FOOD IRRADIATION

INFORMATION DOCUMENT

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PRESERVATION OF FOOD

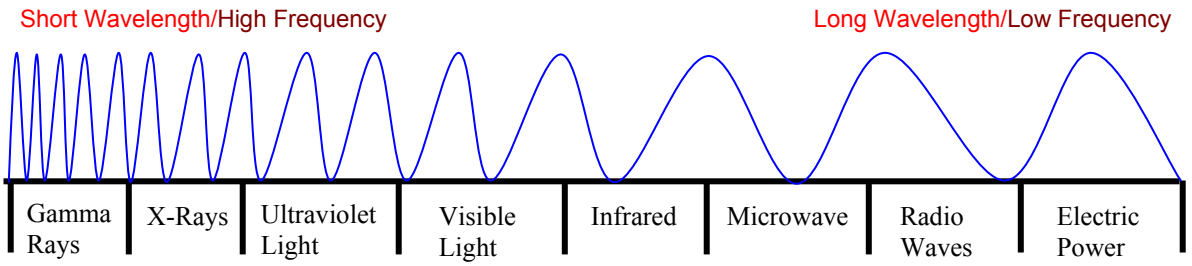
Consumption of fresh food is preferable, but not always possible, in the current global economy as much of our food is consumed at a time and place far from where it is produced. To protect food and extend its shelf life during transport and storage, food can be preserved by a variety of processes such as cooking, refrigeration, pasteurisation, salting, marinating, drying, smoking and more recently irradiation. However, some of these processes can also have undesirable effects on the appearance, odour, texture or even flavour of certain foods and therefore selection of a suitable preservation technique will depend on parameters such as desired effect, possible negative impact, cost and even availability.

FOOD IRRADIATION

Irradiation is a physical treatment where food is exposed to a defined dose of ionising radiation and is used on more than 60 food types in over 40 countries worldwide. Irradiation of food can control insect infestation, reduce the numbers of pathogenic or spoilage microorganisms and delay or eliminate natural biological processes such as ripening, germination or sprouting in fresh food.
LIKE ALL PRESERVATION METHODS, IRRADIATION SHOULD SUPPLEMENT RATHER THAN REPLACE GOOD FOOD HYGIENE, HANDLING AND PREPARATION PRACTICES.

IONISING RADIATION

Radiation is an energy form travelling through space (radiant energy) in a wave pattern and can be either naturally occurring (e.g. from the sun or rocks) or produced by man made objects (e.g. microwaves and television sets). The frequency or wavelength of the energy waves produced by different sources distinguishes the different types and functionality of radiation as shown below, with high frequency radiation of UV, X-rays and gamma-rays posing the most significant risk to human health.



Radiation is called **ionising** radiation when it is at a sufficiently high frequency (gamma rays and X-rays) that it results in the production of charged particles (ions) in the material that it comes in contact with. **Non-ionising** radiation, such as that from microwaves, does not produce ions but can create heat under moist conditions and is routinely used for purposes such as cooking and re-heating of foods.

HUMAN EXPOSURE TO IONISING RADIATION

We are all exposed to low levels of ionising radiation on a daily basis from a variety of natural and man made sources. Under normal circumstances, almost 90% of the ionising radiation we are exposed to is due to natural radiation emitted from rocks, radon gas and even cosmic rays from space. The remaining exposure is due to man made sources such as nuclear reactors, medical x-rays and various electrical household appliances such as televisions. Food irradiation facilities that are built and maintained to accepted standards are no more hazardous than hospitals that carry out numerous X-rays each day and as such do not pose a significant exposure risk.

FOOD IRRADIATION SOURCES

Ionising radiation can be produced by a number of sources such as X-rays, electron beams (generated by electron accelerators) or gamma rays (produced by a radioactive source such as cobalt^{60}). Electron beams are the most cost efficient form of irradiation but they can only penetrate food to a limited depth while X-rays are expensive but are a penetrative form of radiation suitable for bulk operations. However, gamma rays are relatively inexpensive and highly penetrative making them a cost efficient option for any food irradiation.

THE FOOD IRRADIATION PROCESS

Irradiation is carried out in specially contained areas where the food is exposed to a defined dose of radiation in a continuous or batch process. The level of exposure is designed to take into account interdependent parameters such as the type of operation (batch or continuous), the optimum energy requirement to successfully safeguard the food and the source of irradiation (gamma rays, X-rays or electron beam). For example, electron beam irradiation in a continuous process is sufficient to treat most pre-packaged food items whereas treatment of large bulk quantities of food would require a batch system either with X-rays or gamma rays from a radioactive source.

PHYSICAL EFFECTS OF IRRADIATION ON FOOD

Irradiation, even at low doses, is not suitable for all food as it can produce undesirable odours and flavours in certain foods and even tissue damage in some fruit.

During exposure to irradiation, food and water absorb energy, most of which is used in the generation of molecules that are unstable and reactive and are collectively referred to as radiolytic products. These short-lived molecules chemically react with each other and surrounding molecules causing damage to biological cells, including those of contaminating microorganisms or insects. Radiolytic products are not unique to irradiated food however, with identical products being found in food that has been cooked, frozen or pasteurised and even in unprocessed food.

Irradiation also disrupts some of the chemical bonds in DNA of food as well as that of contaminating microorganisms or pests. While this disruption is inconsequential to the food, it considerably reduces the chances of survival and proliferation of the contaminating pests or microorganisms.

SAFETY OF IRRADIATED FOOD

Feeding studies carried out with animals or humans have not identified any safety concerns related to irradiated food. Regulations governing food irradiation within the European Union ensure that this technology is used to the highest safety standards and only where it provides tangible benefits to the consumer. In two reports from 1980 and 1997, joint expert groups from the World Health Organisation (WHO), the Food and Agriculture Organisation (FAO) and the International Atomic Energy Agency (IAEA) concluded that irradiation of any food to a level that achieves the technological benefit posed no extra toxicological hazard and did not microbiologically or nutritionally compromise the food. These conclusions were drawn in cognisance of the fact that certain foods are not suited to irradiation due to possible negative sensory effects such as taste, flavour and odour.

The EU Scientific Committee on Food (SCF) issued favourable opinions on irradiation of a range of foods as long as the process was not used to mask the food's suitability for consumption or to cover poor handling practices. A joint WHO/FAO/IAEA study group convened in 1997 concluded that the data on radiation chemistry, toxicology, microbiology and nutritional properties of foods treated with radiation doses greater than 10 kGy were adequate, and that food irradiated to any dose appropriate to achieve the intended technological objective was both safe to consume and nutritionally adequate. The EU SCF, in an opinion issued in April 2003, does not fully concur with the joint study group conclusion

and recommended that maximum doses of irradiation should continue to be considered for foods on a case by case basis.

Irradiation does not cause food or packaging material to become radioactive, and even when the irradiation source itself is radioactive, it never makes contact with the food and thus the food does not become contaminated.

EFFECTS OF IRRADIATION ON THE NUTRITIONAL CONTENT OF FOOD

The effect of irradiation on the nutritional quality of food is similar to, and in some cases less than that for some other preservation methods. Only minor changes in some vitamins (B_1, C, A and E) occur while carbohydrates fats and proteins remain largely unaffected by low or medium doses. However, nutritional changes in food due to irradiation are dependant on factors such as the temperature, radiation dose, packaging environment and storage. For example, irradiation of frozen food or food in an oxygen-free environment actually minimises any nutrient loss.

STERILISATION OR PASTEURISATION OF FOOD BY IRRADIATION

Irradiation is sometimes referred to as “cold pasteurisation” since the result achieved is similar to heat-based pasteurisation but without the heat. Low to medium doses of irradiation successfully reduce bacterial contamination but are not sufficient to affect viruses or toxins. However, higher radiation doses can be used to kill all living contaminants creating sterile foods. Such foods are necessary for people with reduced immunity such as AIDS or cancer patients, but are also used to feed astronauts and some armed forces.

FOODS SUITABLE FOR IRRADIATION

Thus far, the main types of food that have been classified as safe to irradiate are meat, seafood, fruit, vegetables, herbs and spices. The EU-authorised list of irradiated foods currently only contains dried aromatic herbs, spices and vegetable seasonings, although the EU Scientific Committee for Food has issued favourable opinions on a number of other food types. Member States are allowed to maintain national authorisations (Annex 2) for a range of foods that had been issued prior to development of the EU legislation.

DETECTION OF IRRADIATED FOOD

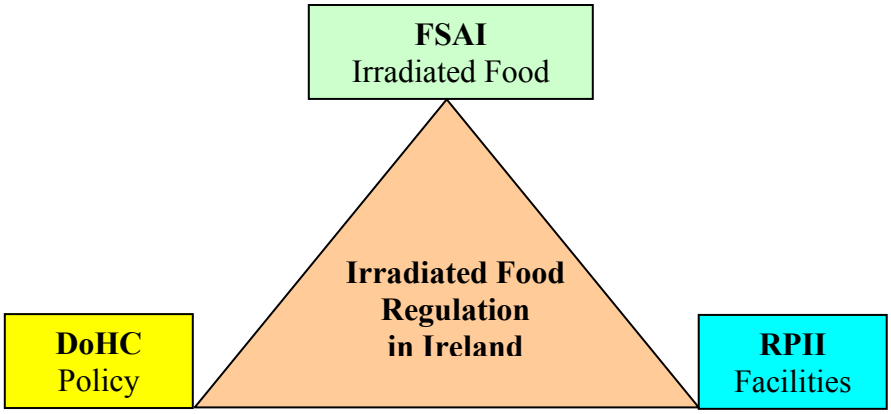
The appearance of a food is not an indicator of whether or not it has been irradiated but laboratory tests have been developed and standardised by the European Committee for Standardisation. These methods employ techniques that include gas chromatography, mass spectrometry, spectroscopy, luminescence and DNA analysis to identify certain molecular and spectroscopic characteristics of particular foods that are altered as a result of irradiation.

LABELLING OF IRRADIATED FOODS

Any irradiated food, or food containing an irradiated ingredient within the EU must carry the word “Irradiated” in a prominent position either as part of the main label or next to the ingredient that has been irradiated. It may also (optional) show the international icon for irradiated food called the “Radura” symbol:

REGULATION OF IRRADIATED FOOD IN IRELAND

Currently there are no authorised food irradiation facilities in Ireland and thus any irradiated food marketed within Ireland is imported. Regulation of food irradiation in Ireland is shared by three Government bodies, each with distinct but inter-dependent roles. The Food Safety Authority of Ireland (FSAI) is responsible for the enforcement of legislation governing irradiated food. Policy matters are the remit of the Food Unit of the Department of Health and Children (DOHC) while the Radiological Protection Institute of Ireland (RPII) ensures that irradiation facilities and processes meet safety and operational standards before and after receiving authorisation.



EU LEGISLATION GOVERNING FOOD IRRADIATION

Two EC Directives (1999/2/EC and 1999/3/EC) relating to irradiated food were implemented in Ireland in September 2000 by Statutory Instrument number 297 of 2000. The marketing of any product not complying with the Directives is prohibited as of 20 March 2001.

The **Framework** Directive 1999/2/EC of the European Parliament and Council covers general and technical aspects for carrying out the process, labelling of irradiated foods and conditions for authorising food irradiation. This Directive does not cover foods inadvertently exposed to ionising radiation from inspection or measuring devices as long as doses absorbed are below certain limits. This Directive also does not apply to irradiation of foodstuffs for patients requiring sterile diets under medical supervision. Under this Directive if a Member State discovers evidence that an authorised food can endanger human health then it may temporarily suspend or restrict marketing of that food in its territory. The Member State shall provide the new evidence to the EC, which will take appropriate measures upon consultation of the Standing Committee on the Food Chain and Animal Health (SCFCAH).

The Framework Directive specifically requires that the irradiation of a specific food item may only be authorised if:

- There is a reasonable technological need
- It presents no health hazard
- It is of benefit to the consumers
- It is not used as a substitute for hygiene and health practices or for good manufacturing or agricultural practice.

The **Implementing** Directive 1999/3/EC provides a list of foods and food ingredients that are authorised across the EU for irradiation though currently only dried aromatic herbs, spices and vegetable seasonings are listed. Until the list is completed, Member States may continue to irradiate those foods that had already received national authorisations (Annex 2) prior to implementation of this directive, 28 national authorisations currently exist. Member States may also retain existing restrictions or bans on irradiated foods not on the EU-authorised list. Ireland does not have authorisation to irradiate any food nor does it ban or restrict the import of any foods irradiated by other Member States.

The Commission maintains a list of Competent Authorities responsible for enforcing food irradiation legislation across the EU:
http://europa.eu.int/comm/food/fs/sfp/fi09_en.pdf

EUROPEAN COMMISSION REPORT ON IRRADIATED FOOD

The European Commission (EC) adopted its first report in October 2002 on the status of food irradiation in the European Union (EU). The report (http://europa.eu.int/comm/food/fs/sfp/fi_index_en.html) is based on the results of inspections carried out between September 2000 and December 2001 in Member States to determine the level of compliance with legislation governing food irradiation.

The Commission expressed its satisfaction with the high level of compliance as only 1.4% of the 6,748 food samples tested across the EU were found to be irradiated and labelled incorrectly (*Table 1*). At the beginning of the reporting period, only facilities in the UK and the Netherlands were approved under 1999/2/EC while those in Belgium, Denmark, France and Germany were nationally authorised. However, all facilities were found to be in general compliance with the legislation and all are now authorised under EU legislation along with facilities in Spain. Results submitted from Ireland by the FSAI were in line with general trends with just 2 out of 317 (0.6%) herbs and spices tested being found to be irradiated and not labelled accordingly.

Results from the UK however, showed that 42% of certain dietary supplements tested were irradiated but not labelled appropriately. Because of the scale of the labelling problem identified by the UK and since most of those products cannot be legally irradiated in the EU, the Commission requested that all Member States carry out a survey of dietary supplements marketed within their own jurisdictions to determine the level of compliance with irradiation legislation.

Table 1. Summary of results for those Member States that carried out surveillance

Member State	Result: non-irradiated	Result: irradiated and incorrectly labelled
Austria	21	0
Finland	153	4
Germany	5491	26
Greece	99	0
Ireland	315	2
Netherlands	88	0
Sweden	5	1
United Kingdom	479	64
Total	**6651**	**97**
% of analysed samples	**98.6**	**1.4**

FSAI PERSPECTIVE ON IRRADIATED FOOD

The FSAI considers irradiation to be a viable option for enhancing the safety of certain foods and food ingredients but only where other alternatives are either not available or fail to achieve an equivalent benefit.

Salmonella, *Campylobacter*, *Listeria* and *E. coli* O157:H7 remain problematic contaminants of meat and poultry in many countries despite high standards of production and processing. In the United States, an increasing number of supermarket chains are turning to irradiation to protect ground or minced beef products from contamination with pathogenic bacteria such as *E. coli* O157:H7. This pathogen can have serious or even fatal consequences if contracted by vulnerable groups including children and sick or elderly people. Contamination of meat products by this pathogen is difficult to prevent as it can be found in the gut of healthy ruminants and since as few as 10 cells can cause infection, any presence may pose a serious health risk.

In Ireland *E. coli* O157:H7 has also been identified as a real threat to public health, the result of survey of beef products carried out between March 2001 and April 2002 by the National Food Centre, Teagasc on behalf of the FSAI. This investigation revealed that 2.8% of these products were contaminated with the bacterium leading to the following conclusion:
…At present there is an unacceptable burden on the consumer to control the risk at a point in the food chain that is least likely to be controlled. Given the morbidity and mortality associated with E. coli O157:H7, if the present production regime in Ireland is unable to reduce the risk sufficiently then additional efforts must be made. For example, pre-cooked frozen beef burgers are already available in Ireland. Furthermore, irradiation is a proven process for eliminating pathogenic microorganisms in raw meat (Olsen, 1998). The provision of minced beef products that are rendered free from E. coli O157:H7 by these means should at least be considered for those catering for vulnerable groups of the population, such as the elderly and young infants…

Similarly, in a 2002 report the FSAI Scientific Committee recommended that irradiation be examined for the control of *Campylobacter* in the food chain:
"*The Food Safety Promotion Board should measure consumer attitudes to interventions, such as irradiation of meat, on an ongoing basis and stimulate dialogue between consumers and scientists in relation to the potential benefits of food irradiation and consumer concerns about perceived hazards*".

The full reports can be accessed on the FSAI website:
http://www.fsai.ie/research/VTEC_survey_report.pdf

http://www.fsai.ie/industry/campylobacter_report.pdf

While any form of preservation should not be used to mask poor hygiene or production standards, maximum effort must nevertheless be put into making food as safe as possible for the consumer. As our knowledge and experience of food irradiation expands, so too will our ability to fully exploit this technology and further protect consumer health.

FURTHER INFORMATION

Further information on food irradiation can be obtained from:

Food Safety Information Centre
Food Safety Authority of Ireland
Abbey Court, Lower Abbey St, Dublin 1

Tel: 1890 336677 Fax: (01) 817 1301
Email: info@fsai.ie Website: www.fsai.ie

ANNEX 1

LIST OF IRRADIATION FACILITIES IN THIRD COUNTRIES APPROVED BY THE COMMUNITY

Reference no: EU-AIF 01-2002 HEPRO Cape (Pty) Ltd 6 Ferrule Avenue Montague Gardens Milnerton 7441 Western Cape Republic of South Africa Tel: +27-21-551 2440 Fax: +27-21-551 1766
Reference no: EU-AIF 02-2002 GAMMASTER South Africa (Pty) Ltd P.O. Box 3219 5 Waterpas Street Isando Extension 3 Kempton Park 1620 Johannesburg Republic of South Africa Tel: +27-11-974 8851 Fax: +27-11-974 8986
Reference no: EU-AIF 03-2002 GAMWAVE (Pty) Ltd P.O. Box 26406 Isipingo Beach Durban 4115 Kwazulu-Natal Republic of South Africa Tel: +27-31-902 8890 Fax: +27-31-912 1704
Reference no: EU-AIF 04-2002 AGROSTER Besugárzó Részvénytársaság Budapest X Jászberényi út 5 H-1106 Hungary Tel: +36-1-262 1922 Fax: +36-1-262 1922

ANNEX 2

LIST OF MEMBER STATES' AUTHORISATIONS OF FOOD AND FOOD INGREDIENTS WHICH MAY BE TREATED WITH IONISING RADIATION

(According to Article 4(6) of Directive 199/2/EC of the European Parliament and of the Council on the approximation of the laws of the Member States concerning foods and food ingredients treated with ionising radiation)

Product	Authorised at the given maximum overall average absorbed radiation dose [kGy]				
	BE	FR	IT	NL	UK
Deep frozen aromatic herbs		10			
Potatoes	0.15		0.15		0.2
Yams					0.2
Onions	0.15	0.075	0.15		0.2
Garlic	0.15	0.075	0.15		0.2
Shallots	0.15	0.075			0.2
Vegetables, including pulses	1				1
Pulses				1	
Fruit (including fungi, tomato, rhubarb)					2
Strawberries	2				
Dried vegetables and fruits		1		1	
Cereals					1
Flakes and germs of cereals for milk products		10			
Flakes from cereals				1	
Rice flour		4			
Gum arabic	3	3			
Chicken meat				7	
Poultry		5			
Poultry (domestic fowls, geese, ducks, guinea fowls, pigeons, quails and turkeys)					7
Mechanically recovered poultry meat	5	5			
Offal of poultry		5			
Frozen frog legs	3	5		5	
Dehydrated blood, plasma, coagulates					3
Fish and shellfish (including eels, crustaceans and molluscs)					3
Frozen peeled or decapitated shrimps	3	5			
Shrimps				3	
Egg white	3	3		3	
Casein, caseinates		6			