Nuclear technology: Keeping your food safe

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Students in the Department of Nuclear Engineering test a livestock radiation portal monitor they developed with collaborators from the animal science department.

As we sit down to our Thanksgiving dinners next week, we probably won't be thinking about radiation.

While most of us do not connect "food" with "radiation," all food is

naturally radioactive. Radiation also helps us treat food to make it free of bacteria and viruses.

Dr. Les Braby, professor in the Department of Nuclear Engineering at Texas A&M University, says that radiation and radioactive materials are a natural part of our environment, but radioactivity can also be created by science. When we create radiation, such as in food treatment or with an x-ray machine, it is usually for a specific benefit that outweighs the risk.

Braby is an expert in radiological health engineering, which focuses on all aspects of radiation in our lives, including radiation associated with food and health, as well as on the consequences of radiation on food after major nuclear-related accidents. Braby says that Sensitive radiation detectors are available to detect radioactivity in food because everything in our lives is naturally radioactive. When the universe was formed, all possible combinations of neutrons and protons to make all elements were produced. Many of those combinations have a different number of protons than neutrons in the nucleus. Sometimes nuclei with a different number of neutrons are unstable and will emit particles until there is a stable ratio of neutrons to protons.

Most of those changes happen very quickly and most of the atomic nuclei that are left in the universe are already stable, Braby says. The remaining radioactive atoms, such as potassium and sodium, are known as naturally occurring radioisotopes and are slower to emit particles and are therefore not yet stable. Because all living things require many atomic elements in order for their life processes to function properly, and because biological systems cannot distinguish between radioactive and non-radioactive atoms of the same element, our food and our bodies contain both. The radioactive potassium is still trying to reach a stable combination of neutrons and protons, so there is a small chance that the atom in your food or your body will decay (by emitting a particle) to

reach the stable combination. However, there is no evidence that the radiation you receive this way is harmful, so don't throw away your banana just yet.

Evaluating food after a nuclear accident

Following a radiological accident such as Fukushima, there will be widespread contamination that can cover land, animals and buildings, says Dr. Craig Marianno, visiting assistant professor in the Department of Nuclear Engineering and a research engineer with the TEES Nuclear Science Security and Policy Institute.

Cattle, sheep and other animals consumed by the public as food will also become contaminated. If an accident happens in one of the states, many may consider all animals in that state contaminated even if they were nowhere near the affected areas.

Consider a state like Texas, Marianno says, where beef is the #1 state commodity accounting for over $6 billion a year in sales. If beef in Texas were considered "unsellable," the financial ramifications would be tremendous.

To ease this potential impact, Marianno and his research team have developed a radiation portal monitor specifically designed for livestock, under a USDA National Institute for Food and Agriculture grant. This scalable system can be used to scan animals of all sizes, from chickens to cattle. Texas A&M students assembled the system, designed custom software and have tested the portal monitor in the lab and field.

Irradiating food to prevent illness, preserve taste

Because of major foodborne-illness outbreaks in the past few years,

researchers have seen a rise in the difficulty in assuring that fruit, such as cantaloupe, is really safe. The problem is that cantaloupe grows on the ground in a field where almost any animal could walk or fly by, and its rind seems to have been designed to provide hiding places for all kinds of microbes that transfer to the edible part of the fruit when it's cut. The packaging house could wash the cantaloupe in a bleach solution, or they could use a highly toxic gas to eliminate the microbes, but there will probably be some residue from those treatments that may affect the flavor or even pose a long-term health risk.

So Texas A&M researchers are investigating alternatives that can eliminate the microbes without leaving a chemical residue. High-energy ultrasound or extremely high pressure might kill the microbes, but they would make a messy pulp of the cantaloupe. Ionizing radiation would kill the microbes, but some people worry that it may damage the nutritional value of the fruit.

The research team is trying to irradiate just the rind of the cantaloupe without affecting the edible part using a machine that produces radiation that can only penetrate partway through a cantaloupe and has no radioactive source to dispose of, such as an accelerator beam. The machine's electrons are very light (compared to an atom) and bounce like popped corn in a hot-air popper. A Texas A&M nuclear engineering graduate student is currently using a computer code to test various arrangements of electron beam barriers in order to find the best solution for solving this problem. The researchers say they hope to soon be able to eliminate those microbes without any chance of damaging the part of the fruit that people want to eat.

Testing the effects of radiation on food bound for space

Of course, food is not the only part of our natural environment that exposes us to radiation. The space around our planet is full of radiation. The sun produces some of it and some of it is produced outside of our solar system. Earth's magnetic field and atmosphere prevent most of this radiation from reaching us, but increasing our altitudes increases our radiation dose. For example, frequent air travelers or people who live in Denver receive almost double the radiation dose as those who remain closer to sea level. While these "radiation doses" are measurable and display a notable difference depending on elevation, they are not significant, nor do they lead to increased health concerns.

If you work on the space station, the amount of radiation is even higher. Scientists have a good idea of how much radiation people receive on the space station, and have instruments that determine radiation dose, so space travelers typically limit their stay to less than a year. NASA, concerned that the radiation on the space station might be damaging the nutritional value of food, asked Texas A&M nuclear engineers to calculate the damage caused by radiation to vitamin molecules in space station food packaging. Using a worst-case scenario, assuming that if a cosmic ray hit a vitamin molecule it would inactivate it, the result of the calculation was that any change produced by radiation would be trivial compared to the changes that occur due to storage in a radiation-free warehouse. In fact, most of the time the vitamin molecule will not be damaged.

However, out of that continuing abundance of caution, Texas A&M nuclear engineers were asked to help test the effects of radiation of food. The researchers exposed NASA food packages to high levels of radiation many times what it would be exposed to in space and found only minor changes. Eventually, food packages were sent to the space station and identical packages were placed in refrigerated storage on the ground. After more than a year, the food was analyzed to see if any nutrients had been lost. The same amount of loss occurred whether the

food had been stored in space or on the ground.

Every day we encounter some form of radioactivity in the air around us, water and food we take in, the earth we walk on, and the products we purchase and use. Beyond the use of radiation to diagnose disease and treat cancer, few people are aware of the many beneficial applications of nuclear technology, and the research currently taking place to further improve our lives. Texas A&M Nuclear Engineers are leading the way to helping the world safely use this resource for its many benefits.

Provided by Texas A&M University