to ethylene concentrations. Potassium permanganate blankets have been used in the past, but there are some downsides. The blankets are expensive, they require someone to manage them, there are questions about regeneration and if they don't regenerate they have to be disposed of as hazardous waste.



The Army's soldier research center in Natick, Mass., designs and tests products for field troops. One of the center's projects was a self-contained kitchen that could be set up and torn down quickly. Photo by Sgt. Ken Hall, courtesy of U.S. Army

That means ethylene has to be controlled in-package or in-container. Lavigne is working on an in-container ethylene control system with just a few requirements that have to be met: it has to use less than 100 watts, it has to cost less than \$500, it has to be no- or low-maintenance, it has to work on a 20-foot container and it can take up no more than 1.3 cubic feet.

"What we've done is look at requirements for extended preservation of fresh fruits and vegetables," Lavigne said. "It's all based on degrees of ripeness and that's constantly changing."

Adaptability is important to the program, because not every application is the same. Some branches use modular containers that have movable walls to section off a cooler and a freezer.

Ethylene systems have opened the door to other technologies that may be incorporated into military shipments. Both ozone and ultraviolet (UV) light show promise in killing other volatile organic compounds (VOC) that – while not directly associated with ethylene – also cause spoilage in produce.

Ozone is reactive and wants to turn back into oxygen gas, he said. Because of its volatility, it breaks down VOCs to carbon dioxide and water vapor, and ozone

is used in such a small concentration that it's not harmful to humans. During shipping, ozone could help reduce off-gassing from diesel power supplies.

Lavigne likes the technology because it's effective at controlling ethylene concentrations and could be effective at controlling VOC.

"It could be effective in reducing internal concentrations because you have an associated generator operating in the area," Lavigne said.

Future Tech

The United States has the most technologically advanced military in the world, and researchers at the Natick center are working to bring the supply chain up to speed. The Army conducted its first test on RFID technology with combat rations, and there are proposals at Natick to work on future RFID projects.

The state-of-the-art research facilities the Natick researchers use were completed in 2006. The Food Laboratory Facility expansion houses five microbiology labs, an analytical chemistry lab, a nanotechnology packaging materials lab and three temperature-controlled storerooms for shelf life studies and evaluation.