Viet Nam enhances food quality using irradiation

Food products undergo irradiation processes at VINAGAMMA using an electron beam irradiator, pictured here, and a gamma irradiator.
(Photo: E. Marais/IAEA)

Each morning hundreds of boxes filled with frozen seafood, dried fruits and vegetables, traditional oriental medicines and health foods are queued up in a storeroom in Ho Chi Minh City, Viet Nam. They will undergo a process similar to security screening at airports, but with higher intensity beams of photons or electrons, as part of a food irradiation programme installed with IAEA support over the last two decades.

Depending on the dose, food irradiation ensures that root vegetables and fruits do not sprout or ripen prematurely; that parasites are killed and spices are decontaminated; that salmonella is destroyed; and that fungi that could spoil meat, poultry and seafood is eliminated.

The process of food irradiation was first introduced in Viet Nam in 1999 with the help of the IAEA and the Food and Agriculture Organization of the United Nations (FAO), and a large market for irradiated products has since opened up, significantly increasing the ability of companies to export their food products. Food irradiation has matured into a mainstay of the country's food industry and is an important contributor to the country's agricultural competitiveness.

"In 1999 we were irradiating 259 tonnes of food per year, and this had grown to 14 000 tonnes by 2017," said Cao Van Chung, Head of the Electron Beam Department at the Viet Nam Atomic Energy Institute's Research and Development Center for Radiation Technology (VINAGAMMA). "This shows a real boom in the demand for our work. Today, we are one of the country's leading facilities in the field of radiation technology — pioneering in food irradiation."

Introduction of gamma and electron beam irradiation

This considerable growth has been possible thanks to the introduction of two irradiation methods. A gamma irradiator, introduced in 1999, which uses ionizing energy from a radiation source shielded in a concrete room, and an electron beam (EB) irradiator, in use since 2013. EB irradiators do not rely on a radioactive source, using instead streams of highly charged electrons produced from specialized equipment, such as a linear electron accelerator. The food never comes into contact with radioactive material, and the irradiation both maintains the quality and increases the safety of the food while leaving no residual radioactivity.

Although the process of irradiation using the two methods is the same, each brings distinct and complementary advantages, Chung said. The gamma irradiator uses tall aluminium boxes, which can accommodate a broad range of product sizes, and the boxes are moved through the irradiation chamber around the radioactive source suspended from an overhead monorail system. Food products require two rounds of irradiation to ensure that all sides of the packaged product have been properly treated.

The EB irradiator, on the other hand, contains double-sided beams, which makes the irradiation process three times quicker than using the gamma irradiator, because the whole product can be irradiated in a single round. However, the EB irradiator has a limited dimension, with a maximum box size of 60x30x50 cm and weight of 15 kg, so gamma irradiation must be used for larger and heavier products. The machines work side by side, running 24 hours a day, 7 days a week, only stopping over the Vietnamese New Year period.

Before the introduction of the gamma irradiator and the EB irradiator, spoilage prevention of food products such as seafood, fruits and vegetables was carried out using traditional methods, including canning, refrigeration and freezing, and chemical preservatives, which, owing to their lower effectiveness, hindered the manufacturers' ability to export their products.

The irradiation machines were acquired with support from the IAEA's technical cooperation programme, which also provided training and expert advice for staff. Viet Nam is 1 of 40 countries that the IAEA is supporting in this area.

Growth in the use of radiation technology

VINAGAMMA has grown from just 20 employees when it was set up in 1999 to 79 today. Besides food irradiation services, it offers radiation sterilization of medical products and pasteurized foodstuffs, and commercializes its research and development products, such as plant protectors used in agriculture and gold and silver nanogels used in medicine.

VINAGAMMA also carries out research and development and provides training in the field of radiation technology. It works with international partners to find ways of further improving irradiation technology.

—By Estelle Marais

IAEA develops new method for tracking sources of water pollution

Excessive nitrate in lakes, seas and rivers can increase algae growth that can lead to toxic blue-green blooms. The IAEA, in collaboration with the University of Massachusetts Dartmouth, has developed an innovative method for tracing the origin of nitrate pollution in water.

(Photo: L. Wassenaar, IAEA)

The IAEA, in collaboration with the University of Massachusetts, has developed an innovative method for tracing the origin of nitrogen pollution in lakes, seas and rivers. The nuclear-derived analytical tool provides a cheaper, safer and faster way to determine whether excessive nitrogen compounds in water stem from agriculture, sewage systems or industry, helping prevention and remediation efforts.Nitrogen, an essential and abundant element on earth, is an important fertilizer that has been widely used in agriculture since the mid-1900s. "One of the major global problems in terms of water quality is that we have been overfertilizing our landscapes for decades, either with manure or synthetic fertilizers," said Leonard Wassenaar, head of the Isotope Hydrology Section at the IAEA. "All of these nutrients, particularly nitrogen forms such as nitrates, are seeping into groundwater and eventually into rivers, lakes and streams."

Excessive nitrate levels increase algae growth that can lead to toxic blooms on the surface of lakes. These can also sink to the bottom of lakes, feeding bacteria and creating what is known as dead zones. "We now see more fish kills, where thousands of fish float to the surface because the bottom of the lake — their usual habitat — is depleted of oxygen owing to this rain of organic material," Wassenaar said.

Removing nitrates from water is very difficult and expensive, so tools are needed to understand nitrogen sources and pathways in order to better inform water protection and remediation efforts.

The new method, published in the journal Rapid Communications in Mass Spectrometry, measures the amount and proportion of nitrate stable isotopes in water. Nitrogen has two stable isotopes, or variations of its atoms, with different weights. Since the weight difference is not the same in human waste or fertilizers, for example, the isotopes can be used to identify the source.

"Isotope tools are very powerful for measuring nutrients in water," said Wassenaar, "but their use has historically been very difficult, hampered by cost and accessibility. The new technique allows scientists to run more samples, and much more cheaply, for large-scale studies. I think it is a game changer."

The new method uses a form of titanium chloride — a salt — to convert nitrate in a water sample into nitrous oxide gas. From this gas, the isotopes can be analysed with equipment such as a mass spectrometer or laser. Current methods use genetically modified bacteria or the highly toxic metal cadmium for the nitrous oxide conversion, making them laborious and costly and their use limited to a few very specialized laboratories.

"It's a relatively simple method for what used to be a very complex and expensive process," said collaborator Mark Altabet, Professor of Estuarine and Ocean Sciences at the University of Massachusetts Dartmouth's School for Marine Science and Technology. Sample analysis costs five to ten times less than in the past, and it takes only minutes to prepare samples.

Altabet plans to use the method to study the impact of measures to control pollution in Long Island Sound, an estuary on the eastern coast of the United States, which was heavily impacted by excessive nitrate in the past.

The IAEA promotes the application of nuclear and isotopic techniques to determine water source, age, quality and sustainability, in order to help countries better manage this vital resource.

—By Luciana Viegas