Advances in Food Safety

by Lauren Kern

You might not see bugs and bacteria on fresh fruit and vegetables, but they’re there. Texas A&M food engineers are experimenting with new technologies to eliminate these threats to keep our produce safe and healthy.

Food engineering graduate student Carmen Gomes searches for new ways to keep fruits and vegetables safer and fresher for longer. Methods include irradiating the produce with a burst of energy and novel packaging.

IRRADIATING CONFIDENCE

Many Americans assume fruits and vegetables sold in supermarkets are safe: wholesome foods that are good for us and won't make us sick. This can be a deadly assumption.

Despite rigorous national standards, in 2006, spinach infected with *Escherichia coli* made it to consumers undetected, and more recently tomatoes hit the market with a rare form of *Salmonella* Saint Paul. According to the Centers for Disease Control and Prevention (CDC), more than 1,000 people in the United States were infected, sending almost 300 to the hospital and possibly contributing to two deaths.

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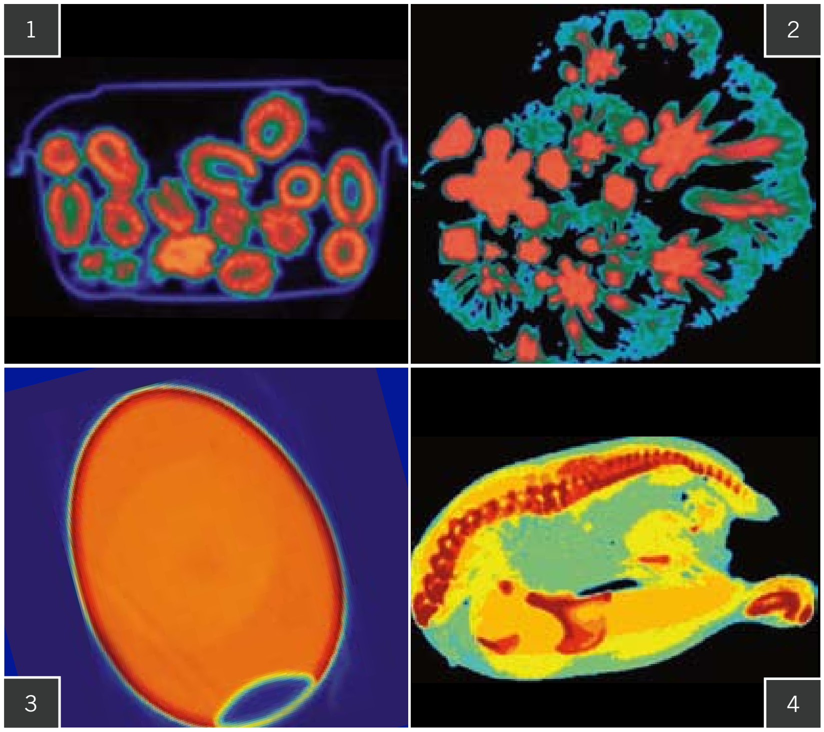
Food engineering researchers at Texas A&M are perfecting a method to ensure the safety of fresh produce: electron beam, or e-beam, irradiation. Electron beam irradiation kills disease-causing organisms that conventional decontamination methods can't touch.

"Irradiating produce reaches bacteria inside the vegetables, not only the organisms that are on the surface," says food engineer Rosana Moreira, professor and assistant department head in Texas A&M's Department of Biological and Agricultural Engineering. "It kills bacteria without damaging produce or making the product unsafe to eat."

The CDC says that food irradiation holds great potential for preventing many foodborne diseases in meat, poultry, fresh produce and other foods without harming the nutritional value of food or making it hazardous to human health.



CT scans of food items:
1) raspberries
2) broccoli florets
3) an egg
4) a whole chicken

These 2-D images are used to calculate the smallest dose of irradiation needed.

Moreira and Elena Castell-Perez, also a food engineer and professor in biological and agricultural engineering, are working with a team of 11 graduate student researchers to calculate the best methods of using electron beam irradiation to eliminate dangerous bacteria and maintain the nutritional content of fresh produce.

Electron beams are streams of high-energy electrons produced by an electron gun. The gun generates the beams by using something found in every home, a larger version of the tube that shoots electrons into your TV screen. The beams are not radioactive, and they can be turned on and off like your TV or a flashlight.

This process is conducted using linear accelerators (LINAC), a 10MeV linac located at the National Center for Electron Beam Research and a 1.25 MeV accelerator located in the Hobgood Building.

A burst of energy

Applying ionizing radiation to food is nothing new; in fact, the technology was introduced more than 100 years ago. Food processors in 50 countries rely upon irradiation to make their food safer, but it's fallen out of favor in the United States — believed largely the result of consumer fear and lack of understanding of "radiation" and its diverse applications. Radiation is radiation, but irradiation used on foods is simply a burst of energy that isn't dangerous to consumers.

"The idea of eating food that has been irradiated concerns some consumers," Moreira says. "But irradiated food is completely safe, and in some ways may be better than food that has not been irradiated."

Chemical vs. e-beam

Almost all fresh fruits and vegetables sold commercially in the U.S. are treated with chemicals before reaching grocery stores. Although beneficial for eliminating many contaminants, some of the chemicals used have been found to leave residues that can become harmful once in the consumer's hands — for instance, when cooking fruits and vegetables at high temperatures, common in the home canning process. And chemical cleaning reaches only bacteria on the surface of the produce, and it may not even eliminate all of that.

Carmen Gomes, a food engineering Ph.D. student who works with Moreira and Castell-Perez, says food irradiation has several advantages over chemical decontamination methods.

"When we treat with chemicals, we just treat the surface of the produce," Gomes says. "Irradiation penetrates the product and helps decontaminate it from harmful bacteria that may have found its way inside lettuce, for instance."

Irradiation also eliminates problems associated with other food safety treatments such as nutrient degradation or changing the produce's color, texture and flavor. Moreira and Castell-Perez are now working to determine precisely how much irradiation is enough.

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"Quality is very important," Castell-Perez says. "We want to maintain everything there — vitamins, color, shelf life — but get rid of things like *Salmonella*."

To accomplish the task, the researchers are taking existing technologies and developing innovative applications specific to food safety.

For instance, the Texas A&M researchers are using CT (computed tomography) scans to map produce, and this puts them at the forefront of imaging and computing to calculate the dosimetry, the absorbed dose of ionizing radiation, for certain fruits and vegetables.

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Using computer simulation, they can cut a cantaloupe, for example, into thousands of layers to create a model that enables the researchers to calculate the smallest dose of radiation needed to reach every part of the product.

No fruit or vegetable is exactly alike, so mapping out a standardized dose is a sizable challenge, says Moreira.

"First, as engineers, we need to understand how to make the energy distribution uniform," Moreira says. "Once you understand the uniformity, which is a big issue, we need to know how much energy to put in the fruit or vegetable to make sure there is no degradation of quality."

Moreira and Castell-Perez say that irradiation may actually improve the quality of food. Their research has shown that irradiation can slow down ripening and spoilage to extend shelf life. Irradiation also destroys insects and parasites.

They are also exploring how irradiation can actually increase nutritional value of fruits that are high in antioxidants, such as blueberries.

Irradiating today for safer food tomorrow

So, what does the future of food irradiation in the U.S. look like? Advances are less likely to be held up by technology; policy and public perception may be the more complex issue. Moreira says the first obstacle is revamping the current Food and Drug Administration regulations.

"The maximum dose currently allowed is 1 kiloGray [a measure of radiation exposure], and our research shows that this is not enough to kill pathogens," Castell-Perez says. "More is necessary to be effective while still being safe for consumption."

Moreira and Castell-Perez have demonstrated that irradiation can be a safe and effective way to treat the food we consume every day. If it were up to Castell-Perez, irradiation would be the only option for treating food in the future.

"Irradiation does not excuse dirty or mishandled produce," Castell-Perez says. "But it is a preventive step and we are working hard at collecting scientific data that proves this point." ✯

GOODBYE, "SELL BY"

New and improved packaging for fresher, safer produce

To most, the plastic wrapped around the fresh produce found in grocery stores provides a simple, basic barrier between your food and anything it might come in contact with before being opened.

But suppose that plastic sheet did more than merely keep food in and contaminants out.

Rosana Moreira and Elena Castell-Perez are studying and improving the sheet plastic that wraps much of the fresh produce we find in supermarkets by adding a combination of techniques to enable the plastic wrap to fight off unwanted germs.

The researchers, along with graduate student Carmen Gomes, are working to make food packaging materials more effective by approaching the issue from a wide range of applications.

Texas A&M is a leader in food safety engineering research, and Moreira, Castell-Perez and colleagues use engineering principles in combination with radiation physics and biology, food science, packaging materials, and computer methods to optimize intervention technologies such as irradiation to ensure safety of fresh and fresh-cut fruits and vegetables.

Such a comprehensive approach to enhancing plastic packaging for food safety has not been done in quite this way before, where an emphasis on irradiation combined with several other technologies is producing a new generation of protective packaging.

"The idea to improve effectiveness of packaging came to us when we first irradiated a bag of spinach," Castell-Perez says. "The applied dose was too much for a food sensitive to radiation and though the process eliminated the pathogens, it also destroyed the food."

The Texas A&M researchers are investigating new methods of keeping bagged produce fresher longer, including embedding natural enzymes and extracts in the plastic wrap as well as combining with gases or a low dose of irradiation inside the bag.

This sparked the inspiration to focus on improving the packaging so that it protects food and preserves quality.

"The next thing was to explore ways to reduce the required dose so that the product integrity is maintained," Castell-Perez says. "So we thought, can the package be 'active' and help maintain the quality as well as the safety of the spinach?"

They are looking for the package to be active in protecting food as well as fighting off unwanted bacteria and other microbes.

Spicing up food freshness

To do this, researchers apply natural enzymes and natural extracts, such as cinnamon, garlic, clove, thyme and rosemary, into plastic films used for food packaging. These spices have shown to be powerful antimicrobial substances, Gomes says.

A major challenge is making sure the spice used for protection does just that, without leaving anything behind — like its flavor. While garlic may enhance the bacteria-fighting ability of the plastic packaging, the distinctive flavor would not be a good addition to berries, for instance.

These extracts are embedded into a basic FDA-approved plastic film coating and then the extracts are mixed with a natural polymer.

"We use microencapsulation," Gomes says. "We coat our compound with another substance, making a capsule, and when it's in contact with the food, the compound migrates to the food."

This effect must be carefully designed so that the exact amount of the extract at the desired rate is released into the food.

In addition to experiments with natural extracts, the researchers are evaluating the feasibility of using the plastic film in combination with certain gases such as air, 100 percent oxygen, combinations of nitrogen and oxygen, and ozone.

Irradiating for safety

When a bag of spinach is irradiated, the air inside the bag is also exposed to ionizing radiation. This creates active radicals, meaning they are ready to react with another compound, such as ozone, hydroxide ions and even carbon dioxide. Reactions between these compounds are harmless to the consumer, but they destroy unwanted bacteria.

Moreira and Castell-Perez are taking a new approach in the field of packaging. Combining the antimicrobial packaging with atmospheres, an application of modified atmosphere packaging, could increase the radiation sensitivity of the pathogen in question, thus requiring a smaller dose while ensuring wholesome, safe and long-lasting spinach.

"When you talk about using those gases in combination with irradiation, then there is a synergistic effect so that the irradiation converts that gas into some compounds that will be antimicrobial," Moreira says.

The Texas A&M researchers are working toward a common goal: improving packaging safety. As they work through these challenges, they're also building synergy that has fueled innovation for attacking the challenge from all directions. Among them: applications including extracts, different types of atmospheres, and irradiation treatments that are leading to new discoveries in the packaging world. ✯

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