FOOD SAFETY FOCUS ON RADIOLOGICAL HAZARDS

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There are three main buckets of hazards when it comes to food safety: chemical, physical and biological. Radiological hazards, a type of chemical hazard, were an addition to the Food Safety Modernization Act (FSMA) regulations in 2011. This small detail sometimes can feel like a "got you" during any audit/inspection of your food safety plan. As food processors, radiological hazards may not always be at the top of our minds. This may be because it doesn't happen often, but, it is our duty as manufacturers to identify possible hazards in our process and to eliminate or reduce them to an acceptable level.

Radiological hazards in food recently came to the forefront with a "radioactive shrimp" recall in the U.S. (*more on this later*). This incident is a reminder that while radiological hazards are a rare occurrence, they certainly are not an impossibility.

So, what does guarding against radiological hazards look like in a food safety plan? If you look at the Food and Drug Administration (FDA) document, "Draft Guidance for Industry – Hazard Analysis and Risk Based Preventive Controls for Human Food," (1) there aren't any particular ingredients that are labeled as high risk for radiological hazards. It is also the general consensus of food safety experts that radiological hazards are not a routine hazard in the food supply.

Radiological hazards can happen when people are exposed to tiny radioactive materials called radionuclides. Radionuclides are types of atoms that are unstable, which means they slowly break down and give energy. This is called "radioactive decay." (2) These radionuclides release high energy particles such as Alpha particles (α), Beta particles (β), Gamma rays (γ), and X-rays (see Diagram A). Radionuclides can be naturally occurring or man-made (typically nuclear reaction byproducts). Here is a list from the Environmental Protection Agency of some radionuclides:

- Americium-241
- Cesium-137
- Cobalt-60
- Iodine (131, 129)
- Plutonium
- Radium
- Radon
- Strontium-90
- Technetium-99
- Thorium
- Tritium
- Uranium

So, where does risk of exposure to radionuclides come from? There are two main instances where radiological hazards in foods can occur:

1. In areas after a nuclear plant accident where accidental radioactive release occurs through natural disaster or poor industrial practices.

2. Radionuclides hazards in contaminated water.

An example that encompasses all of the above risks is the Fukushima nuclear reactor incident.

> *On March 11, 2011, a magnitude 9.0 earthquake—one of the largest ever recorded—occurred 80 miles off the coast of Japan. The earthquake created a series of tsunamis, the largest estimated to be over 100 feet, that swept ashore. In addition to the tragic toll of dead, injured, and displaced people, the earthquake and tsunamis badly damaged the Fukushima Daiichi nuclear power plant, eventually causing four of the six reactors there to release radiation into the atmosphere and ocean (3).*

The catastrophe of these reactors releasing radionuclides into the environment resulting in potential food supply chain contamination.

Nuclear reactor disasters, like the one that occurred in Fukushima, can cause a number of potential risks for the food supply, including:

1. Atmospheric deposition on crops and soil - The fallout can drift and land on soil. Plants, such as leafy vegetables, can uptake radiological contaminants.

2. Water contamination - The contaminates enter the water being used in food processing and water that fish live in. Biological magnification can happen when predatory fish eat contaminated prey.

3. Livestock exposure through feed and water - Cows consume a large amount of feed, leafy greens, and water. If the fallout of a nuclear disaster contaminates water and grass with radionuclides, the cow will consume these materials and lead to the contamination of her milk.

4. Radioactive materials contaminating raw material for other processes - Raw material for steel or other products that may be repurposed/processed/reprocessed and lead to more subsequent fallout (4).

Noted earlier, another unfortunate example of the potential risk for radiological contamination is the recent "radioactive shrimp" recall. The contaminated shrimp ➡

originated from a shipment from Indonesia that had been contaminated with the radioactive isotope Cesium-137 (a byproduct of nuclear fission). In this instance, the source of contamination wasn't from a nuclear power plant, it was from a nearby industrial factory that was smelting metal that likely contained cesium chloride.

According to an article in Food Safety Magazine (5), "It is likely that the cesium was incorporated into the firm's waste stream and then processed, releasing Cs-137 particles into the air, which may have spread to nearby shrimp packaging facility…located approximately two kilometers away." In addition, cloves from Indonesia were also contaminated with cs-137. The plant processing the cloves is in a different part of Indonesia than where the shrimp were processed and the source of contamination for the cloves hasn't yet been confirmed. However, Indonesian officials discovered that shipping containers were contaminated with cs-137.

In the U.S., well water can be another area of concern. Radionuclide contamination can occur through contamination of well water that contains radioactive isotopes or elements. Some areas in the U.S. have radioactive isotopes that naturally occur in the earth such as radium-226, radium-228, and uranium present in their untreated well water. There are various mitigation measures that are available, including reverse osmosis, ion exchange, lime softening, and alum treatment (6).

The Current Good Manufacturing Practices (CGMPs) require that water that contacts food, food contact surfaces, or food-packaging materials be safe and of adequate sanitary quality (see 21 CFR 117.37(a)). Verifying local testing from the city for any radionuclide contaminants is important to check at least once per year. Print the report and place it with your food safety plan and HACCP validation.

One helpful resource for monitoring air and drinking water for radiation is RadNet (epa.gov/radnet). It is a nationwide monitoring system run by the Environmental Protection Agency.

You should note in your hazard analysis that you evaluated the proximity of your location to nuclear power plants. This is especially important if your location is within a 50-mile radius of a nuclear power plant. There is an active radiological monitoring system at epa.gov/radnet. You can take a look at https://enviro.epa.gov/envirofacts/radnet/search to evaluate the nuclear power plant near you. Depending on the area, you can search the level of air contamination, water testing results, and sometimes milk testing results.

One other important point in this discussion is that food and food ingredients become contaminated when radionuclides or radioactive isotopes get into the food, not when exposed to radiation (See diagram A). Irradiation, or exposure to radiation, is used to reduce the risk of biological hazards in food and ingredients like spices and seasonings (see Diagram B). A radiological hazard is when the radioactive isotope is present in the food. So don't worry, irradiated spices or seasonings aren't a radiological hazard rather they are reducing the possibility of microbe contamination. The foreign material detector using X-rays is also not creating a radiological problem, but instead, it is helping you identify metal and other materials that are not supposed to be in your product. Key message: It's when **radionuclides** are present in the product that it becomes a radiological hazard.

Sources:

1. Food and Drug Administration. "Draft Guidance for Industry – Hazard Analysis and Risk Based Preventive Controls for Human Food." https://www.fda.gov/regulatory-information/search-fda-guidance-documents/draft-guidance-industry-hazard-analysis-and-risk-based-preventive-controls-human-food

2. United States Environmental Protection Agency. Radionuclides. https://www.epa.gov/radiation/radionuclides

3. Woods Hole Oceanographic Institution. FAQs: Radiation from Fukushima. https://www.whoi.edu/ocean-learning-hub/ocean-topics/ocean-human-lives/pollution/radiation/fukushima-radiation/faqs-radiation-from-fukushima/

Continued on page 9