Global Update

Food Irradiation - Sky's the Limit

Strictly from the scientific point of view, no ceiling should be set for food irradiated with doses greater than the currently recommended upper level of 10 kGy[1] by the Codex Alimentarius Commission. The food irradiation technology itself is safe to such a degree that as long as sensory qualities of food are retained and harmful microorganisms are destroyed, the actual amount of ionizing radiation applied is of secondary consideration. That was the main conclusion of a week-long meeting on high dose irraidation (Geneva, 15-20 September 1997) organized jointly by the World Health Organization (WHO), the United Nations Food and Agriculture Organization (FAO) and the International Atomic Energy Agency (IAEA).

"The knowledge of what can .and does occur chemically in high dose irradiated foods which derives from over 50 years of research tells us that one can go as high as 75 kGy, as has already been done in some countries, and the result is the same - food is safe and wholesome and nutritionally adequate", comments Dr. Fritz Kaferstein, Director of the WHO Programme of Food Safety and Food Aid.

The participants reviewed all relevant data related to the toxicological, microbiological, nutritional, radiation chemical, and physical aspects of food exposed to doses greater than 10 kGy and came to the unanimous conclusion that the food is safe for consumption. The focus of the meeting was on considering the generic wholesomeness of foods, appropriately treated and packaged, that are irradiated in the range of 10-100 kGy to eliminate all spoilage and pathogenic microbial contaminants.

"Food irradiation is perhaps the most thoroughly investigated food processing technology. We are quite satisfied with the existing scientific evidence that higher doses of radiation can provide wholesome, nutritious and safe foods", says Dr. Terry Roberts, Chairman of the meeting, former Head of Microbiology at the Institute of Food Research, Reading Laboratory, United Kingdom. "Similar to thermal sterilization of food, the dose should be sufficient to produce a shelf-stable and microbiologically safe product depending on the type of food and specific consumer requirements".

The presence in food of harmful microorganisms such as *Salmonella* species, *Escherichia coli O* 157: H7, *Listeria monocytogenes,* or *Yersinia enterocolitica* is a problem of growing concern to public health authorities all over the world. In an attempt to reduce or eliminate the resulting risks, national regulations on food safety are being tightened up in many countries. In the Unites States of America, for example, the Department of Agriculture has recently issued new regulations for meat and poultry requiring that testing for *Escherichia coli* begin in January 1997 and that raw meat and poultry processed by large firms be virtually free of *Salmonella* beginning in January 1998. For some of these products, food irradiation may well be the best method to

[1] Amount of radiation energy asborbed per unit mass of the material irradiated.

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ensure the absence of these microorganisms. However, in some instances, an upper limit of 10 kGy for the overall average dose could preclude the effective use of the technology.

In the case of irradiation of spices, this need for a greater average dose has already been recognized in several countries. France permits an average dose of 11 kGy for the irradiation of spices and dry aromatic substances, whereas Argentina and the United States of America permit a maximum dose of 30 kGy for this purpose.

Still higher doses are required for sterilization of food, for instance for immunocompromized hospital patients. For this purpose, the Netherlands permits an average dose of 75 kGy which implies that some parts of the food are exposed to doses over 100 kGy. Some other countries, such as the United Kingdom, permit the use of this technology without specifying an irradiation dose limit for this application. South Africa has permitted the marketing of shelf-stable meat products irradiated to an average dose of 45 kGy. For over 20 years, US and Soviet astronats have been enjoying their irradiated foods, indeed choosing them over other food preservation technologies.

As with other food pasteurization and sterilization technologies involving thermal, mechanical, or photonic energy input, the objective of processing with ionizing radiation is to destroy pathogenic and spoilage microorganisms without compromizing safety, nutrition and sensory quality. Common to all these processes are subsequent physical and chemical changes, the extent of which differs significantly among them. In comparison to thermally sterilized foods, the amount of chemical change in a radiation sterilized food is uniform and relatively small.

"For high dose food irradiaton, as with other methods of food production, it is important to use raw materials of good quality, to provide adequate packaging, to follow proper processing procedures and to have sound record-keeping, to follow good personal hygiene and sanitation practices, and to handle the processed foods appropriately during distribution", explains Dr. Roberts.

The group came to the following overall conclusions. Doses *g) eater than 10 kGy:* (i) will not lead to changes in the composition of the food that, from a toxicological point of view, would have an adverse effect on human health; *{it)* will greatly reduce potential microbiological risk to the consumer; and (in) will not lead to nutrient losses to an extent that would have an adverse effect on the nutritional status of individuals or populations.

Therefore, foods treated with doses greater than 10 kGy can be considered safe and nutritionally adequate when produced under established Good Manufacturing Practice.

"Given these reassuring conclusions, the World Health Organization hopes that food irradiation will now become more acceptable as a means for the improvement of food safety which remains one the Organization's priorities", says Dr. Fernando Antezana, WHO Assistant Director-General. At the present time, some 30 countries are using food irradiation technology for processing a variety of food products.

Electromagnetic Fields and Public Health: Health Effects of Radiofrequency Fields

Radiofrequency (RF) fields are part of the electromagnetic spectrum. Such fields are defined as those within the frequency range 300 Hz (or 0.3 kHz) and *300 GHz.* Natural and human-made sources generate RF fields of different frequency. Common sources of RF fields include: monitors and video display units (3 - 30 kHz), AM radio (30 kHz - 3 MHz), industrial induction heaters (0.3 - 3 MHz), RF heat sealers, medical diathermy (3 - 30 MHz), FM radio (30 - 300 MHz), mobile telephones, television broadcast, microwave ovens, medical diathermy (0.3 - 3 GHz), radar, satellite links, microwave communications (3 - 30 GHz) and the sun (3 - 300 GHz).

RF fields are *non-ionizing radiations (NIR)*. Unlike X-rays and gamma rays, they are much too weak to break the bonds that hold molecules in cells together and, therefore, produce ionization. RF fields may, however, produce different effects on biological systems such as cells, plants, animals, or human beings. These effects depend on *frequency* and *intensity* of the RF field. By no means, will all of these effects result in adverse health effects.

■ RF fields above 10 GHz are absorbed at the skin surface, with very little of the energy penetrating into the underlying tissues.

* The basic dosimetric quantity for RF fields above 10 GHz is *the intensity* of the field measured as *power density* in watts per square metre (W/m^2) or for weak fields in milliwatts per square metre (mW/m^2) or microwatts per square metre *($\mu W/m^1$).*

*For adverse health effects, such as eye cataracts and skin burns, to occur from exposure to RF fields above 10 GHz, power densities *above 1000 W/m^2* are needed. Such densities are not found in everyday life. They do exist in very close proximity to powerful radars. Current exposure standards preclude human presence in this areas.

■ *RF field between 1 MHz and 10 GHz* penetrate exposed tissues and produce *heating* due to *energy absorption* in these tissues. The depth of penetration of the RF field into the tissue depends on the frequency of the field and is greater for lower frequencies.

* *Energy absorption* from RF fields in tis sues is measured as a *specific absorpiton rate (SAR)* within a given tissue mass. The unit of *SAR* is *watts per kilogram (W/kg)*. *SAR* is the basic dosimetric quantity for RF fields *between about 1 MHz and 10 GHz.*

* An *SAR* of at least *4 W/kg* is needed to produce adverse effects in people exposed to RF fields in this frequency range. Such energies are found tens of meters away from powerful FM antennas at the top of high towers, which makes these areas inaccessible.

* *Most adverse health effects* that could occur from exposure to RF fields *between 1 MHz and 10 GHz are consistent with responses to induced heating, resulting in rises in tissue or body temperatures higher than 1 ° C.*

* *Induced heating* in body tissues may

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provoke various *physiological* and *thermoregulatory responses,* including a decreased ability to perform mental or physical tasks as body temperature increases. Similar effects have been reported in people subject to heat stress: for example, those working in hot environments or suffering a prolonged fever.

*Induced heating may affect *the development of a fetus. Birth defects* would occur only if the temperature of the fetus is raised by 2-3° C for hours. Induced heating can also affect male fertility and lead to the induction of eye opacities (cataracts).

* *It is important to emphasize that most RF studies conducted at frequencies exceeding 1 MHz, examined the results of acute exposure to high levels of RF fields - an exposure that is not normally found in everyday life.*

■ *RF field below 1 MHz* do not produce significant heating. Rather, they induce *electric currents and fields* in tissues, which are measured as a current density in amperes per square metre (A/m^2). Current density is the basic dosimetric quantity for RF fields with frequencies below about 1 MHz.

* The many chemical reactions involved in staying alive have associated normal "background" currents of about 10 mA/m^2.

* Induced current densities that exceed at least 100 mA/m^2 can interfere with normal functioning of the body and cause in voluntary muscle contractions.

■ Other effects on the body from exposure to low-intensity RF fields, present in the living environment, have been report ed. But, either they have not been confirmed by other laboratory studies, or their health implications are unknown. However, these studies have raised important health concerns about an increased risk of cancer.. It is for this reason that they are being monitored and evaluated under the International EMF Project.

■ Exposure to RF fields and cancer: Current scientific evidence indicates that exposure to RF fields is unlikely to induce or promote cancers.

* Cancer studies using animals have not provided convincing evidence for an effect on tumor incidence. A recent study found that RF fields, similar to those used in mobile telecommunications, increased the incidence of cancer among genetically engineered mice that were exposed near (0.65 m) an RF transmitting antenna. Further studies will be carried out to determine the relevance of these results to cancer in human beings.

* Many epidemiological *{human health)* studies have addressed possible links between exposure to RF fields and excess risk of cancer. To date these studies do not provide enough information to allow a proper evaluation of human cancer risk from RF exposure because the results of these studies are inconsistent. This can be explained by differences in the design, execution and interpretation of these studies, including the identification of populations with substantial RF exposure and retrospective assessment of such exposure. The" International EMF Project is encouraging coordinated research in this area.

■ *Exposure to low-levels of RF fields,* too low to produce heating, has been reported to alter the electrical activity of the brain in cats and rabbits by changing calcium ion mobility. This effect has also been reported in isolated tissues and cells. Other studies have suggested that RF fields change the proliferation rate of cells, alter enzyme activity or affect the genes in the DNA of cells. However, these effects are not well established, nor are their implications for human health sufficiently well understood to provide a basis for restricting human exposure.

■ *Electromagnetic interference and other effects:* Mobile telephones, as well as many other electronic devices in common use, can cause electromagnetic interference in other electrical equipment. Therefore, caution should be exercised when using mobile telephones around sensitive electromedical equipment used in hospital intensive care units. Mobile telephones can, in rare instances, also cause interference in certain other medical devices, such as cardiac pacemakers and hearing aids. Individuals using such devices should contact their doctor to determine the susceptibility of their products to these effects.

■ RF field from *natural sources* have very low power densities. RF intensity from *the sun*—the primary natural source—is *less than 0.01 mW/tn²*. *Human-made sources,* which emit the majority of RF fields found in the immediate environment, can be divided into those found in *the community, home, and workplace:*

* *Community:* Most RF fields found in the environment are due to commercial *radio* and TV broadcasting, and from *telecommunications facilities.* RF exposure from telecommunications facilities is generally less than from radio or TV broadcasting. A study conducted in the United States found that, *in large cities, the average background* RF levels were *about 50 p,W/m²*. About 1% of people living in large cities are exposed to RF fields *exceeding 10 mW/m²*. Higher RF field levels can occur in areas located close to transmitter sites or radar systems.

* *Home:* RF sources in the home include microwave ovens, mobile telephones, burglar alarms, video display units and TV sets. Microwave ovens that could potentially be the source of very high RF levels, are covered by product performance standards which limit the amount of microwave leakage. Overall, the RF field background from household appliances is low, and of the order of *a few tens of ji\N/m²*.

* *Workplace:* There are a number of industrial processes which use RF fields: dielectric heaters used for wood lamination and the sealing of plastics; industrial induction heaters and microwave ovens; medical diathermy equipment to treat pain and inflammation of body tissues; and electrosurgical devices for cutting and welding tissues. There is the potential for excessive exposure to personnel operating these systems, especially in industries involved in RF heating or sealing, or from the operation of medical diathermy units. RF fields near equipment in the workplace can exceed *tens of W/m²*. All these levels of exposure are regulated nationally and internationally

* Relatively high levels of exposure to RF fields can occur to workers in the *broadcasting, transport* and *communications industries* when they work *in close proximity* to RF transmitting antennas and radar systems. An important subset of these workers are *military personnel.* Stringent regulations controlling the civil and military Use of RF fields exist in most countries.

■ *Safety Standards:* To ensure that devices emitting RF are safe and their use does not interfere with other devices, international standards are adopted. Exposure limits for RF fields have been developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP)—a nongovernmental organization formally recognized by WHO. ICNIRP guidelines were developed following reviews of all the peer-reviewed scientific literature, including thermal and non-thermal effects. The RF field limits are well above the levels found in the living environment. The standards are based on evaluations of biological effects that have been established to have health consequences. The objective of the International EMF Project is to determine if the biological effects reported from exposure to RF fields at low levels have any adverse health consequences. If such consequences were found, this may result in a reevaluation of the limits of human exposure.

- *Exposure of RF fields* may cause *heating* or induce *electrical currents* in body tissues. Heating is the primary interaction of RF fields at high frequencies, above about 1 MHz. Below about 1 MHz, the induction of electrical currents in the body is the dominant action of RF exposure.
- A scientific review by WHO, held under the International EMF Project (Munich, November, 1996), concluded that, *from the current scientific literature, there is no convincing evidence that exposure to RF shortens the life span of humans, induces or pro motes cancer.*
- However, the same review also stressed that *further studies are needed to draw a more complete picture of health risks, especially about possible cancer risk from exposure to low-levels of RF exposure.*