Irradiation

FOOD SAFETY TECHNOLOGY SUMMARY	
Status	Partially Emerged Technology
Location	Normally packaging/retail, though whole carcasses can be treated
Intervention type	Surface treatment for E-beam, but Gamma irradiation can penetrate deeper
Treatment time	seconds
Regulations	Approved in US. Not yet approved for meat in Australia
Effectiveness	Very good
Likely Cost	Up-front capital cost of equipment A$1,000,000 +
Value for money	Poor in Australia unless central service facility available
Plant or process changes	The unit may be retro-fitted after the packing machine, but extra space may need to be provided E-beam cabinet would require space for installation at the end of the slaughter line
Environmental impact	The equipment requires power
OH&S	Irradiation units must be properly screened
Advantages	E-beam radiation capable of treating whole carcasses after chilling Easy to treat packaged primals In-package treatment can reduce potential post-processing contamination Good for smaller cuts such as patties and individual steaks etc
Disadvantages or Limitations	Consumer perceptions may be hard to overcome Packs must be labelled i.e. “Treated with radiation”

Irradiation

In this process, products are exposed to Ionizing radiation- radiant energy that includes gamma rays, electron beams, and x-rays. Gamma irradiation uses high-energy gamma rays with high penetration power and thus can treat bulk foods on shipping pallets. Electron beam (E-beam) irradiation uses a stream of high-energy electrons, know as beta rays, which can penetrate only about 5 cms, while X-irradiation has intermediate penetration. Irradiation damages the bacterial cells' genetic material, disrupting their normal functions and can result in significant extensions in shelf-life of the product treated. The biggest obstacle to irradiation as an intervention is consumer acceptance. There is a perception that irradiation is dangerous to health, which in large doses, it is, but the doses required to treat foods are tiny and considered safe.

The organisms responsible for meat spoilage and food-borne illness are readily destroyed using irradiation. Doses of 1.0 to 10.0 kGy have been shown to be effective in food decontamination, and a dose of approx 1kGy with depth penetration of 15mm reduces stationary phase *E. coli* O157:H7 on the surface of beef tissue by at least 4 log with acceptable effects on organoleptic properties (Arthur 2005), while 0.4-0.6 KGy would give a 1 log reduction in *Listeria monocytogenes* (Radomyski *et al.* 1994). Considering the fact that the numbers of pathogens present on fresh meats are usually below 2 log cfu/cm^2, an irradiation dose of 1.5 KGy would in theory remove this level of contamination (Murano 1995).

Irradiation also increases the shelf-life of meats, by reducing the initial load of spoilage organisms present. Most authors agree that irradiation at medium doses does not affect the organoleptic properties of red meat, with no significant difference being found between pork chops that had been treated with 1 KGy and those that had not after fourteen days of vacuum-packed storage (Mattison *et al.* 1986). In a trial on beef patties, the only difference noted was that the irradiated patties were considered to be juicier than the non-irradiated patties (Murano *et al.* 1998). Low-dose/low-penetration electron beam (E-Beam) irradiation has now evolved to the point where large non-uniform surface areas can be effectively treated, which allows whole carcasses to be treated after chilling. Only the surface (about 15mm penetration) receives a significant radiation dose (Koohmaraie *et al.* 2005). A recent study showed that a 1 kGy dose of E-beam radiation applied to chilled beef primals reduced *E. coli* O157:H7 numbers by 4 log, with no adverse effects on the sensory attributes of the meat, as judged by a trained taste panel (Arthur *et al.* 2005). The packaging method used for the meat will affect the efficacy of the irradiation treatment. Irradiation is far more effective on packs containing air than on vacuum packs or MAP packs (Thayer & Boyd 1999).

Irradiation is approved by more than 40 countries and endorsed by such international and governmental organisations as the World Health Organisation (WHO) and the FDA. It offers a significant opportunity to reduce pathogens and extend the shelf life of meat, but consumer acceptance is still a hurdle. In Australia, Food Standard 1.5.3 of the Food Code governs irradiated food and to date, only herbs and spices and some tropical fruits have been approved to be irradiated, as is the case in the EU. Labeling requirements vary from country to country. Some, like Australia, New Zealand and the EU, require the labeling of any food that contains an irradiated ingredient, however small the percentage of that product, whereas in the United States, labeling applies only where the whole food item is treated. Ionizing radiation has been approved in the US for use in treating refrigerated or frozen uncooked meat, meat by-products, and certain other meat products to reduce levels of foodborne pathogens and to extend shelf life (USDA/FSIS 1999). Irradiated product must bear a particular logo and must either have the word "Irradiated" in the product name, or the pack must be labelled "Treated with radiation" or "Treated with irradiation".

Like other physical processes such as cooking and freezing, irradiation can cause some alteration of the chemical and sensory profiles of a food but, in general, most nutrients are unaffected by irradiation with the exception of some vitamins for which minor decreases may occur. It is unlikely that any vitamin deficiency would result from the consumption of irradiated food (IFT 2000). The two most important concerns related to the microbiological safety of irradiated foods are: (1) the potential to create highly virulent mutant pathogens; and (2) the potential that reducing the harmless background microflora could eliminate competitive microbial forces and allow uncontrolled pathogen growth (IFT 2000). A key advantage of food irradiation is that it reduces the microbial load at the point at which the product has been packaged, which increases the likelihood that the product the consumer receives will be safe.

Electron beam ionising radiation has been successfully used for irradiation of ground beef in the US and now has significant consumer acceptance there. However the main proponent of the technology, SureBeam Corporation filed for bankruptcy in January 2004, halting virtually all meat E-beam irradiation activity. It appears that the company is unlikely to resume trading, and this is likely to deal a severe blow to E-beam irradiation as a commercially viable technology.

Proponent/Supplier Information

ScanTech Holdings, LLC

75 Fifth Street NW, Suite 218

Atlanta, GA 30308, USA

www.scantech.com.mx

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