FAO/IAEA/WHO INTERNATIONAL CONFERENCE ON ENSURING THE SAFETY AND QUALITY OF FOOD TROUGH RADIATION PROCESSING

Antalya, Turkey

(19-22 October 1999)

Summary of the Conference and its Conclusions

OBJECTIVES

The specific goals of the Conference were -:

- to assess the past achievements in the practical application of food irradiation processing;
- to identify key issues in further development of food irradiation to ensure food safety, quality and security; facilitate international trade in agricultural commodities; and,
- to develop an agenda for its wider application in the next century.

The Conference was attended by 144 designated participants from 46 Member States including 16 observers from 5 inter-governmental organizations.

The Conference included discussions on the contribution of the technology in ensuring microbial safety of food; enhancing food quality, security and international trade; marketing and consumer acceptance; economics; and regulatory aspects.

BACKGROUND

As the world enters the new Millennium, the provision of safe and nutritionally adequate diets for the world's population will increasingly become a major challenge for governments and the food industry. Many countries at different stages of development are experiencing rapid changes in their health and social environments, where governments are faced with decreasing public sector spending. The strain on limited resources will be further compounded by demographic changes, such as expanding urbanization, the increased dependence on stored and processed foods, and insufficient access to safe water and essential facilities for safe food preparation.

The intensification of food production and the consolidation of the food industries present opportunities for foodborne pathogens to infect large numbers of consumers. In recent years, a number of extremely serious outbreaks of foodborne diseases have occurred on virtually every continent, demonstrating both the public health and social significance of foodborne diseases. In spite of great efforts at the national and international levels, progress in combating foodborne diseases has largely been offset by other global trends, including growing consumer demand for foods of animal origin, longer food distribution networks and many basic changes in the way food is produced, transported, processed, prepared and consumed, Globalization of food trade presents a transnational challenge to food safety

control agencies to ensure that imported food is safe consistent with consumer and, in some cases, the environmental protection, but are not unduly restrictive of trade.

To meet these challenges, governments, industry and consumers must join together to assure safe and nutritionally adequate food supplies for present and future generations. This includes the use of all safe and appropriate technologies for improving and extending the availability of food. Seen from this perspective, radiation processing will have an important role to play in ensuring the safety and quality of food in the new Millennium.

The 20th Century has witnessed several advances in the technology of food preservation and processing. These include controlled and modified atmospheres (usually in conjunction with refrigeration), high pressure, high electric field pulse, pulsed light, ohmic heating , oscillating magnetic fields, microwave and extrusion cooking. Some of these technologies are now routinely applied commercially while some others are still in the developmental stages. However, no single technology has such diverse applications as radiation processing. Research and development work in the last five decades have demonstrated that radiation processing can contribute to food safety, food security and trade. Proven practical applications include -:

- destruction of pathogenic bacteria and parasites of public health significance in raw and minimally processed foods;
- microbial decontamination of spices and dried vegetable seasonings;
- insect disinfestation of grains and other stored products;
- inhibition of sprouting in bulb, tuber and root crops;
- shelf-life extension of fruits and vegetables by delaying maturation, ripening and microbial spoilage;
- control of insect pests in fresh fruits and vegetables for quarantine purposes;
- enhancement of the refrigerated shelf-life of meat, poultry, seafood and fresh fruit and vegetables by reduction of spoilage causing microorganisms.

The Conference took place at a time when there is increasing acceptance and application of irradiation as a sanitary and phytosanitary treatment as influenced by-:

- Regulations on food irradiation in several countries and regions either have been or are being harmonized based on the Codex General Standard for Irradiated Foods and relevant recommendations of the International Consultative Group on Food Irradiation (ICGFI);
- The Sanitary and Phytosanitary Agreement of the World Trade Organisation requires that any measures to protect human, animal and plant health must be based on the standards and recommendations of the recognised international authorities. Such authorities include the Codex Alimentarius Commission;
- Irradiation as a method to ensure the hygienic quality of food, especially those of animal origin, as a quarantine treatment of fresh horticultural commodities, and as a substitute for fumigants has been given fresh impetus, especially in the U.S.A., through the regulatory environment, the positive attitude of several major industry and trade organisations and commercial initiatives;
- In 1997 an FAO/IAEA/WHO Study Group on High Dose Irradiation concluded that foods treated with doses greater than 10 kGy can be considered safe and nutritionally adequate

when produced under Good Manufacturing Practice. The Codex Alimentarius Commission has already initiated steps to amend the Codex General Standard for Irradiated Foods accordingly;

- Specialised or multi-purpose irradiation facilities are available for treating food in increasing numbers and many more are under construction or are being planned;
- Consumers are receiving accurate information regarding the benefits of food irradiation and as a result are more positive towards its acceptance.

IRRADIATION AND SAFE FOOD

a) Safety of the Process

The Conference agreed that the safety and nutritional adequacy of irradiated foods produced under conditions of Good Manufacturing Practice is no longer in question. The findings of the 1980 JECFI on the safety of any food irradiated up to an overall average dose of 10 kGy were reinforced by an Expert Group convened by the WHO and which reported in 1994. More recently, an FAO/IAEA/WHO Study Group met in 1997 to examine the results of safety studies carried out on foods irradiated with doses higher than 10 kGy. Their 1999 report stated that food irradiated to any dose appropriate to achieve the technological objective is both safe and nutritionally adequate. The Conference endorsed the conclusion of the Study Group that no upper dose limit need be imposed from a food safety standpoint. Similar to other physical food processes, the technical requirements to provide a product that meets technical objectives and has sensory properties acceptable to consumers can determine the upper dose applied to a food.

b) Role of Irradiation as a Sanitary Treatment

The Conference stressed that irradiation is an effective control measure for eliminating pathogenic bacteria and parasites from solid food, especially those eaten raw or minimally processed, of both plant and animal origin without substantial increases in temperature and without causing any significant physical or chemical changes. The need for applying irradiation as a cold pasteurization/decontamination treatment, as an essential step in the Hazard Analysis Critical Control Point (HACCP) based approach, becomes necessary in ensuring their safety. The role of irradiation in combination with other processes and packaging technologies to ensure the hygienic quality of ready-to-eat food, composite food and prepared meals as well as improving shelf-stability of many food products is also likely to increase in the near future.

The widespread and increasing incidence of foodborne illness caused by pathogenic bacteria and parasites and the consequent social and economic impact on the human population have brought food safety to the forefront of public health concerns. Hundreds of millions of people worldwide are affected by diseases caused by contaminated food and the toll in terms of human life and suffering is enormous, particularly among infants and young children, the elderly and other vulnerable groups. At present, food borne disease and the use of irradiation to assist in its control is a focus mainly in developed countries. However, as developing countries become more industrialised, the importance of food borne disease and irradiation will increase further.

Reliable statistics on foodborne diseases are available from very few countries and there is severe under-reporting especially in most developing countries. According to WHO the growing incidence of foodborne diseases already affects between 5-10% of the population each year in industrialized countries. Epidemics of emerging foodborne pathogens such as *Escherichia coli* O157 and *Campylobacter jejuni* in Australia, Japan, Europe and the United states of America, have claimed thousands of victims and caused many deaths. The Conference heard about an improved, active surveillance system (FoodNet) for food borne disease in the USA. Estimates for foodborne illnesses in that country have been revised to about 76 million cases in 1998 amounting to some 30% of the population with about 5,000 deaths.

Outbreaks of foodborne diseases in many industrialized countries are frequently attributed to raw or minimally processed foodstuffs. The young, elderly and immune-suppressed are particularly at risk. Raw foodstuffs including poultry, meat and meat products, seafoods, fruits and vegetables are frequently contaminated with one or several types of food borne bacterial pathogens such as *Salmonella*, *Campylobacter*, *Yersinia*, *Listeria*, *Shigella*, *Vibrio*, *E.coli* O157, and parasites such as protozoa, nematodes and trematodes. These contaminations can result in severe, chronic or fatal health consequences apart from the reduced economic productivity. Government sources in the United States of America estimate the cost of human illness of seven foodborne pathogens to be between US$5.6 to 9.4 billion. The pathogens also pose a liability risk to food companies as shown by massive recalls of some 10,000 tonnes of ground beef in the U.S.A in 1997 because of contamination with *E.coli* O157:H7 and some 7,000 tonnes of ready-to-eat meat contaminated with *Listeria monocytogenes* in late 1998 and early 1999. These recalls have resulted in severe economic losses (estimated to be US$1-3 billions) from destroyed products, liability as well as decreased consumer confidence. Other serious outbreaks of *E.coli* O157:H7 in meats and other minimally processed foods have also occurred in Australia, Japan and Scotland.

c) Role of Irradiation as a Phytosanitary (Quarantine) Treatment of Fresh Fruits and Vegetables

The effectiveness of irradiation as a broad spectrum quarantine treatment of fresh fruits and vegetables is gaining acceptance and application following the endorsement in 1992 by regional plant protection organizations which operate under the framework of the International Plant Protection Convention (IPPC). These organizations include the North American Plant Protection Organization (NAPPO), European Plant Protection Organization (EPPO), Asia and the Pacific Plant Protection Commission (APPPC), Comite de Sanidad Vegetal del Cono Sur (COSAVE), Organism International Regional de Sanidad Agropecuria (OIRSA) etc.

The International Consultative Group on Food Irradiation (ICGFI) has recommended specific treatment schedules for fruit flies of the tephritidae family and other arthropod pests since 1991. The USDA/APHIS issued a policy in 1996 to set a framework for the use of irradiation as a phytosanitary treatment to control 10 species of fruit flies in fresh fruits and vegetables. A large number of countries in Asia and the Pacific agreed in 1999 to implement a harmonized protocol for this purpose. Small scale commercial application of irradiation of tropical fruits to control fruit flies from Hawaii has been successfully implemented in the USA since 1995. A recently concluded international Co-ordinated Research Programme on Use of Irradiation as a Quarantine Treatment of Mites, Nematodes and Insects other than Fruit Flies

under the sponsorship of the International Atomic Energy Agency and the Food and Agricultural Organization has shown the potential of irradiation as a phytosanitary treatment for fruits, vegetables, cut flowers and ornamental foliage plants.

The importance of irradiation as an environmentally-friendly phytosanitary treatment is gathering momentum as part of a world-wide trend to reduce chemical treatments of foodstuffs. Ethylene dibromide (EDB) was banned as a fumigant for phytosanitary applications and to control insects in stored food and agricultural commodities in the USA in 1984. Several other countries (e.g., Japan, Germany and other EU countries) also banned EDB. The major fumigant for post-harvest disinfestation is now methyl bromide (MB). The global phase-out of MB in advanced countries by 2005 and in developing countries by 2015 under the Montreal Protocol because of its ozone depleting property, has prompted increasing interest in the use of irradiation as an alternative to MB for insect control in food and agricultural commodities in recent years. The use of MB for quarantine and pre-shipment purposes is exempted from the Montreal Protocol, however.

d) Enhancing Food Security Through Irradiation

Estimates of the amount of post-harvest storage losses of food vary widely, but are known to be unacceptably high (perhaps as high as 30-50%, especially in fruits and vegetables in some developing countries). Insect infestation is the major cause of post-harvest loss in grains, the staple food of most countries. Satisfactory long-term storage of staple crops may be at risk as the traditional fumigant methyl bromide is being phased out and because of the increasing resistance developed by a number of stored product pests to phosphine, the only other major post harvest fumigant used worldwide. Irradiation can contribute significantly to alleviate the post-production losses in staple grain crops caused by insect pests and has several advantages over the traditional post-harvest fumigants as it is a sustainable and environment friendly technology. Irradiation can also reduce post-harvest losses in tuber and bulb crops by inhibiting sprouting in storage under environmental conditions where chemical sprout inhibitors are not effective.

e) Irradiation and International Food Trade

Irradiation of food has considerable potential to increase international trade in agricultural commodities. This presents an opportunity particularly for developing countries as they seek to improve their economies through trade with markets in developed countries. The ability of irradiation to reduce food borne pathogens, to meet quarantine requirements and to extend shelf (or transport) life can all assist in increasing trade.

For example, health authorities in many countries have imposed stricter hygienic standards in food trade. Such standards may require zero tolerance of pathogens such as *Salmonella* and *Vibrio cholera* in imported food products such as seafoods. US authorities have already introduced zero tolerance for *Listeria monocytogenes* in ready to eat food in trade and reclassified *E.coli* O157:H7 as an adulterant of raw ground beef and other non-intact meat. Following the ban on ethylene oxide in the EU and Japan, irradiation has provided an effective alternate decontamination process for spices and dried seasonings. In 1998 some 70,000 tons of these products were irradiated worldwide and this is expected to increase in volume in the coming years. In addition, irradiation provides the most versatile treatment for fresh horticultural commodities to overcome quarantine barriers.

REGULATORY ISSUES

The Conference agreed that national regulations -:

- had no need to regulate for maximum dose limits from a toxicological and nutritional perspective provided that Good Manufacturing and Irradiation Practices are maintained;
- should concentrate not on dose limits per se but on the production of microbiologically safe products that meet the stated technical purpose; this may require the imposition of specific conditions of dose or storage in certain situations, for example for phytosanitary uses or where there could be a risk of botulism;
- should provide appropriate flexibility for processors;
- should be in conformity with Codex and take into account the implications of the WTO Agreements.

The Codex General Standard on Food Irradiation recognizes that irradiation is a food process and should be regulated in the same way as other physical processes of foods. However, most countries still regulate on the basis of a case-by-case assessment and as if the treatment is a chemical additive. This is a major cause of variability (non-harmonisation) between national regulations and is a potential barrier to trade.

The Conference was informed of considerable progress towards harmonised regulations in a number of countries and regions, particularly ASEAN. These harmonised regulations are based on the ICGFI Guidelines for the Authorisation of Food Irradiation Generally or by Classes of Food that is itself based on the Codex General Standard. The Harmonised Regulation for Asia and the Pacific is noteworthy for providing only Advisory Technological Dose Limits, not mandatory limits. The Conference also noted that under the WTO Agreements, especially the Sanitary and Phytosanitary (SPS) Agreement, governments which have import regulations stricter than recognized international standards, guidelines and recommendations, may be requested to furnish justifications based on scientific grounds to the WTO. The recognised international standards etc. are those of the Codex Alimentarius Commission, the International Plant Protection Convention and the International Office of Epizootics. Thus, non-tariff barriers to foods by importing countries solely because of an irradiation treatment are no longer justified and may be subject to challenge under the WTO procedures.

FACILITIES AND ECONOMICS

Current trends indicate that both isotopic and machine sources will be used to process food products. There is a wide variety of irradiator designs with varying throughput capacities and capital and operating costs. New developments include -:

- the design of the horizontal Cobalt-60 source concept for efficient processing of meat and poultry products;
- electron accelerators producing energies up to 10 MeV with beam up to 200 kW for treatment of thin products with high throughput rates;

- the availability of high-power electron beam machines permitting the production of X-rays at dose rates and with throughput comparable to radionuclide sources; and,
- low energy electron irradiation for surface treatment of foods for microbial decontamination of grains and seeds; a prototype irradiator is under construction in Japan.

The economics of isotopic and machine sources have been shown to be comparable for specific processing requirements. New commercial scale facilities available for treatment of foods are under construction or about to be commissioned in Brazil, India, Thailand and U.S.A. An electron beam facility for commercial scale food irradiation, being constructed in Sioux City, Iowa, USA, will be able to pasteurize up to 100,000 tonnes of chicken, ground beef or other products per year. The Conference heard that the leading US producer of chicken had entered into an agreement to utilise the EB facility and that another major food consortium were ready to irradiate other meats and meat products. In addition, sales of irradiated chicken treated by a cobalt-60 facility are increasing to both the retail and food service industries due to a successful local educational campaign and collaboration with the State Department of Health in Florida. A nationwide chain has committed to marketing irradiated beef as soon as regulations permit its sale. The availability of irradiation facilities and radiation sources to meet the increasing demand of the food industry on a global scale in the foreseeable future was assured by the suppliers.

CONSUMER ACCEPTANCE AND INDUSTRY INTEREST

Market experience in several countries show that consumers are willing to purchase irradiated food whenever it has been available once they understand the benefit. Numerous consumer acceptance studies and market tests worldwide indicate that majority of the consumers are ignorant about irradiated foods and acceptance increases when consumers are provided with information about the safety and benefit of the process. Consumer information and awareness have shown an upward trend in the recent times through the efforts made by National Governments, food and health professionals, ICGFI, and a responsible media.

Experience in the USA and several Asian countries has indicated that acceptance will increase with increased consumer education and with public endorsements by health professionals. A 1999 survey in USA revealed that a majority of supermarket shoppers are "very/somewhat likely" to purchase food products like strawberries, poultry, pork or beef if they had been irradiated to kill germs and keep it safe.

Despite this evidence, there is still reluctance within the food industry in many countries to adopt the technology. This is due to several reasons that include a perceived consumer resistance, or an unwillingness either to upset the status quo or to be the first to promote a technology that is often regarded as controversial. The recent initiative from the Coalition on Food Irradiation, represented by major food industry and trade associations, co-ordinated by the National Food Processors Association in the USA in petitioning to the Food and Drug Administration (FDA) for approval of irradiation for a variety of fresh, minimally processed and ready to eat foods of both plant and animal origin points to the changing industry interest in food irradiation processing. The Conference agreed that this change needs to be accelerated by the provision of more and better prepared information to leading industry executives.

As the commercial use increases, further research will be required to assist industry address specific issues for particular products such as the phytotoxic effects of radiation on fresh, cut vegetables and the suitability of packaging materials.

CONCLUSIONS

- The Conference agreed that the safety and nutritional adequacy of foods irradiated below and above 10 kGy and produced under Good Manufacturing Practice is now well established.

- Food irradiation is beginning to play an important role in contributing to improved food safety and security and to increased trade as a proven sanitary, phytosanitary and preservation method. This role will be even more important in the new Millennium in view of the increasing awareness of the risk of food-borne pathogens and global trade in food commodities.

- The rapid increase in the global population from 6 billion in 1999 to an expected 9 billion by 2040, a significant proportion of whom will be immuno-compromised, will require a new food safety and security strategy to meet the demand on the food supply of this population increase. As governments have the responsibility to ensure the safety and nutrition of food supplies to their population, it is of critical importance that they adhere to international agreements and standards to improve food availability, safety and trade based on the provisions of the SPS and TBT Agreements of the WTO especially relevant Codex Standards and recommendations of the IPPC.

- Major food importing countries (EU, Japan, USA) are keys to the economy of developing countries which need to export their food supplies to generate foreign exchange. Based on the Codex General Standard for Irradiated Foods and the endorsement of irradiation as a phytosanitary treatment of fresh horticultural commodities by regional plant protection organizations which operate within the framework of the IPPC, trade barriers against food treated by irradiation, still imposed by some major importing countries, are no longer justified and may be subjected to challenge. The Conference urged all governments, especially those from major importing countries, to ensure that their regulations are based on the principle of the Codex General Standard for Irradiated Foods and the relevant recommendations of the International Consultative Group on Food Irradiation, to overcome trade barriers and to encourage the acceptance of food irradiation alongside other food technologies at the earliest opportunity.

The Conference also considered a number of specific issues, and reached the following recommendations by consensus.

1. Food safety regulations should concentrate on production of microbiologically safe products that meet the stated technical purpose rather than on dose limits, and provide appropriate flexibility for processors to provide a quality product. Irradiation should be considered as an integral component of HACCP to ensure microbiological safety of solid foods, especially those eaten raw or minimally processed, equivalent to thermal

pasteurization of liquid foods, and to prevent cross contamination during food preparation;

2. Regulations should be in conformity with the Standards, Guidelines and Recommendations of the international authorities recognised by the SPS Agreement of the WTO, and in particular with the Codex General Standard for Irradiated Foods and the recommendations of the IPPC;

3. Irradiation is established as a versatile, environmentally-friendly treatment of foods for sanitary, phytosanitary and shelf-life extension purposes that can contribute to better food safety, phytosanitary and food security, to reduced use of chemical treatments and to increased trade;

4. Market trials indicate that in many countries a majority of consumers are willing to purchase irradiated products; there is, however, a significant barrier to adoption of the technology from the food industry that either perceives significant consumer resistance or has concerns about being seen as the leader in a technology often perceived as controversial;

5. Scientists and public health officials have a responsibility to ensure that factual information is continuously generated and presented to key government officials, media and consumer organisations etc., and to influential decision makers in the food trade;

6. As specific commercial applications are developed, there will be a need for further research to adapt the treatment to be efficient and effective; examples requiring further research may include the radiation tolerance of irradiation on fresh, cut vegetables and on packaging materials;

7. Wherever feasible, new market trials of irradiated foods should be carried out in regions where there is a well established database on existing foodborne disease in order to provide evidence for the effect of irradiation on disease incidence.