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Food Irradiation Newsletter

JOINT FAO/IAEA DIVISION OF NUCLEAR TECHNIQUES IN FOOD AND AGRICULTURE
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA

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CONTENTS

TO THE READER

1. The Gulf War resulted in some delay in implementation of a number of activities of the Section including those by the International Consultative Group on Food Irradiation (ICGFI). This issue reports some activities of ICGFI with regard to the issuing the Fact Sheets, finalization of Codes of Good Irradiation Practice for specific applications and Guidelines for regulatory control of food irradiation facilities.

2. Summaries of three co-ordinated research meetings held this year, i.e. (i) Irradiation in combination with other processes for improving food quality, (ii) Application of irradiation technique for food processing in Africa and (iii) Food irradiation programme for Middle East and European countries are reported in this issue.

3. The first Workshop on Public Information on Food Irradiation was successfully organized under the scope of the UNDP funded Regional Co-operative Project on Food Irradiation - Process Control and Acceptance, in Bangkok, 27-31 May 1991. The reader will find it interesting to read the summary report of the Workshop and to learn the view of journalists and representatives of consumer organizations in Asian countries.

4. A new Co-ordinated Research Programme (CRP) on Irradiation as a Quarantine Treatment of Mites, Nematodes and Insects othr than Fruit Fly, has recently been approved by the IAEA. Scientists and institutes which would like to collaborate with us under the scope of this CRP are cordially invited to submit applications to the Food Preservation Section at the earliest opportunity.

5. The reader will be interested in reading developments on commercial application of food irradiation in China, especially on market testings of irradiated food. This issue reports the testings of irradiated apples in Shanghai and irradiated seasonings in Chengdu. It also mentions the number of irradiation centers in China which have large demonstration/commercial irradiators equipped with a minimum of 100 kCi of Co-60.

6. As previously done, an up-dated list of clearance of irradiated food in different countries is published as Supplement to this issue.

7. The distribution list of our Food Irradiation Newsletter has significantly grown in the past 3 years to some 1400 readers. For economic reasons, we would like to limit further expansion and review present situation to maintain effectivity of the Newsletter. THE READERS ARE REQUESTED TO FILL-IN AND RETURN THE QUESTIONNAIRE (attached to the last page) BEFORE 31 DECEMBER 1991 IF THEY WISH TO CONTINUE RECEIVING THE NEWSLETTER. The names of the readers who do not return the questionnaire will be automatically removed from the distribution list.

8. Please send your contribution to be included in the next issue of our Newsletter before 31 January 1992.

FOOD PRESERVATION SECTION

Staff Members

P. Loaharanu (Thailand)
L. Ladomery (Australia)
M. Ahmed (Bangladesh)
A. Brynjolfsson (U.S.A.)
G.G. Giddings (U.S.A.)
Socorro Espiritu (Philippines)
Guerra-Garouno M. Eugenia (Mexico)
B. Puthenpurakal (India)

INTERNATIONAL CONSULTATIVE GROUP ON FOOD IRRADIATION (ICGFI)

1. Fact Sheets

At the 7th Annual Meeting, ICGFI approved the publication of a series of "Fact Sheets" to help address concerns and correct myths about food irradiation with the assistance of Ms. P. Wills, retired senior official of Australian Nuclear Science and Technology Organization (ANSTO), and a number of experts and officials, the following colourful "Fact Sheets" were issued by the ICGFI Secretariat in May 1991:

1. Status and Trends
2. Scientific and Technical Terms
3. Food Irradiation and Radioactivity
4. Chemical Changes in Irradiated Foods
5. Nutritional Quality and Irradiated Foods
6. Genetic Studies
7. Microbiological Safety of Irradiated Food
8. Irradiation and Food Safety
9. Irradiation and Food Additives and Residues
10. Packaging of Irradiated Foods
11. Safety of Irradiation Facilities
12. Controlling the Process
13. Food Irradiation Costs
14. Irradiated Foods and the Consumer

Limited number of copies of these Fact Sheets may be obtained upon request from:

The ICGFI Secretariat
Joint FAO/IAEA Division of Nuclear Techniques
in Food and Agriculture
International Atomic Energy Agency
Wagramerstrasse 5, P.O. Box 100
A-1400, Vienna, Austria
Tel: 2360-1638
Fax: 234564
Tlx: 1-12645

2. Codes of Good Irradiation Practice (for specific applications of food irradiation).

With the initial assistance of Dr. W.M. Urbain, Professor Emeritus, Food Science and Technology, Michigan State University, East Lansing, Michigan, and after elaboration under ICGFI procedures including comments made by experts in

the field and member governments of ICGFI, the following Codes of Good Irradiation Practice have been finalized this year:

- Code of Good Irradiation Practice for Insect Disinfestation of Cereal Grains (ICGFI Document No. 3).

- Code of Good Irradiation Practice for Prepackaged Meat and Poultry (to control pathogens and/or extend shelf-life) (ICGFI Document No. 4).

- Code of Good Irradiation Practice for the Control of Pathogens and Other Microflora in Spices, Herbs and Other Vegetable Seasonings (ICGFI Document No. 5).

- Code of Good Irradiation Practice for Shelf-life Extension of Bananas, Mangoes and Papayas (ICGFI Document No. 6).

- Code of Good Irradiation Practice for Insect Disinfestation of Fresh Fruits (as a quarantine treatment) (ICGFI Document No. 7).

- Code of Good Irradiation Practice for Sprout Inhibition of Bulb and Tuber Crops (ICGFI Document No. 8).

- Code of Good Irradiation Practice for Insect Disinfestation of Dried Fish and Salted and Dried Fish (ICGFI Document No. 9).

- Code of Good Irradiation Practice for the Control of Microflora in Fish, Frog Legs and Shrimps (ICGFI Document No. 10).

These Codes are intended for those engaged in the commercial application of radiation technology to food. They may also be useful for governmental authorities in considering the authorization of the application of food irradiation or the import of irradiated food. The Codes are complementary to the Codex General Standard for Irradiated Foods as they describe "good irradiation practice" on specific applications of food irradiation.

The Codes are being printed and will be available upon request after 8th Annual Meeting of ICGFI, Vienna, 4-6 November 1991.

3. Guidelines for Preparing Regulations for the Control of Food Irradiation Facilities.

At the 7th Annual Meeting, ICGFI adopted the Guidelines initially prepared by Mr. W.R. Bradford, retired senior official, Ministry of Agriculture, Fisheries and Food, U.K., and assisted by Messrs. R.E. Engel (USA), P. Roberts (New Zealand) and M. Camcigil (IAEA). The Guidelines are intended to assist governments in introducing regulations or some other form of legal control of irradiation facilities authorized for radiation processing of food. The Guidelines reflect the various provisions of the Codex General Standard for Irradiated Foods and its associated Code of Practice as well as the recommendation of the International Conference on the Acceptance, Control of and Trade in Irradiated Food (Geneva, 1988) concerning irradiation facilities and radiation processing of food.

The Guidelines are being published by ICGFI and should be available upon request after the 8th Annual Meeting of ICGFI.

RESEARCH CO-ORDINATION MEETING

A. First FAO/IAEA Research Co-ordination Meeting (RCM) on Irradiation in Combination with Other Processes for Improving Food Quality, Strasbourg, France, 8 - 12 April 1991

INTRODUCTION

In recent years, minimally processed, chilled foods, have been marketed in several advanced countries to satisfy the demand for convenient and fresh-like food products. Such food could introduce new microbiological risks in view of emerging problems related to certain pathogenic micro-organisms which can grow at chilled temperature, e.g. Listeria monocytogenes, Yersinia spp. Combination treatments involving irradiation can ensure the safety of such products while retaining the quality demanded by the consumer.

Developing countries require wholesome foods with a prolonged shelf-life. Irradiation in combination with other preservation techniques can supply such products, thus reducing food losses and promoting distribution.

It is recognized that the need for using combination processing for treating food concerns the synergism of the combined treatment without compromising safety and quality factors. The role of irradiation in such a combined treatment is significant in refrigerated, raw and semi-processed food as well as shelf-stable food, in terms of microbiological safety and quality of the product.

The technology has been established for processing non-food items in both advanced and developing countries during the past 4 decades. The same technology is beginning to play a role in the processing/preserving of various food items in recent years.

In 1987, FAO/IAEA convened an expert consultation to evaluate the possible role of irradiation in combination with other food processes to achieve some or all of these demands. The consultation recognized that combination processes involving irradiation coupled with other treatments may result in high quality, convenient foods that are close to fresh foods or foods prepared from fresh items. In some instances, irradiation of foods in appropriate packaging, under frozen or refrigerated conditions, could result in sterilized or pasteurized products which could be marketed either at ambient or at refrigeration temperature. Such combination processes would be of benefit to developing countries, where facilities for frozen storage and distribution of foods are not widely available, and where large distances separate production areas from centres of population. The energy consumption required for storage and distribution of foods could be reduced significantly if a greater number of raw and semi-processed foods could be subject to combination process involving irradiation. Following these recommendations the Joint FAO/IAEA initiated the Coordinated Research Programme (CRP) on Irradiation in Combination with Other Processes for Improving Food Quality in 1990.

OBJECTIVES

The aim of this CRP is to assist institutions in developing countries and to co-ordinate activities in advanced countries to investigate possible benefits from using irradiation in combination with other food processes. Such benefits could be improvements in microbiological safety and organoleptic quality, increased shelf-life, ease of storage and distribution, nutrition,

convenience in use and energy savings. Other paramenters involved in combination treatment of irradiation include, among others, heat, water activity (including drying, salting and syruping), pH, optimal use of additives, modified atmosphere, packaging.

Major area of investigation envisaged under this CRP are:

(a) microbiological safety of chilled raw, prepared meals, processed and semi-processed food;

(b) quality and shelf-life of chilled instead of frozen food of animal origin and prepared meals, as well as developing shelf-stable products;

(c) quality and shelf-life of fruits and vegetables;

(d) quality and shelf-life of aseptic packs containing large pieces of food;

(e) reduction of severity of food processing/preservation parameters, e.g. salting, drying or smoking (Hurdle concept).

(f) energy saving and cost-effectiveness of the combined treatment.

(g) packaging requirements for combination treated products.

The first RCM on this programme was hosted by the Centre Régional d'Innovation et de Transfer de Technologie, AERIAL and held at Nouvel Hôtel Maison Rouge, Strasbourg, 8-12 April 1991. The RCM was co-sponsored by AERIAL and the city of Strasbourg. It was attended by 14 participants from Argentina, Canada, France, India, Poland, Chile, Hungary, Israel, Republic of South Africa, United Kingdom, Vietnam and Yugoslavia. Six observers also attended. The meeting was opened by Mr. G. Monsonego, a representative of the Ministry of Research and Technology in the Alsace Region. Ms. C. Couvercelle-Halbwachs, Director of AERIAL served as the Chairman of the RCM. She was assisted by Drs. J. Farkas, D. Kilcast and I. Klinger as discussion leaders of three working groups of the RCM. The list of participants and observers is attached as Annex.

The following Co-ordination Research Programme was agreed to be carried out.

I. Use of combination process to enhance food safety

General recommendations

1. Microbiological safety considerations must be seen as a priority for all proposed processes. For example, non-sterile irradiated food should have additional preservation to ensure safe storage at ambient temperatures. Further research is necessary to determine optimum conditions for such products.

2. Combined technologies should not be used as a substitute for good manufacturing practices (GMP) during food production, processing and storage. Even with the best available GMP, there can be a microbiological risk associated with the survival and growth of certain pathogenic micro-organisms such as Listeria monocytogenes. Irradiation in combination with other treatments can significantly improve the hygienic quality of such products.

3. Listeria monocytogenes has been recognized throughout the world as a potential problem in chilled foods, due to its relatively resistance to traditional treatments such as heat, drying and chemical agents and its ability to multiply under chilled storage condition. It is known that Listeria monocytogenes is relatively sensitive to irradiation. Thus it is recommended that combination treatments involving irradiation should be used to reduce listeria numbers in foods where other suitable decontamination methods are not available.

4. It is recommended that data be obtained on the time/temperature conditions to ensure the safety of irradiated chilled foods.

5. Combination processes involving irradiation can be used to supply safe, high quality products in countries which do not have chilling facilities or which have poor transportation. For example, irradiation can be used in combination with other preservation treatments (NaCl, nitrite, vacuum packaging and heat) to produce beef of good sensory quality which is stable for 6 months at ambient temperature.

6. To ensure better transfer of information between participants it is essential that details will be provided on:

   1. experimental design methodology,
   2. physicochemical parameters of the irradiated products including, pH, water activity, salt concentration, storage temperature and atmosphere and any other additives which are used.

II. Use of combination process on individual food commodities

General recommendations

1. There is a need to compare the efficacy of various combined processes by applying quantitative assessments of the safety and stability of combination treated products using, for example, the Hauschild method and multi-dimensional surfaces approach as suggested by the FAO/IAEA Consultants Meeting on Combination processes in 1987.

2. Further research work is needed on the mechanisms and modelling of combined effects, particularly non-additive ones, in order to enable development of process designs and methodologies.

III. Use of combination processes on composite foods/prepared meals

Overview

1. Combination processes involving the irradiation of food offer the prospect of high quality foods that are closer in perceived quality to fresh foods or foods prepared from fresh items. Such processes can be designed for the production of shelf-stable foods that would be of particular value in environments where the possibilities of temperature-controlled storage are limited and also for the production of minimal-processed short shelf-life foods with enhanced microbiological safety.

2. Combination processes with suitable packaging hold promise in providing microbial safety and better retention of overall quality of various individual food commodities such as specific fresh fruits, vegetables, fish, poultry, meat, rice and pasta products, where this goal cannot be achieved effectively by individual processes.

3. A wide range of processing technologies is available for use in combination with irradiation, including the following:

   3.1 Thermal processes, including newer processes such as microwaving.
   3.2 Modified atmosphere packaging, including vacuum packaging.
   3.3 Adjustment of water activity, such as drying and curing.
   3.4 Use of chemical preservatives, including smoking.
   3.5 Use of competing micro-organisms, such as Lactobacilli.
   3.6 Controlled storage conditions.
   3.7 Use of new developments in packaging technology.

4. In view of the continuing developments in processing technologies, it is important that any programme on combination treatments reviews regularly the potential value of such developments.

5. Individual food components of composite food/prepared meals respond differentially with regard to processing and to possible interactive effects. The purpose of using combination processing for such foods will be to:

   a. Obtain products with high consumer appeal.
   b. Achieve microbiological safety without compromising organoleptic quality.

Therefore, the research work for process design needs to examine the effects of process parameters on the microbiological and organoleptic quality of the foods, and also on relevant physicochemical parameters. The effect of the combination process on important nutrients may also require evaluation. The complexity of the composite system will necessitate examination of interactive effects.

Annex 1

LIST OF PARTICIPANTS

First Research Co-ordination Meeting on
"Irradiation in Combination with Other Processes
for Improving Food Quality"

Centre Régional d'Innovation et de Transfert de Technologie
Association d'Etudes et de Recherches pour l'Ionisation en Alsace (AERIAL)
Strasbourg, France
8 to 12 April 1991

Dr. Jorge A. Lasta
Instituto Nacional de
Tecnologia Agropecuaria
Rivadavia 1439
(1712) Buenos Aires
ARGENTINA
Tel : 621-1390
Tlx : 17518 INTA AR
Fax : 54 111 1917

Dr. Monique Lacroix
Institut Armand-Frappier -
Canadian Irradiation Centre
Res. Center in Sciences Applied to Food
535 Blvd. Cartier
Ville de Laval, P.Q., C.P. 320, succ. L-D-R
CANADA H7N 4Z9
Tel : 514-686-5485
Fax : 514-687-5792

Dr. Kazi Shamsuzzaman
Radiation Applications
Research Branch
AECL Research
Pinawa, Manitoba
ROE ILO
CANADA
Tel : (204) 753 2311 ext. 2516
Tlx : 07-57553
Fax : 209-753-8802

Dr . C. Couvercelle-Halbwachs
AERIAL CRN-CTT
23 rue du Loess
B.P. 20
F-67037 STRASBOURG Cedex
FRANCE
Tel : 33 88-27-27-77
Fax : 33 88-28-48-81

Dr. Pushpa Paul
Bhabha Atomic Research Centre
Food Techn. & Enzyme
Engineering Div.
Trombay
Bombay 400 085
INDIA
Tel : 5514910 extn. 2551
Fax : 91-022-5560-750

Dr. Wlodzimierz Fiszer
Lab. of Nuclear Methods in Agric
University of Agriculture
Wojska Polskiego St. 28
60-637 Poznan
POLAND
Tel : 48-61-467-71
Tlx : 041 3322 AR PL
Fax : 48-61-411022

Dr. David Kilcast
Manager Sensory Analysis
Technology Group
Leatherhead Food Research Association
Randalls Road, Leatherhead
Surrey KT22 7RY
UNITED KINGDOM
Tel : 372 376761
Tlx : 929 846
Fax : 372 386 228

Ms. Bui Thi Yen
Dalat Nuclear Research Institute
Radiobiology Department
Dalat
VIET NAM
Tel : 2191

Dr. Saturnino de Pablo
Instituto de Nutricion y Tecnologia de
Alimentos - INTA, Unit of Food Biochemistry
Universidad de Chile
Jose Pedro Alessandri 5540
Casilla 138-11, Santiago
CHILE
Tel : 2214030
Fax : 56 2 2214030

Dr. J. Farkas, Director
Inst. of Preservation and Livestock
Prod. Technology
Univ. of Horticulture and Food Ind.
Ménesi ut 43-45, H-1118 Budapest
HUNGARY
Tel : 36-1-1664635
Tlx : 22-60-11 UHORT
Fax : (36) 1-166-6220

Dr. Isaac Klinger D.V.M.
Head Laboratory of Food and Feed Hygiene
Kimron Veterinary Institute
P.O. Box 12, 50250 Bet-Dagan
ISRAEL
Tel : 972 3 9681648
Tlx : 381 472 VSAH IL
Fax : 972 3 9681753

Dr. Albert Ernest McGill
Faculty of Agricultural Sciences
University of Pretoria
Pretoria 0002
REPUBLIC OF SOUTH AFRICA
Tel : 27-12-420-3280
Tlx : 3-22723 SA
Fax : 27-12-342-2713

Dr. K. Niranjan
Dept. of Food Science and Technology
University of Reading, Whiteknights
P.O. Box 226
Reading RG6 2AP, Berkshire
UNITED KINGDOM
Tel : 734 318 700
Fax : 734 310080

Dr. Vlado Mihokovic
Institute of Public Health of
SR. Croatia/IPH
Rockefellerova 7, 41000 Zagreb
YUGOSLAVIA
Tel : 41 27 28 22
Fax : 41 27 21 66

O B S E R V E R S

Mr. Tomasz Magnuski
Lab. of Nuclear Methods in Agric.
University of Agriculture
Wojska Polskiego St. 28
30-637 Poznan
POLAND
Tel : 467-71
Tlx : 041 3322 AR PL
Fax : 48-61-411022

Prof. Mordecai Lapidot
Head of Radiation Technology Section
SOREQ NUCLEAR RESEARCH CENTER
Israël Atomic Energy Commission
Yavne 70600
ISRAEL
Tel : 972-8-434432
Tlx : 381455
Fax : 972-8-437364

Dr. Margaret Patterson
Department of Food and
Agricultural Microbiology
Agriculture and Food Science Centre
The Queen's University of Belfast
Newforge Lane
Belfast BT9 5PX, Northern Ireland
UNITED KINGDOM
Tel : (0232) 661166
Fax : (0232) 669551

Dr. D. Ehlermann
Federal Research Centre for Nutrition
Engesserstr. 20
D - 7500 Karlsruhe 1
GERMANY
Tel : 49(7247)823612
Teletex : (17) 724716
Fax : 49(07247)825070

Mrs. Amanda Minnaar
Faculty of Agricultural Sciences
University of Pretoria
Pretoria 0002
REPUBLIC OF SOUTH AFRICA
Tel : 27-12-420-3211
Tlx : 3-22723 SA
Fax : 27-12-342-2713

Dr. Marie-Hélène DESMONTS
AERIAL CRN-CTT
23 rue du Loess
B.P. 20
F-67037 STRASBOURG CEDEX
FRANCE
Tel : 88-27-27-77
Fax : 88-28-48-81

S E C R E T A R I A T

Mr. Paisan Loaharanu
(Scientific Secretary)

Head, Food Preservation Section
Joint FAO/AIEA Division
Wagramerstrasse 5
P.O. Box 100
A-1400 Vienna
AUSTRIA

B. Second FAO/IAEA Research Co-ordination Meeting (RCM) on the Application of irradiation Technique for Food Processing in Africa, Legon-Accra, Ghana, 8-12 April 1991.

INTRODUCTION

The use of ionizing radiation has demonstrated that post-harvest losses of food could be reduced in order to provide safe food supply, attain food security and enhance export potentials of food and agricultural products in Africa. The FAO/IAEA implemented this CRP in order to achieve the objectives of introducing food irradiation processing in Africa to reduce post-harvest food losses. In this Second RCM participants discussed on the activities conducted during last three years, formulated a plan of action and made some conclusions and recommendations.

STATUS OF ACTIVITIES

The results of disinfestation studies from Algeria showed that disinfestation of dates from insects Ectomyelosis ceratonae, Oryzaephilus, surinamensis, Carpophilus dimidiatus and C. hemipterus could be achieved at 0.7 kGy up to a period of six months with an infestation rate of 5.5% in contrast to 14.5% in fumigated products during the same period. Quality of the irradiated dates were comparable to fumigated dates. Disinfestation of cereals was achieved at 0.5 kGy in Algeria and Zaire. Low density polyethylene bag with 0.1 mm thickness largely prevented reinfestation of Sitophilus oryzae. Consumer testing in Nigeria showed irradiated maize was acceptable to the people. Cow peas were disinfested at a dose of 0.5 kGy and above and reinfestation was checked by polyethylene bags of 0.01 mm and 140u thickness in Zaire and Nigeria respectively. Results in Nigeria also showed that infestation of Callosobruchus maculatus was eliminated by combination of traditional packaging and irradiation. Consumer testing of peas either at 0.5 kGy or 1 kGy produced positive results. There was an agreement of the previously produced results in Zaire that dried fish irradiated at a dose of 0.5 kGy could be disinfested from Dermestes beetles and copra beetles. A report on radiation disinfestation of egg plant fruits showed that a dose of 0.5 kGy could control the egg plant fruit borer (Leucinodes orbonalis). Preliminary results on Kolanut weevil, Balanogastris kolae showed that eggs were very sensitive to irradiation (i.e. 5 Gy). A dose of 20 kGy prevented adult females to lay eggs.

Shelf-life extension studies on semi-dried and fresh fish was carried out in Egypt. A shelf-life extension of about 4 months was achieved at room temperature by irradiation of semi-dried fish at 7 kGy in combination with propionic acid and common salt. A dose of 3.5 kGy extended the shelf-life of fresh fish at refrigerated temperature upto 21 days. In Nigeria, extension of shelf-life of in-foil packaged smoked dried fish was achieved from 2 to 12 months with total elimination of fungi and beetles at 5 kGy.

A decrease in total bacterial count and total elimination of yeasts and moulds were achieved in spices in Algeria at a dose of 6 kGy.

At present Ghana, Côte d'Ivoire, Algeria, Zambia, Egypt, Libya and Nigeria are conducting studies on the inhibition of sprouting in yams, potatoes and onions. Côte d'Ivoire showed that a dose of 0.08 kGy could control sprouting of yams and extend shelf-life exceeding one year. Côte d'Ivoire also carried out consumer acceptability studies on irradiated yams and showed that irradiated yams were acceptable to consumers. Algeria and Zambia, using doses of 0.12 and 0.19 kGy respectively, extended the shelf-life of potatoes and onions for eight months by inhibition of sprouting. Ghana

achieved sprouting inhibition of onions at 0.03 kGy and extended shelf-life upto one year. Zambia had made arrangement to conduct large scale irradiation studies with potatoes and onions. Ghana will do so after the establishment of a new irradiation facility at the end of 1991.

DISCUSSION OF RESULTS

The group discussed on results reported by the contract/agreement holders. Due to limitation of suitable irradiation facilities several participants of this CRP could not conduct large scale irradiation studies. Therefore, pilot scale irradiation studies could only be conducted in Algeria, Egypt, Libya and Zambia where suitable facilities are available. The participants agreed that some transportation studies on irradiated foods could be initiated.

The group discussed on the undesired repetion of previously done studies on various commodities. It, however, felt that such repetitions might only be desirable in order to generate local data for use in complementing earlier works in persuading government clearances.

The group emphasized on further studies leading to the technology transfer on food irradiation in the region. These would include establishment of protocol for irradiation of different food commodities, field testing of laboratory results using available pilot-scale irradiation facilities and the transfer of pilot scale results to the industry and public. Results received on consumers studies from Nigeria and Côte d'Ivoire suggested a need for development of a standard protocol.

The group considered that immediate studies leading to technology transfer could be conducted in yams, potatoes and onions. Côte d'Ivoire, Algeria, Libya and Egypt could initiate activities in sensory evaluation, consumer acceptance and marketing trials leading to commercialization of roots, tubers and bulbs in Africa. Scientists from Africa should be encouraged to exchange data on research findings in irradiation of foods and agricultural products.

CONCLUSION:

1. During the review of the activities presented by the Chief Scientific Investigators, it appeared that some basic studies were undertaken by some of them. They justified that several such studies would be necessary considering the agro-climatic condition and the varieties of food products; and particularly when regional data were not available. The meeting concluded that under the above mentioned circumstances, some repetition of works could be necessary in order to generate regional data on specific food items.

2. Although techno-economic feasibility studies were conducted in a few countries of the region the meeting felt that in view of the availability of data on irradiation preservation of several food products, a fresh economic feasibility studies should be conducted in the regional countries where such data were not available. This would hasten practical application of food irradiation processing in Africa.

3. Several laboratories in the region have undertaken the packaging studies on some food items. A few had conducted studies on storage and transportation of irradiated foods. The meeting suggested that emphasis should be placed on further studies on packaging, transportation and storage of irradiated foods. Both inter and intra-country transportation studies should be organized.

4. The meeting felt a strong need for further strengthening of the food irradiation activities within the regional institutions/organizations. Encouragement should be given to the bilateral activities between the regional countries and outside.

5. There exists an information gap on food irradiation in several regional countries due to non-availability of published materials. The meeting had the opinion that FAO/IAEA and the International Consultative Group on Food Irradiation could furnish information on food irradiation to those countries which would need them. The FAO/IAEA could also make available the information from other sources.

6. The meeting discussed on the status of regulation/legislation on food irradiation in Africa. Although in a few countries food irradiation regulations were in their final stage of approval (i.e. Côte d'Ivoire and Ghana), none of the participating countries in this CRP had approved food irradiation regulations. Such approvals would be necessary in order to conduct studies relating to technology transfer of food irradiation in the region as several countries had completed R&D on some specific food items. Therefore meeting concluded that in absence of regulations practical application on food irradiation would not be materialized. The countries which have already embarked on food irradiation studies should consider approval of food irradiation.

7. The meeting was pleased to learn that African Regional Co-operative Agreement (AFRA) which had been strongly recommended by the First RCM of this CRP in 1989 has been approved by the Agency. AFRA-II which is the regional project on food irradiation has been approved for 1991. However, the meeting noted that only training component was included in AFRA-II. For technology transfer to African region there would be a further need for equipments, expert assignments and infrastructure buildings. Therefore the meeting had the opinion that AFRA should be extended beyond 1991 in order to allow other countries to join in the cooperative activities and reap the benefit of this emerging technology. This on-going CRP should be included under the AFRA-II.

8. Due to the unavailability of appropriate irradiation facilities in several countries in the region there is a hinderance in conducting further studies in food irradiation leading to its practical application. The meeting concluded that participating countries which would need such facilities should seek assistance of the Agency or other donor countries/organizations.

FUTURE PLAN OF ACTION

To accelerate the practical application of food irradiation processing in Africa, the participants suggested the following plan of action to be followed by the participating countries:

1. Development of suitable packaging material in order to check reinfestation of products (i.e., dates, dried fish, cereals, peas, kola nuts, etc.,).

2. Disinfestation studies of Kolanut weevils and egg plant fruit borers.

3. Comparison of shelf-life of products by traditional methods and irradiation under African condition.

4. Determination of processing, irradiation treatment, packaging and storage conditions for the hygienic improvement and elimination of mycotoxin forming fungi and chemical carcinogen from fish, meat and other products.

5. Storage, transportation and test marketing studies with irradiated products, onion and yams.

6. Quality evaluation of some foods such as kola nut and consumer acceptance studies on irradiated foods.

7. Economic feasibility studies to be carried out with locally available data.

8. Formulation of national regulations/legislations on food irradiation.

List of Participants

Prof. M. El-Din Zohear El-Fouly
National Centre for Radiation
Research and Technology
Microbiology Dept.
P.O. Box 29, Nasr City
Cairo
EGYPT

Dr. Gabriel Kouman Kouadio
Centre Ivoirien de Rech. Techn.
Faculte des Sciences et Techn.
08 BP 881, Abidjan 08
COTE D'IVOIRE

Dr. A. Akingbohungbe
Center for Energy Research
and Development
Dept. of Plant Science
Obafemi Awolowo University
Ile-Ife
NIGERIA

Dr. Tshisand Musasa
Commissariat General à l'Energie Atomique
C.R.E.N.-K.
B.P. 868
Kinshasa XI
ZAIRE

Dr. Bernard E. Chishya
Natl. Council for Scientific Res.
Food Technology Research Unit
P.O. Box 310158
Lusaka
ZAMBIA

Ms. Valérie Stahl
Association d'Etudes et de
Recherches pour l'Ionisation en Alsace
23 Rue du Loess
B.P. 20
67037 Strasbourg Cedex
FRANCE

Dr. David Alonge
Department of Veterinary Public
Health and Preventive Medicine
University of Ibadan
Ibadan
NIGERIA

Ms. Bensaada Rafika
Centre de Developpement des
Techniques Nucleaires
Haut Commissariat a la Recherche
2 Blvd Frantz Fanon
B.P. 1017
Algiers
ALGERIA

Dr. Victoria Appiah
Head
Dept. of Biology, Food & Agriculture
Ghana Atomic Energy Commission
P.O. Box 80
Legon-Accra
GHANA

Observers

Mr. Frank Kofi Nagetey
P.O. Box M245
Ghana Standards Board
Accra
Ghana

Dr. S. Sefa Dedeh
Food & Nutrition
University of Ghana
Legon
Ghana

Dr. Jimmy Edwards
Ghana Food Distribution Corporation
Accra
Ghana

Mr. K.G. Montford
Ghana Atomic Energy Commission
Legon-Accra
Ghana

Mrs. Stella A. Nkansah
Ghana Atomic Energy Commission
P.O. Box 80
Legon-Accra
Ghana

Ms. Josephine Nketsia-Tabiri
Ghana Atomic Energy Commission
P.O. Box 80
Legon-Accra
Ghana

Mr. Charles M. Gbedemah
Ghana Atomic Energy Commission
P.O. Box 80
Legon-Accra
Ghana

Scientific Secretary

Mainuddin Ahmed
Joint FAO/IAEA Division of Nuclear Techniques
in Food and Agriculture
International Atomic Energy Agency
P.O. Box 100, A-1400 Vienna
Austria

C. Third Technical Co-operation Meeting of the Regional Food Irradiation Project for Developing Countries in the Middle East and Europe, Ankara, Turkey, 2-3 May 1991.

1. **INTRODUCTION**

The Coordination Meeting was opened by Prof. Dr. Atilla Ozmen, President of the Turkish Atomic Energy Authority, who welcomed the participants. He expressed the view that prevention of food losses and ensuring safe food supply represented a major concern in which food irradiation could play a significant role. One of the issues was ensuring public acceptance of this technology through the elimination of misconceptions. There was a need to define research topics and activities in such a way as to generate useful information needed for the establishment of regulations and for facilitating the application of food irradiaiton. Dr. Oztasiran, Director of the Lalahan Nuclear Research Institute for Animal Health, joined Dr. Ozmen in welcoming participants (see Annex 1).

The technical secretary, Dr. L. G. Ladomery (FAO/IAEA, Vienna) expressed his Organization's gratitude to the Government of Turkey for offering to host the meeting. He pointed out that the development of food irradiation technology had to be seen as part of socio-economic development. Food irradiation was just another food processing method which could be useful to consumers and the food industry alike, as part of overall food production and marketing. The Coordination Meeting was requested to review work carried out under the Regional Project and make recommendations in order to assist governments in the region in planning their research and development work in cooperation with FAO and IAEA. The FAO/IAEA expert, Dr. A. Brynjolfsson present at the meeting assisted in this task.

1. **REPORT OF THE TECHNICAL SECRETARY:**

The Meeting received a report on the Regional Workshop on Food Irradiation Technology, held in Warsaw, 30 May - 16 June 1988 and on the Regional Workshop on Good Irradiation Practices and Conduct of Pilot-Scale Food Irradiation Studies, held in Budapest 8-18 November 1988. Dr. Brynjolfsson (FAO/IAEA) also gave an account on the planned Workshop on the Use of Electron Accelerators for Food Irradiation to be held in Warsaw, 10-22 June 1991. Holding such a Workshop was necessitated by interest in a quick and practical method of treating deboned frozen poultry meat. The Workshop was intended to inform about the capabilities of electron machines and types available. The point was made that the Workshop should be open for people

with a general knowledge of food irradition rather than only specialists (eg physicists) in the operation of the system.

The Meeting noted that the implementation of planned activities under the Regional Project had been satisfactory, but that activities on food irradiation generally in the region of the Middle East and Europe had been rather limited.

2. STATUS REPORTS BY THE NATIONAL COORDINATORS:

Coordinators from Bulgaria, Czechoslovakia, Hungary, Poland, Syria and Turkey presented status reports on food irradiation in their countries (See Appendix 3). In addition they informed the Meeting of their particular difficulties and planned activities. The following is a summary of their statements:

BULGARIA

Projects in Progress:

The project related to the irradiation treatment of mechanically deboned poultry meat will be completed by the end of 1991. At least a provisional clearance is expected to be given for the process.

Investigations are underway in the project aimed at the development of detection methods. The research team involved has joined the Coordinated Research Programme ADMIT. Good results have been obtained under the project in the development of routine dose meters. Participation in interlaboratory studies is being sought.

Legislation:

In 1990, the first unconditional clearances were granted for the irradiation treatment of onions, potatoes and black pepper. Recently approved RULES for the development of process specification documents and the procedures for their approval is a good base for obtaining new clearances in the near future.

Facilities:

"Pharmachim" gamma-sterilization plant (100 kCi) meets the requirements for food irradiation. But no food item has been irradiated there as yet. The mobile irradiator 6UP-Y was used to irradiated 153 T of black pepper (8kGy) in 1989. A new multipurpose irradiation facility (30 kCi) is expected to be in operation by September 1991.

CZECHOSLOVAKIA

RESEARCH

A systematic investigation of foods with low water content has been carried out. The following foods have been found without change in taste and odour after irradiation: coconut (0.5 kGy), rice (0.7 kGy), cocoa, hazel nut, wheat flour (1kGy), allspice, almond, bay, chili powder, clove, fennel, ginger, groundnut, lentil, mace, pepper, raisin, tea (4kGy), paprika (9kGy). Also changes in chemical composition of these foods after the irradiation and during subsequent storage have been studied. This research, sponsored by the state, was stopped for financial reasons from January 1st, 1991. Other investigations run on a very small scale.

Technology

On the basis of the technologies, which ahve been worked out approx. 10 T of food commodities (rice, hazel nut, fennel and chili powder) were irradiated in 1990.

Legislation

A draft Act has been prepared by the Czechoslovakian Atomic Energy Commission. It is based on the recommendations of the Codex Alimentarius Commission. Recently public opinion (strongly affected by the Austrian Green Peace movement) negatively affected the attitude of the Ministry of Health Office towards food irradiation; the Act has, therefore, not come into force up to now.

HUNGARY

The revised Hungarian Food Law was confirmed in 1988, which has a part on Food Irradiation (para. 22). This part is based on the Codex Alimentarius Standard and lays down the requirements and rules for licencing the irradiation of foods. The Food Irradiation Expert Committee acts as an Advisory Group for the Ministry of Agriculture.

AGROSTER (food irradiator company) irradiated 800-900 tonnes of food items annually, which were used by the industry or sold at retail. The company, which is developing technology continuously, set up a computer system to control the facility at the beginning of this year. In co-operation with a foreign company, a large facility is being planned in Budapest, which will be set up in the near future.

Besides commercialization activities, intensive research was carried out on the following topics: improving irradiation technology to control chemical changes in products; detection of the irradiation process in treated products (dried and fresh) by CL-, TL-, viscosity-, ESR-, DSC-techniques and ultrastructural experiments; combined treatment for reducing the irradiation dose; heat-treatment to eliminate side effects (eg. organoleptic changes), sensitizing bacterial spores and dose distribution in products using the electron accelerator.

POLAND

Since 1988 acitivities in the field of food irradiation have been co-ordinated under the Central Programme on Radiation Techniques in Agriculture. It comprised research, implementary work and investments.

An experimental plant for food irradiation was built in Warsaw in 1990. The first 10 MeV 1kW linear accelerator (PILOT I) constructed in Svierk. The Institute of Nuclear Science in Svierk has actually been tested for routine operation. The second linear 10MeV 10 kW Elektronika UELW Soviet made accelerator will be installed early next year (1992).

A new project of a Co-60 commercial food irradiaton plant in Poznan-Swodrim is in progress. Installation of the irradiator is expected in 1994 - 95.

Extensive studies on irradiated food detection are in progress. Electron spin resonance spectroscopy, chemoluminescence and thermoluminescence methods are being studied.

At present, clearances for onions, spices and garlic (unconditional) as well as for potatoes and mushrooms (temporary for 3 years) have been issued.

Lectures on radiation processing of food, its control system and detection methods are being given now in Warsaw and Katowice by INCT specialists to health inspectors on the recommendation of the Minsitry of Health and Social Care.

Meeting of the IAEA Coordinated Research Programme on Detection Methods was organized in Poland in 1990, while the Workshop in the use of Electron Accelerators for Food Irradiation will be held in Warsaw, 9-22 June 1991.

SYRIA

A techno-economic feasibility study on potatoes, garlic and onions irradiation has been conducted and Syria is in the process of studying the possibility of constructing an irradiation plant for this purpose. At present, Syria is building an irradiaton facility with the help of the IAEA for sterilizing medical supplies which may also be used for agricultural products.

A general clearance for food irradiation has been approved by the government and it is now legal to sell irradiated food in Syria.

Last year a research study on the feasibility of the disinfestation of pulses and cereal grains by irradiation was initiated. So far, it has been possible to determine the most important insect pests on stored pulses and cereal grains in Syria. The radiation dose needed for irradiation disinfestation of faba bean seeds infested with faba bean seed beetle has also been determined and the possibility of installing a mobile irradiation source for free flowing-grains to be used for radiation disinfestation of faba bean seeds as early as possible after harvest is being investigated.

A training programme for scientists in food technology and entomology is necessary and would be very helpful.

TURKEY

Research studies are going on with different commodities.

Studies are being conducted by a working group jointly with the related state organizations, to prepare a proposal for regulations for food irradiation. An expert for assisting in work on regulations studies is needed.

Data for various food commodities which can be irradiated, are being collected and evaluated.

Some research staff has attended workshops and training programmes related to irradiation technology during 1989 - 91.

7. FUTURE ACTIVITIES IN PARTICIPATING COUNTRIES:

Bulgaria

Funding is expected for at least two new projects for the period of 1992-1995: (a) market tests for some irradiated products (onions, potatoes, frozen poultry, etc.); (b) possibility of *Salmonella* decontamination of raw-dried salami-type sausages.

Czechoslovakia

It is unlikely that research on food irradiation will develop in the immediate future. However, it seems that radiation decontamination and

sterilization of biological materials at a commercial scale will be of interest to the industry.

Hungary

It is hoped to increase the number of applications of food irradiation and to market and export irradiated food products and to realize a new food irradiator project. Work will be carried out on the development of detection methods for various additional products already studied and on the prediction of the microbiological stability of irradiated foods. Pilot-scale experiments will be carried out on the development of detection methods for various additional products already studied and on the production of the microbiological stability of irradiated foods. Pilot-scale experiments will be carried out on combined treatment to study the effect on reduction of energy requirements and the use of electron accelerators. The Hungarian Food Law will be harmonzied with the Regulations of the European Economic Community. Hungary will cooperate under the INTFI in training activities.

Poland

In 1992 commercial irradiation of several commodities will be started. Spices and herbs, mushrooms (champignons) fresh fish (trouts), casein powder, egg powder will be processed.

Clearances for chicken carcasses, egg powder and fresh fish are being prepared for acceptance.

Animal and fish foods will be irradiated for agricultural private companies.

Training courses will be encouraged in the field of feasibility studies, legislative problems and international trade not only for those who are engaged in food irradiation but also for health controllers and inspectors, etc.

In connection with the extended work on implementation in the field of food processing, the technical basis of control for both accelerators and conveyors will be introduced for routine operation. On the other hand, effective dosimetric control of EB food processing as well as detection methods for irradiated food will be developed.

Syria

Syria will continue to study the application of irradiation of cereals, pulses, etc. for disinfestation and is investigating the possibility of installing a mobile irradiation source for free flowing grains for this purpose.

Turkey

A working group is preparing draft regulations on food irradiaton. There is no pilot or commercial food irradiation facilities in Turkey. Studies are underway to collect data on spices and poultry in ordert to evaluate these commodities as possible priorities for irradiation. The Coordinator from Turkey indicated that workshops could be organized in that country on regulatory questions in collaboration with the IAEA.

Annex 1

List of Participants

DR. A. BRYNJOLFSSON (IAEA expert)	Food Preservation Section Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture International Atomic Energy Agency Wagramerstrasse 5, P. O. Box 100 A-1400 Vienna AUSTRIA FAX: 222-234564
Dr. V. DUCHACEK	Czecholsovak Atomic Energy Com. Slazka 9, Vinohrady 120 29 Pruha 2 CZECHOSLOVAKIA FAX: (422)216 2467
Dr. A. GROZDANOV	Institute of Meat Industry Cherni Vrach, 65 1407 Sofia BULGARIA
Dr. B. KALMAN	AGROSTER Irrad. Co. Jászbérenyi St. 5 Budapest 1106 HUNGARY FAX: 36-1-157-5563
DR. I. KISS	Central Food Research Institute Herman O. St. 15 Budapest 1022 HUNGARY FAX: 36-1-1558-991
DR. M. MANSOUR	Syrian Atomic Energy Commission P. O. Box 6091 Damascus SYRIA
DR. W. MIGDAL	Institute of Nuclear Chemistry and Technology Dorodna 16 03-195 Warsaw POLAND FAX: 48-22-111532
DR. I. OZTASIRAN	Lalahan Nuclear Research Institute for Animal Health 06852 Lalahan, Ankara TURKEY FAX: 4515-1020
DR. G. SIYAKUS	Lalahan Nuclear Research Institute for Animal Health 06852 Lalahan, Ankara TURKEY 4515 1020 FAX: 4516-1020

DR. W. STACHOWICZ

Institute of Nuclear Chemistry
and Technology
Dordona 16
03-195 Warsaw
POLAND
FAX: 48-22-111532

DR. L. LADOMERY
(Scientific Secretary)

Food Preservation Section
Joint FAO/IAEA Division of Nuclear
Techniques in Food and Agriculture
International Atomic Energy Agency
Wagramerstrasse 5, P. O. Box 100
A-1400 Vienna
AUSTRIA
FAX: 222-234564

D. Second FAO/IAEA Research Co-ordination Meeting on Food irradiation Programme for the Middle East and European Countries, Lalahan Nuclear Research Institute for Animal Health, Lalahan, Ankara, Turkey, 6-10 May 1991.

1.INTRODUCTION

The Second Research Co-ordination Meeting (RCM) of the Co-ordinated Research Programme on Food Irradiation for the Middle East and European Countries (FIPMEE) was held at the Lalahan Nuclear Research Institute for Animal Health, Lalahan, Ankara, Turkey from 6 - 10 May 1991 at the courtesey of the Government of Turkey. With the exception of Dr. Todorovic (Yugoslavia), Dr. Ahmed (Iraq) and Dr. Triantaphylides (France), all members of FIPMEE or their representatives were in attendance. The list of participants is given in Annex 1.

The meeting was opened by Dr. I. Oztasiran, Director of the Lalahan Nuclear Research Institute for Animal Health, who welcomed participants. He stated that Turkey was interested in the application of food irradiation technology and was making efforts in this direction. He stressed the need for further research into individual applications. Dr. Jan Doorenbos, FAO Representative in Turkey, pointed to Turkey's rich cultural background and supported Turkey's interest in introducing this new food technology, especially in view of Turkey's self sufficiency in food production. He and the Scientific Secretary, Dr. L.G. Ladomery (FAO/IAEA), expressed their gratitude to the Government of Turkey for hosting the Second RCM of FIPMEE.

2.ADOPTION OF PROGRAMME

The meeting adopted the programme with some rearrangement of the order of the presentations to take account of the absence of certain participants. It was also decided that there was no need to have separate working groups.

3.APPOINTMENT OF OFFICERS

Dr. M. Szczawinska (Poland) was appointed Chairman of the Meeting.
Dr. H. Stevenson (Northern Ireland, U.K.) was appointed rapporteur.

4.REPORT BY THE SCIENTIFIC SECRETARY

The Scientific Secretary (Dr. L.G. Ladomery) gave a report of the recommendations of the Third Coordination Meeting of the Regional Food Irradiation Project for Developing Countries in the Middle East and Europe, held in Ankara from 2 - 3 May 1991. The meeting noted that the Coordination Meeting had recommended that research should be encouraged at the practical (eg. commercial) level, in cooperation between the interested sectors (eg. health, industry, agriculture, etc.) to generate research data required to transfer the technology to the industry and for regulatory action. Research should concentrate mainly in the area of food hygiene, with additional techno-economic feasibility studies and market trials (to test consumer acceptance). The meeting was informed of the establishment of a new CRP on detection methods for irradiated foods (ADMIT) and the consequential deletion of this research activity from FIPMEE. This had resulted in the transfer of four members of FIPMEE to ADMIT.

The Scientific Secretary also gave a report on the status of food irradiation (commercial applications, regulatory actions by governments). He stressed that the "nineties' should be regarded as the decade of application of the technology and that research should be directed to this end.

5.REVISION OF THE OBJECTIVES

In the light of the recommendations of the Third Coordination meeting of TC and discussions of the work carried out and planned for the region, the original objectives were up-dated as follows:

a. To carry out pilot scale experiments on irradiation of food of commercial interest, including dose distribution studies, in order to transfer the technology to local industry and to provide information for regulatory authorities.

b. To carry out techno-economic feasibility studies using gamma and EB sources.

c. To conduct shipment studies and properly designed market trials to assess public acceptability of irradiated products.

d. To carry out research to improve the hygienic quality of food and to limit food losses, e.g. by insect disinfestation.

e. To carry out research on the effects of food irradiation on food quality, (eg. sensory, vitamin changes, etc.)

6. TOPICS OF GENERAL INTEREST

6.1 Hygienic Quality of Food.

The number of food-borne diseases caused by pathogenic bacteria have increased dramatically during the last five years in many parts of the world.

The main reason for the above is the frequent occurrence of these microorganisms in food of animal origin. In chicken meat the presence of Salmonellae and Campylobacter in foods still creates a severe epidemiological problem.

Increasing contamination of various kinds of food by Listeria also remains a major concern. The results of the studies made within FIPMEE show that application of ionizing radiation to different food items is an effective method of eliminating these pathogens from foods.

6.2 Sensory Evaluation:

Irradiation is effective in enhancing the hygienic quality of food and in extending its shelf-life. In addition, the organoleptic quality of the product must also be acceptable to the consumer. Some differences between irradiated and unirradiated fresh and frozen chicken have been reported when trained sensory panellists were used to assess the products. Further information on the sensory quality of these products is required. For example the influence of poultry breed, feed composition and fat content of the chicken merits investigation. In order to establish if these slight organoleptic changes noted in chicken and other foods are detectable by the public, properly designed and controlled market trials need to be conducted. This would give the consumer the opportunity to purchase irradiated food and thus be in a position to make an informed judgement about whether or not the irradiated product is acceptable

6.3 Post-Harvest Losses

In view of an ever increasing world population, serious problems arise, especially in the developing countries regarding the availibility of food. The problem is aggravated by the considerable post-harvest losses which occur in these countries. Insect infestation is responsible for much of these losses, especially in arid regions. Syria for example has serious pest problems in stored pulses and cereal grains. Radiation processing could make a significant contribution to insect pest cotrol and, hence, reduced post harvest losses.

6.4 Pilot-scale Experiments

Pilot-scale experiments are an obvious extension of this research programme and are part of the stated objectives in order to transfer the technology to the food industry. This cannot be achieved unless pilot-scale food irradiation facilities are available in the participating countries.

6.5 Techno-economic Feasibilty Studies

To facilitate the transfer of the technology to the food industry, techno-economic assessment of individual applications is necessary. This type of applied research is needed and should be carried out to complement ongoing investigations.

6.6 Marketing and Shipment Trials

Prior to full commercialization of the irradiated product, it is necessary to carry out appropriate trials to test transportablility, regulatory control and public acceptance under realistic commercial conditions. These trials require cooperation between governments, the industry and interested research organisations. Such tests are to be encouraged under FIPMEE.

In some instances marketing and shipment trials and consumer acceptance trials can be arranged through cooperation between FIPMEE countries.

A test of this type involving onions and garlic may be expected through a cooperation between the Central Institute for Isotope and Radiation Research (Leipzig) and the interested organizations. Experts from Hungary, Poland and Syria expressed their interest in participating in such cooperation. It was noted that for this purpose government approval will be needed.

6.7 Consumer Acceptance Trials

In order for the consumer to be in a position to make a sound judgement about the acceptability of irradiated food, properly designed and executed market trials need to be carried out. This must involve the purchase of the irradiated product without incentive or disincentive through price adjustments. The trials should be supplemented with an appropriate questionnaire which will assess the consumer's attitude to the product. Guidelines are available for this purpose.

7. FUTURE WORK PROGRAMME

The meeting agreed to the following areas in which work under FIPMEE should be carried out; preferably at the pilot-scale or industrial level and involving food of commercial interest:

(a) Effectiveness of the process in improving the hygienic quality of food and limiting food losses (eg. through insect infestation);

(b) Techno-economic feasibility studies (gamma sources and electron beam machines);

(c) Shipment studies to assess the effects of transport on quality, keepability of the product; to gain experience in the distribution and control of irradiated foods in trade;

(d) Market trials (properly designed) to assess pulbic acceptability of irradiated foods;

(e) Effects of radiation treatment on food quality (sensory, vitamin content, chemical changes etc.);

Annex 1

L I S T O F P A R T I C I P A N T S

1.	GABOR FOLDIAK	Institute of Isotopes of the Hungarian Academy of Sciences P.O. Box 77 H-1525 Budapest HUNGARY Telephone: (36-1) 155-0520 Telex: 22-5360 Telefax: (361) 156-5045
2.	ALEXANDER GROZDANOV	Institute of Meat Industry 65, Cherni Vrach Blvd. 1407 Sofia BULGARIA Telephone: 683352 Telex: 22646 RODPRO Telefax: 626104
3.	ISTVAN F. KISS	Central Food Research Institute Herman Ottó út 18 H-1022 Budapest HUNGARY Telephone: (36-1) 155-8964, 155-8244 Telex: 22-4709 Telefax: (36-1) 155-8991

4. THOMAS LUTHER
Central Institute for Isotopes and Radiation Research, Leipzig
Permoserstrasse 15
O-7050 Leipzig
GERMANY
Telephone: 2392 284 Telefax: 2392 489

5. MOHAMMED MANSOUR
Syrian Atomic Energy Commission
P.O. Box 6091
Damascus
SYRIA
Telephone: 668114 Telex: ATENCO 411420
Cable: TAKA

6. IZZET OZTASIRAN
Lalahan Nuclear Res. Inst. for Animal Health
Lalahan, Ankara
TURKEY
Telephone: 9(4515)1243 Telefax: 9(4515)1020

7. *JASMINKA PAPIC*
Public Health Inst. of the Republic of Croatia
Rockefellerova 7
41000 Zagreb
YUGOSLAVIA
Telephone: 272822 Telefax: 276248

8. HILARY STEVENSON
Food and Agricultural Chemistry
Research Division
Department of Agriculture
Newforge Lane
Belfast BT9 5PX
Northern Ireland
UNITED KINGDOM
Telephone: 44 232 661166
Telefax: 44 232 669551

9. MALGORZATA E. SZCZAWINSKA
Department of Food Hygiene
Faculty of Veterinary Medicine
Warsaw Agricultural University
Nowoursynowska 166
02-975 Warsaw
POLAND
Telephone: 471903 Telefax: 471562
Telex: 816238 SGGW PL

UNDP/FAO/IAEA WORKSHOP ON PUBLIC INFORMATION ON FOOD IRRADIATION, U.N. BUILDING, BANGKOK, THAILAND, 27-31 MAY 1991.

Under the scope of the Asian Regional Cooperative Project on Food Irradiation - Process Control and Acceptance (RPFI Phase III), funded by UNDP, a Workshop on Public Information on Food Irradiation was organized by FAO and IAEA in Bangkok from 27 - 31 May 1991. The purpose of the Workshop was to provide factual information concerning the safety, benefits and limitations of food irradiation to members of national press corps and consumer organizations in countries of the Asian and Pacific region.

Fifteen participants who are journalists or representatives of consumer organizations from Bangladesh, People's Republic of China, Indonesia, Japan, Rep. of Korea, Malaysia, Pakistan, Philippines, Sri Lanka and Thailand, attended the Workshop. They were nominated by their respective governments on the basis of their professional qualifications. The list of participants and observers is attached as Annex I.

The Workshop was officially opened by H.E. Prof. Dr. Sanga Sabhasri, Minister of Science, Technology and Energy of the Royal Thai Government which hosted the Workshop. He stressed that food irradiation has been shown to be a promising means for preventing food losses, improving hygienic quality of food and reducing dependence on chemicals. However, the implementation of commercial application of food irradiation is inhibited by anti-food irradiation activities which take advantage of consumers' fears especially of the "unknown". To counteract the fear of the unknown and misinformation, public information campaigns in this field are required. Prof. Sabhasri's statement was complemented by Mr. A.Z.M. Obaidullah Khan, Assistant Director General of FAO for Asia and the Pacific and Mr. Sunil Saigal, Assistant Regional Representative of UNDP in Asia and the Pacific, at the opening of the Workshop. The former stated that "We are familiar with the pasteurization of milk. Who would deny the benefit to human health resulting from this technology? Why should solid foods not be provided the same degree of safe protection from food borne pathogens that liquid foods can? It would appear obvious that we should do all we can, utilizing whatever technologies are available, to ensure that all foods, not just liquids are safe from food borne diseases. This will also allow much greater confidence in international trade among all countries."

The latter stated that " With regard to food irradiation, extra time (for acceptance) must be calculated because the process is erroneously - though perhaps not unnaturally - perceived by the public to be associated with radioactivity, nuclear waste, environmental contamination, health risks etc. Consumers suspect irradiated food to be nutritionally inferior, microbiologically unsafe and risky for long term consumption. Strong opposition also comes from environmental groups which believe that any technology related to nuclear science is liable to cause environmental pollution and is therefore unacceptable. The dissemination of proper information is, therefore, vital in addressing the concerns of the consumers."

According to the Programme of the Workshop, the participants from each country initially presented information concerning food irradiation in their home countries based on whatever information available to them. As anticipated, the information available to journalists and representatives of consumer organizations ranged from technically accurate to highly emotional on the subject depending on where they received the information from. In a few instances, the participants mixed up irradiated food with food contaminated with radionuclides.

The Workshop provided an ideal opportunity for the participants, most of whom do not have technical background in food science or related field, to receive factual information from invited experts and officials responsible for this subject from FAO and IAEA. In addition, a representative of the International Organization of Consumer Unions (IOCU) also presented IOCU's view on food irradiation. IOCU continues to oppose the introduction of this technology based on the moratorium resolution adopted at its Congress held in Madrid in 1987.

The highlight of the Workshop was a visit to the Thai Irradiation Center (TIC), Office of Atomic Energy for Peace, Pathum-Thani, on 29 May 1991. The participants were able to see the operation of a large gamma irradiator being used for treating food and non-food items. The safety features of the irradiator, one of some 160 such units in operation around the world, were explained to them. The TIC was used on that occasion to irradiate Nham (fermented pork sausages which are almost always consumed raw by the local population) to destroy pathogenic microorganisms and parasites, for local market. In addition, the participants were served two sets of luncheon; one consisted of irradiated food and ingredients - the other consisted of the same food and ingredients but were not irradiated. Both sets were identically prepared according to the traditional Thai cuisine. The participants together with local observers (a total of 41) were invited to taste both sets and to determine the difference, if any, between the two sets. The following were the number of scores on the food served at the luncheon:

Food	Right Answer	Wrong Answers	Unable to tell the difference
Chicken curry (chicken and curry were irradiated).	4	6	31
Fried sweet noodles (dried noodles were irradiated)	2	7	32
Irradiated Fermented Pork Sausages (Nham)	3	5	33
Irradiated Rice	5	7	29
Irradiated prawns in garlic and pepper	3	8	30
Irradiated mangoes	6	7	28

From the above, it was clear that most participants and invited lecturers were unable to distinguish irradiated food from non-irradiated counterparts.

A number of documents on various aspects of food irradiation including a series of 14 "Fact Sheets" just published by the International Consultative Group on Food Irradiation (ICGFI), were given to the participants in addition to summaries of lectures delivered at the Workshop. On the basis of the information provided, the participants were asked to prepare a short article on food irradiation and present it on the last day of the Workshop.

From the articles prepared by the participants, it is clear that the participants had picked up valuable information concerning food irradiation at

the Workshop. This in contrast to the articles previously prepared by them prior to attending.

The following are some of the statements made by some participants in their report on the last day of the Workshop:

"A regional workshop on PUBLIC INFORMATION OF FOOD IRRADIATION that concluded here today felt the need for public information campaign to counter act any fear of this technology created by dissemination of misinformation." "The workshop was in the opinion that since the people were saturated with information on the harmful effects on nuclear radiation some psychological barring had been created in their minds against use of irradiated foods which were not harmful." (Bangladesh)

".....Similarly making weapons of mass destruction is a crime and those who participate in such acts should never be forgiven. So those who oppose nuclear irradiation, they have a valid fear, though they may or may not have a solid reason." "And I believe that the best way to get rid of this fear is to promote peaceful use of nuclear energy, to make things that make the life easy rather than destroying it. Things like food irradiation or nuclear power plant can help the scientists in improving their image and that of the technology they promote. But please, for your sake and ours, be very careful in doing so. Please make sure that 10 or 20 years from now we don't have to look back and regret our participation in this workshop." (Pakistan)

".....So no more questions that irradiated food is safe or not for the people. The important thing now is how to convince them. It is really the task of all of us here, particularly the journalists, to provide proper information and guidance to the people on this processing technology" - (Indonesia).

"..... what matters here, in making food irradiation popular and acceptable is not just the facts and figures - but how these facts and figures are perceived by the lay public." "..... in promoting a new technology among the lay public, it is not sufficient to just place the hard scientific facts and figures and expect them to endorse it readily. In spite of several decades of widespread science education, many people are still influenced and driven by irrational and unscientific perceptions. As one of my editors used to say, common sense is not so common!" (Sri Lanka)

".....Before participating in this workshop, we made much preparation. We collected a lot of data and heard opinions of experts in the Korean government, research centers, consumer groups and enterprises. In our preparation, however, I and my co-worker encountered some difficulties in understanding the specific and detailed items. This workshop was a unique occasion for us to collect various, exact and useful information to the Korean people by newspapers and other means after our return. I am also considering to publish a booklet on the food irradiation. It is my wish that an occasion similar to this workshop could be held in Korea in a near future." (Republic of Korea).

In addition, all participants requested that they be kept informed of further developments in the field so they could transmit such information to the public in their countries. They promised to serve as contact points concerning public information on food irradiation as well as the beneficial uses of nuclear techniques in agriculture.

LIST OF PARTICIPANTS

(as of 1991-04-29)

BANGLADESH

Dr. Ahsan Ali Khan
Member, Consumers Association of Bangladesh
Associate Professor, Bangladesh University of Engineering and Technology
DHAKA 1000

Telex :
Phone : 505171-77 ext. 191 (OFFICE)
399 (RESIDENT)

Mr. Gaziur Rahman
Special Correspondent, Bangladesh Sangbad Sangstha News Agency
68/2, Purana Paltan
DHAKA BANGLADESH 1000

Telex : 642405 BS BJ Cable DRUTA
Phone : 235036-9

CHINA

Mr. Chen Xin
Xinhua News Agency
57 Xuanwumen Xidajie
BEIJING 100803

Telex : 22316 XNABJ CN
Phone : 3073666
Fax : 3071206

INDONESIA

Mr. Agus Pambagio
Board of Director, Indonesian Consumer Organization
Jl. Pembangunan I
No.1 Duren Tiga
JAKARTA 12760

Telex : 44872 SWIDJO IA
Phone : 62-(021) 798-1038

INDONESIA

Mr. Mochammad Subandi
Antara Indonesian News Agency
Kantor Berita Antara
Wisma Antara Lt. 18-20
Jl. Merdeka Selatan
JAKARTA 10110

Telex : 44305, 46646 ANTARA IA
Phone : 374962, 3844465
Fax : (021) 343052

JAPAN

Mr. Sueo Iitaka
Writer & Editor, The Japan Atomic Journal
Japan Atomic Industrial Forum, Inc.
31-7, 4 Chome
Shimbashi, Minato-Ku
TOKYO 105

Telex : 2226623
Cable : JATOMFORUM TOKYO
Phone : 3-3508-2411
Fax : 3-3508-2094

REPUBLIC OF KOREA

Mr. Ki Jin Lee , Journalist
Department of Science
Korea Saegye Daily Newspaper
63-1, Hangang-Ro
SEOUL

Phone : 82 (2) 799-4348
Fax : 82 (2) 799-4344

Ms. Jung Hee SUH , Senior Investigator
Department of Testing
Korea Consumer Protection Board
191, 2-KA, Hangang-Ro
Yongsan-Ku
SEOUL

Phone : (2) 796-4384
Fax : (2) 796-5770

MALAYSIA

Ms. Selvamany Pahang Gabriel , Lecturer
School of Mass Communication
Institute of Technology MARA
Level 13, Bangunan Menara
40450 Shah Alam
SELANGOR DARUL EHSAN

Telex : TEKMA 38671
Phone : 5500226, 5500229, 5592311
ext. 4142, 4753

Ms. Fairos Mohd, NAZRI , Journalist
Malaysian National News Agency (BERNAMA)
Wisma BERNAMA
28, Jalan 1/65A
Off Jalan Tun Razak
Peti Surat 10034
50700 KUALA LUMPUR

Telex : MA 30461
Phone : 03-2939933
Fax : 2981102, 2929729

PAKISTAN

Mr. Anwar IQBAL , Journalist
The News
ISLAMABAD

Telex : 5586 UPI PK
Phone : 852546
Fax : 555371

PHILIPPINES

Mr. Artuto ORIG , Correspondent/Journalist
Manila Bulletin
Publishing Corp.
P.O. Box 769
PHILIPPINES

Telex : c/o Mr. Aleta, PNRI 66804 PNRI PN
Phone : 40-12-37
Fax : 499050

PHILIPPINES

Ms. Zenaida REYES , President
National Committee on Food Irradiation
Consumers Federated Groups of the Philippines Inc.
c/o U.P. Law Center
Bocobo Hall
DILIMAN, QUEZON CITY 1101

Telex : c/o Mr. Aleta, PNRI, 66804 PNRI PN
Phone : 97-71-37
Cable : UPLACEN

SRI LANKA

Mr. Nalaka Jayampati GUNAWARDENE , Science Correspondent
"The Island" Newspaper
Upali Newspaper Limited
223 Bioemendhal Road,
Colombo 13, SRI LANKA

Phone : (94-1) 563068
Fax : (94-1) 589225

THAILAND

Mr. Charal PHAKPHIAN. Editor
Health Magazine
Samaphan Publishing Co., Ltd.
305/1 Pichai Road
Dusit
BANGKOK 10300

Phone : 2434147-9
Fax : 2435015

LIST OF OBSERVERS

1. Ms. Nuatong Vananuvat
   Head, Department of Food Science & Technology
   Faculty of Agro-Industry
   Kasetsart University
   Bangkok, Thailand

2. Mr. Pornsak Manassiripen
Food Engineer
Institute of Food Research and Product Development
Kasetsart University
Bangkok, Thailand

3. Ms. Tippawan Ningnoi
Medical Scientist
Division of Food Analysis
Department of Medical Sciences
Yodse, Bangkok 10100
Thailand

4. Ms. Ladda Thitigiatipong
Voluntary Group for Consumers of Thailand (VGCT)
495/44 Soi U-Omsin, Jaransanitwong Rd. 40
Bangkok 10700, Thailand

5. Mr. James Fahn
The Nation
59 Soi Saeng Chan
Sukhumvit 42
Bangkok 10110, Thailand

6. Ms. Ann Danaiya Usher
Editorial Department
The Nation

7. Ms. Nantiya Tangwisuttijit
The Nation

8. Ms. Suwanna Sisawad
Head, Food Technology Laboratory
Thailand Institute of Scientific and
Technological Research (TISTR)
196 Phaholyothin,
Bangkok 10230, Thailand

9. Ms. Jariya Prasatsrisupat
Scientist
Department of Agricultural
Bangkok, Thailand

10. Ms. Supranee Changbumrung
Associate Professor
Department of Tropical Nutrition and Food Sciences
Faculty of Tropical Medicine
Mahidol University
420/6 Rajvithi Road
Bangkok 10400, Thailand

11. Mr. Sanguan Chiravathanapong
Plant Manager
Thai Irradiation Center
Office of Atomic Energy for Peace
Bangkok, Thailand

12. Ms. Saiyuod Prasertvit
    Food Technologist
    Food Control Division, Food and Drug Administration
    Ministry of Public Health
    Devavas Palace
    Bangkok 10200, Thailand

13. Ms. Pairin Radomvivat
    Food and Drug Administration

14. Ms. Pannee Pakkong
    Applied Radiation and Isotopes Department
    Faculty of Science, Kasetsart University
    Bangkok 10900, Thailand

15. Mr. Yuthapong Prachasitthisak
    Radiobiologist
    Office of Atomic Energy for Peace
    Thailand

16. Ms. G. Beishon
    IOCU
    2 Marylebone Road
    London NW1 4DX

17. Ms. Pongpen Rattagoal
    Department of Fisheries
    Ministry of Agriculture & Cooperatives
    Bangkok, Thailand

NEW CO-ORDINATED RESEARCH PROGRAMME

1. Programme Title

CRP on Irradiation as a Quarantine Treatment of Mites, Nematodes and Insects Other than Fruit Fly.

2. Scientific Background

The CRP on Use of Irradiation as a Quarantine Treatment of Food and Agricultural Commodities (D6-10-08), in operation from 1986 to 1990, was highly successful. The data generated under this CRP showed conclusive evidence that a minimum dose of 150 Gy can be effectively used as a disinfestation treatment of fresh fruits and vegetables against fruit fly of Tephritidae family to satisfy quarantine regulations. Other data indicated that a minimum dose of 300 Gy could be used to prevent the establishment of other quarantine insects (e.g. mango seed weevil) in non-infested areas. These data were evaluated by leading experts on plant protection and quarantine at the Task Force on Irradiation as a Quarantine Treatment of Fresh Fruits and Vegetables, convened by the International Consultative Group on Food Irradiation (ICGFI), Bethesda, Maryland, January 1991. The Task Force recommended that irradiation be accepted as a quarantine treatment against fruit fly and other insect pests. Canada, Mexico and USA through the North American Plant Protection Organization (NAPPO) have accepted irradiation as a quarantine treatment of fresh agricultural produce.

Preliminary data indicated that irradiation could also be used as a quarantine treatment of a number of agricultural commodities in trade, which are infested by other arthropod pests, e.g. mites, nematodes. Trade in such agricultural commodities (e.g. cut-flowers, foliage, peat moss, hays, tree barks/wood chips, ornamental soil) is presently inhibited by infestation of various arthropod pests. Present use of fumigation, especially methyl bromide, is likely to be prohibited or increasingly restricted because of environmental and worker safety reasons. Data are urgently needed to demonstrate the effectiveness of on physical treatments such as irradiation as a quarantine treatment of various agricultural commodities against mites, nematodes, thrips and insects other than fruit fly, and without having adverse effect on the host commodities.

The CRP is included in the Agency's revised Programme of Work and Budget for 1992.

3. Scientific Scope and Proposed Programme Goals

The aim of this CRP is to assist institutions in developing countries and to co-ordinate activities in advanced countries to investigate the effectiveness of irradiation as a quarantine treatment against mites, nematodes and insects other than fruit fly which impede trade in agricultural products.

Major activities envisaged under this CRP are:

(a) Determination of criteria for accepting irradiation as a quarantine treatment against mites, nematodes, thrips and other insects which do not belong to Tephritidae family (e.g. inability to reproduce).

(b) Determination of effect of irradiation on the most resistant stage of various quarantined pests.

(c) Determination of a marker which could be used in practice to verify that the survived stage(s) of quarantined pests cannot reproduce or establish in non-infested areas.

(d) Evaluation of quality and shelf-life/vase-life of agricultural commodities irradiated at 2-3 times the dose required for quarantine purpose.

4. Implications for the Future

a. Estimated duration of the CRP: 5 years

b. Co-ordination Meeting planned: 3 times

5. Participation and Funding

Limited funds are available to assist institutions in developing countries to conduct research according to the scientific scope of this CRP. Research contracts (approx. US$ 5,000/year) could be awarded to qualified institutions in these countries. For institutions in advanced countries, another form of collaboration without direct financial supports, i.e. on the basis of research agreements, could be made. Chief scientific investigators of projects approved under this CRP will be entitled to attend periodic co-ordination meetings of the CRP at the expenses of FAO/IAEA.

Scientists/institutions which would like to participate in this CRP should submit research contract/agreement application forms to the IAEA before 31 December 1991.

STATUS OF FOOD IRRADIATION IN CHINA*

Chen Qixun[1], Zhu Jiang[2], Xu Zhicheng[3]

1. Sichuan Provincial Institute of Nuclear Technolgoy Application, Chengdu.
2. Ministry of Energy, Beijing.
3. Shanghai Research Institute, Shanghai.

A. List of Major Irradiation Facilities

Name	Completion date	Initial capacity (kCi)	Maximum capacity(kCi)
Chengdu	1979	280	500
Shanghai	1986	177	500
Nanjing	1986	220	500
Zhengzhou	1986	100	300
Shenzhen	1986	500	4,000
Lanzhou	1987	500	500
Daqing	1987	100	600
Tianjing	1987	100	600
Beijing	1988	330	1,000
Changsha	1989	100	500
Changshu	1989	100	300
Shi Jiazhuang	1989	100	500

2. Market Testing of Irradiated Foods in China

Item	Dose (kGy)	Quantity (tonne)	Place	Date
Sprit (sweet potato)	2-4	16,000	Sichuan etc.	1984-90
Sausage	8	200	Sichuan	1984-86
Apples	0.2-0.8	860	Shanghai	1985-90
Potatoes	0.08-0.12	960	Henan, Shanghai	1985-90
Garlic	0.07-0.12	20,300	Henan, Shanghai	1985-90
Onion	0.12-0.15	1,250	Shanghai, Taiyuan	1985-89
Hot pepper & products	5-8	430	Sichuan etc.	1985-90
Orange	0.2-0.8	10	Hunan	1986-87
Pear	0.2-0.8	5	Shandung	1985-87
Tomato		25	Nanjing	1987-90

*Excerpts from paper presented at the Tripartite Meeting held during the Second FAO/IAEA Research Co-ordination Meeting on the Asian Regional Co-operative Project on Food Irradiation with Emphasis on Process Control and Acceptance (RPFI-Phase III), Jakarta, Indonesia, 15-19 July 1991.

Consumer In-Store Response to Irradiated Apples in China*

Xu Zhicheng, He Fuying and Cai Dong
Shanghai Irradiation Centre
Institute of Nuclear Research
Academia Sinica, Shanghai, China

In order to collect consumers in-store response to irradiated foods, a special counter was set up for selling irradiated apples in Hua Feng Fruit Store, Nan Jing Road, Shanghai. This store is located within Shanghai commercial area near the Shanghai Exhibition Center, where most of the buyers are mobile representing various sections of the population.

Before selling the irradiated apples, some leaflets were distributed to consumers. These included the following informations:

- Various processing methods for preservation of foods;
- What is food irradiation technology?;
- Purpose of irradiation processing;
- Advantages of food irradiation processing;
- Whether any induced radioactivity in food after irradiation by gamma rays;
- Safety of eating irradiated foods;
- List of irradiated foods approved in China;
- Purpose of the test marketing of irradiated foods.

In the special counter, irradiated apples were displayed beside the unirradiated apples and clearly identified with the label "Irradiated Food" and the international logo. For fair competition and choice by consumer, irradiated apples and nonirradiated apples were sold for the same price, i.e. at 6.58 yuan per kilogram before Spring Festival in February, 1991.

The buyer received an information leaflet and a consumer acceptance questionnaire when he bought irradiated apples. When he filled out the questionnaire and returned it to us, we allowed him to buy again 1.5 kg of irradiated apples with a 10% discount.

Within three days in February, 300 sheets of investigation form were distributed and 255 sheets of them were returned. During April 28 to May 4, 550 sheets were sent out, and 390 sheets were returned. The consumer acceptance questionnaire included the name, sex, age and occupation of respondents. Besides, eleven questions were asked on the irradiation technology and irradiated food. The questionnaire included six questions before tasting irradiated food and five questions after tasting irradiated food.

The demographic characteristics of the sample of consumers who bought irradiated apples showed that percentage of female and middle age population was relatively higher, agreeing with the chinese consumer tradition.

The table 1 shows the familiarity of consumers to irradiated foods. These results are achieved due to our information campaign in newspapers, magazines, video and radio since 1982. As a result of this campaign 30.28% buyers said they tasted irradiated food before and 32.81% of buyers said they understood this technology. These results have shown that education of

*Excerpt from paper presented at the Second Research Co-ordination Meeting of the Asian Regional Co-operative Project on Food Irradiation with Emphasis on Process Control and Acceptance, funded by the UNDP.

consumer is a prerequisite to make informed choices. Given proper information on irradiation, the majority of consumers will choose irradiated foods. After consumers heard factual information on food irradiation, the percentage of misgivings in irradiated foods dropped from 43% to 10.88%. When asked the purpose of buying irradiated apples, 91.8% of buyers said that they bought irradiated apples for tasting.

Table 1. Familiarity with irradiated food by consumers before buying irradiated apples.

	Questions	Response	Frequency	Per cent
1.	Have you heard of irradiated food before?.	Yes	377	59.46
		No	242	38.17
		Uncertain	15	2.37
2.	Have you ever tasted irradiated food before?.	Yes	192	30.28
		No	427	67.35
		Uncertain	15	2.37
3.	Have you understood irradiated food before?.	Yes	208	32.81
		No	392	61.83
		Uncertain	34	5.36
4.	Do you feel misgivings for irradiated food before?.	Yes	274	43.22
		No	275	43.38
		Uncertain	85	13.40
5.	Were your doubts removed after having seen the information about irradiated food?.	Yes	503	79.34
		No	69	10.88
		Uncertain	62	9.78
6.	Would you buy some irradiated apples for tasting?.	Yes	582	91.80
		No	37	5.84
		Uncertain	15	2.36

Table 2 shows the reaction of consumers after tasting irradiated apples.

Table 2. Appreciation of consumer for irradiated foods.

	Questions	Response	Frequency	Per cent
7.	Do you like qualities and flavours of irradiated food?.	Yes	476	75.08
		No	19	3.00
		Uncertain	139	21.92
8.	Would you consider the advantages of irradiated food (i.e. longer shelf-life and lower spoilage?).	Yes	526	82.96
		No	26	4.11
		Uncertain	82	12.93
9.	Would you buy irradiated food again, if you understand the irradiated food?.	Yes	569	89.75
		No	17	2.68
		Uncertain	48	7.57

Table 2. Appreciation of consumer for irradiated foods.

	Questions	Response	Frequency	Per cent
10.	Would you consider the irradiated food must continue development and use?.	Yes	565	89.12
		No	21	3.31
		Uncertain	48	7.57
11.	Would you like additional items of irradiated food?.	Yes	590	93.06
		No	9	1.42
		Uncertain	35	5.52

The results of the table 2 show that consumers appreciated organoleptic qualities and advantages of irradiated apples. They expressed their willingness to buy them again and would favour developing markets of irradiated food.

From these results of the study, the following conclusions are drawn.

1. Need to strengthen education of consumers.

Our study showed that when consumer understands the benefit of irradiation technology such as higher quality, greater safety, longer shelf-live, wider product availability, or good prices for value, consumer would willingly buy irradiated food. After introducing irradiation technology, over 90% of consumer stated that they would buy irradiated foods again. To strengthen consumers understanding, we still need to make further campaign through various channels such as newspapers, magazines, radio, TV broadcasting, exhibitions and other forums.

2. Improve the quality of irradiated food.

Besides the enlargement in the quantity of irradiated food, the quality should also be improved. Some factors including the quality control of the raw materials, pre-irradiation and post-irradiation condition should be considered. Therefore strict adherence to Good Manufacturing Practices (GMP) is very necessary. Our next step will be to formulate the technological standards (GMP) according to the ICGFI Guidelines. These standards will include quality control and supervision during pre-harvest, post-harvest, irradiation, storage, transportation and sales.

3. Continue to provide factual information during the test marketing and consumer acceptance trials.

The scientists and technologists who serve behind the counter during test marketing can directly meet consumer and answer various questions. This is an effective technique for providing on-the-spot information on irradiated foods. Therefore, for further popularizing the irradiation preservation of food we will continue to follow this technique of consumer information.

Test Marketing and Consumer Acceptablity of Irradiated Seasonings in China*

Chen Qixun, Xu Peishu, Chen Hao, Chen Lihua, Dong Shaobin,
Sichuan Provincial Institute of Nuclear Technology Application,
124 Sha He Bao, Chengdu, Sichuan 610066,
People's Republic of China

China is a large producer of seasonings with over 3,000 factories producing about 3.5 million tonnes per year. Problems associated with seasonings include high bacterial counts, infestation, moulding and short shelf-life. The seasonings which are necessary for processed meat, and fish products and could affect the products' quality. With the increasing interest of the food industries in using clean seasonings, research on the use of irradiation to reduce microbial contamination and insect infestation has been conducted since 1983. The results of the research were satisfactory and the technology is receiving increasing recognition and acceptance by national authorities and food industries.

To evaluate consumer acceptance of irradiated food in China, an experiment was carried out under the IAEA Research Contract No. 6034/DP, funded by UNDP as part of the Asian Regional Co-operative Project on Food Irradiation. Food stuffs such as hot pepper, thick broad-bean sauce, flavour sauce, dry beef slice, Sichuan sausage and loach, etc. were supplied by Bean Sauce Factory of Sichuan Pixian and Zhiyang Linjangshi and Jiale Flavour Sauce Factory in Chengdu and Yuanjing New Technology Corporation, etc. They were irradiated at 5-8 kGy to improve their quality and extend their shelf lives in Sichuan Provincial Inst. of Nuclear Technology Application. The total quantities of irradiated foods to be tested amounted to about 110 tons in Chengdu, Lanzhou, Taiyuan, Xian and Zhengzhou, etc., from August, 1990 to April, 1991.

Consumer's acceptability tests were conducted from Dec. 1990 to April, 1991 in Chengdu, which is the capital of Sichuan province with a population of about 8,300,000 and centre of politics, business and science.

Many irradiated seasonings and meat as well as fish products were sold in special desks in some department stores with the support of Sichuan Provincial Business Department, Sichuan Provincial Food Industries Association, Chengdu Consumer Association, Chengdu Department Store, People's Department Store and Hongqi Market, etc. Meanwhile, unirradiated foods were also supplied to the stores for comparison of consumers' assessment.

In order to assist consumers in understanding irradiated food, we had carried out an active information campaign before acceptability tests. The following were the detail steps:

(a) A news conference on commercialization of food irradiation was held by Sichuan Provincial Business Department, Sichuan Food Industries Association and Science and Technology Committee of Sichuan Province: 80 participants came from newspaper office, radio, TV, food industry and business society. The news conference was reported over 20 times in newspaper, radio and TV.

*Excerpt from paper presented at the Second FAO/IAEA Research Co-ordination Meeting on Asian Regional Co-operative Project on Food irradiation - Acceptance and Process Control (RPFI Phase III), Jakarta, Indonesia, 15-19 July 1991.

(b) A movie introducing food irradiation was produced by Chinese Agriculture Film Studio with the help of our institute and shown in China.

(c) Irradiated foods were sold in special desks in three big department stores in Chengdu and about 5,000 booklets named "the basic knowledge of food irradiation" were distributed to consumers.

Information desks were established in big department stores to answer the questions asked by consumers and market survey forms were supplied to the consumers who were willing to fill them. The number of the forms collected were 2045.

(d) Ten "point group" were established in Sichuan University, Medical University of West China, Chengdu Seamless Steel Tube Plant, People's Army in Chengdu and Agricultural Science Academy, etc. Different opinions concerning irradiated foods were collected through lectures and discussions.

The following were questions which consumers were asked. The total of consumers were 2045.

	QUESTION	ANSWER	NUMBER	% OF ANSWER
1.	Have you heard of irradiated food?.	a) Yes	1,374	67%
		b) No	504	25%
		c) Uncertain	167	8%
2.	Do you know 8 kinds of irradiated foods have been approved Department of Public Health of China.	a) Yes	460	22%
		b) No	1,016	50%
		c) Uncertain	569	28%
3.	Which seasonings do you think is better?	a) Unirradiated	99	5%
		b) Irradiated	1,469	72%
		c) Uncertain	477	23%
4.	Are you willing to buy irradiated seasonings?.	a) Yes	1,474	72%
		b) No	228	11%
		c) Uncertain	343	17%
5.	Which seasonings do your family like to buy?.	a) Unirradiated	139	7%
		b) Irradiated	1,367	67%
		c) Uncertain	539	26%

The results showed that the per cent of persons who have heard of irradiated food is 67% and that of persons who were willing to buy them is 72%. The per cent of persons who knew 8 kinds of irradiated foods approved by the Department of Public Health of China is only 22%. This is normal because most of persons who were involved in the consumer tests were not specialists in this field.

During the trial, many of the consumers expressed the view that the food irradiation technology should be promoted and applied to food in the markets as soon as possible so that they could buy more such food. However, few consumers objected to irradiated foods and did not believe that the irradiated foods were safe and nutritious. Therefore, additional information campaign on the use of food irradiation is needed. Co-operation among government, institutes, food industries, markets and consumers, is needed to ensure the success of the introduction of the technology.

ADDITIONAL CLEARANCE OF IRRADIATED FOOD

Translated from French

OFFICIAL GAZETTE OF THE FRENCH REPUBLIC
25 July 1991

ORDER OF 17 JULY 1991 RELATING TO THE TREATMENT BY IONIZING RADIATION OF CERTAIN DRIED FRUITS

NOR: ECOC9100067A

The Minister of State, Minister of the Economy, Finance and Budget, the Minister for Agriculture and Forestry and the Minister-Delegate for Health,

In view of the Act of 1 August 1905 on fraud and falsification relating to goods or services, amended inter alia by Act No. 78-23 of 10 January 1978 and Act No. 83-660 of 21 July 1983;

In view of Decree No. 70-392 of 8 May 1970 implementing the above-mentioned amended Act of 1 August 1905 in respect of trade in irradiated foods intended for consumption by persons or animals;

In view of Decree No. 84-1147 of 7 December 1984 implementing the above-mentioned amended Act of 1 August 1905 in respect of the labelling and presentation of foodstuffs;

In view of the opinion issued by the French High Council for Public Hygiene on 10 October 1989;

In view of the opinion issued by the National Academy of Medicine on 27 February 1990;

In view of the opinion issued by the interministerial commission on artificial radioelements on 12 June 1990,

Order:

Art. 1. Authorization is granted, under the conditions described below for the following activities: possession with a view to sale, offering for sale, and sale of dried apricots, dried figs, raisins and dried dates which have undergone microbial decontamination by means of exposure to gamma rays from cobalt-60 or caesium-137 or to accelerated electron beams with an energy less than or equal to 10 MeV.

Art. 2. The dose absorbed by the dried fruits listed in Article 1 shall not exceed 6 kilograys (kGy) and shall ensure the microbial decontamination of these products.

Art. 3. The dried fruits listed in Article 1 shall, before irradiation, meet the following criteria: maximum level of yeast and mould contamination: 10^6 microorganisms per gram.

Art. 4. The dried fruits listed in Article 1 shall not, after harvesting, have undergone any chemical decontamination treatment before or after the irradiation.

Art. 5. The dried fruits listed in Article 1 shall be treated in packaging which complies with the current regulations for materials intended for contact with foodstuffs, and particularly those to be subjected to irradiation.

Art. 6. In order to carry out the control measures provided for in Article 9 of the above-mentioned amended Decree of 8 May 1970, the Departmental Director for Competition, Consumption and the Prevention of Fraud in

the administrative region (Department) where the establishment carrying out the radiation treatment of the products mentioned in Article 1 is situated shall be notified, at least one day in advance, by the person in charge of the said establishment of the date of processing and the quantities of goods to be treated.

When the establishment carries out the radiation treatment on a regular basis, an annual statement specifying the days and times during which the treatment will be performed may replace the notification mentioned above.

Art. 7. The firm responsible for ionizing radiation treatment shall perform at least one direct measurement of the absorbed dose on each production batch treated.

The results shall be entered in a record kept by the firm.

The use of sources installed on vehicles is not permitted if the monitoring conditions specified in this Article are not practicable.

Art. 8. The firms responsible for the ionizing radiation treatment of the dried fruits listed in Article 1 shall keep records of the names and addresses of the consignees, the quantities of irradiated goods dispatched, the date of dispatch, the date of treatment by ionizing radiation and the number of the production batch.

Art. 9. Dried fruits treated by ionizing radiation listed in Article 1, which have been imported from other countries shall be accompanied by an official certificate stating that the treatment has been carried out in accordance with the conditions specified in this Order.

Dried fruits which have been treated by ionizing radiation in EEC member states and are accompanied by official documents showing that the procedures used and the control measures carried out are equivalent to those specified in this Decree are assumed to be in compliance with this Order.

Art. 10. The Director General for Competition, Consumption and the Prevention of Fraud within the Ministry of the Economy, Finance and Budget, the Director General for Foodstuffs within the Ministry for Agriculture and Forestry and the Director General for Health within the Office of the Minister-Delegate for Health are responsible, in their respective areas, for the implementation of this Order, which will be published in the "Official Gazette" of the French Republic.

Done in Paris, 17 July 1991.

The Minister of State, Minister of the Economy, Finance and Budget
For the Minister and by delegation:
The Director General for Competition, Consumption and the Prevention of Fraud,
C. BABUSIAUX

The Minister for Agriculture and Forestry
For the Minister and by delegation:
The Director General for Foodstuffs,
J.-F. GUTHMANN

The Minister-Delegate for Health
For the Minister and by delegation:
The Director General for Health,
J.-F. GIRARD

OFFICIAL GAZETTE OF THE FRENCH REPUBLIC
21 July 1991

ORDER OF 17 JULY 1991 RELATING TO THE TREATMENT BY IONIZING RADIATION OF CASEINS AND CASEINATES INTENDED FOR HUMAN CONSUMPTION

NOR: ECOC9000129A

The Minister of State, Minister of the Economy, Finance and Budget, the Minister for Agriculture and Forestry and the Minister-Delegate for Health,

In view of the Act of 1 August 1905 on fraud and falsification relating to goods or services, amended by Act No. 78-23 of 10 January 1978 and Act No. 83-660 of 21 July 1983;

In view of Decree No. 70-392 of 8 May 1970 implementing the above-mentioned amended Act of 1 August 1905 in respect of trade in irradiated foods intended for consumption by persons or animals;

In view of Decree No. 71-636 of 21 July 1971 issued to implement Articles 258, 259 and 262 of the Rural Code and relating to the health and quality inspection of living animals, and animal products and products of animal origin;

In view of Decree No. 84-1147 of 7 December 1984 implementating the above-mentioned amended Act in respect of the labelling and presentation of foodstuffs;

In view of Decree No. 88-1097 of 2 December 1988 implementing the Act of 1 August 1905 on fraud and falsification relating to goods and services in respect of certain lactoproteins (caseins and caseinates) intended for human consumption;

In view of the amended Order of 21 December 1979 concerning the microbiological criteria to be met by certain animal products or products of animal origin;

In view of the opinion issued by the French High Council for Public Hygiene on 12 January 1988;

In view of the opinion issued by the National Academy of Medicine on 15 March 1988;

In view of the opinion issued by the interministerial commission on artificial radioelements of 7 July 1988,

Order:

Art. 1. Authorization is granted, under the conditions described below, for the following activities: possession with a view to sale, offering for sale, and sale of edible acid casein, edible rennet-casein and edible caseinates which have undergone microbial decontamination by exposure to gamma rays from cobalt-60 or caesium-137 or to accelerated electron beams with energy less than or equal to 10 MeV.

Art. 2. The dose absorbed by the caseins and caseinates referred to in Article 1 during treatment shall not exceed 6 kilograys (kGy) and shall ensure the microbial decontamination of these products.

Art. 3. Caseins and caseinates which are to undergo the treatment described in Article 1 shall comply with the provisions of the above-mentioned Decree No. 88-1097 of 2 December 1988.

Art. 4. The caseins and caseinates referred to in Article 1 shall, before and after treatment, meet the microbiological criteria established by the above-mentioned amended Order of 21 December 1979.

Art. 5. The caseins and caseinates referred to in Article 1 shall be treated in packaging which complies with the current regulations for materials intended for contact with food, and particularly those to be subjected to irradiation.

Art. 6. In order to carry out the control measures provided for in Article 9 of the above-mentioned Decree No. 70-392 of 8 May 1970, the Departmental Director for Competition, Consumption and the Prevention of Fraud and the Director of Veterinary Services of the administrative region (Department) where the establishment carrying out irradiation of the products referred to in Article 1 is situated shall be notified, at least one day in advance, by the person in charge of the said establishment of the date of processing and the quantities of goods to be treated.

When the establishment carries out radiation treatment on a regular basis, an annual statement specifying the days and times during which the treatment will be performed may replace the notificaion mentioned above.

Art. 7. The firm responsible for irradiation shall perform at least one direct measurement of the absorbed dose on each production batch treated.

The results shall be entered in a record kept by the firm.

The use of sources installed on vehicles is not permitted if the monitoring conditions specified in this Article are not practicable.

Art. 8. The firms responsible for the irradiation of the products referred to in Article 1 shall keep records of the names and addresses of the consignees, the quantities of irradiated goods dispatched, the date of dispatch, the date of treatment by ionizing radiation, and the number of the production batch.

Art. 9. Irradiated caseins and caseinates referred to in Article 1 which have been imported from other countries shall be accompanied by an official certificate stating that the treatment has been carried out in accordance with the conditions specified in this Order.

Irradiated caseins and caseinates imported from Member States of the European Economic Communities shall be accompanied by official documents showing that the procedures used and the control measures carried out are equivalent to those described in this Order.

Art. 10. The Director General for Competition, Consumption and the Prevention of Fraud within the Ministry of the Economy, Finance and Budget, the Director General for Foodstuffs within the Ministry for Agriculture and Forestry and the Director General for Health within the Office of the Minister-Delegate for Health are responsible, in their respective areas, for

the implementation of this Order, which will be published in the "Official Gazette" of the French Republic.

Done in Paris, 17 July 1991.

The Minister of State, Minister of the Economy, Finance and Budget
For the Minister and by delegation:
The Director General for Competition, Consumption and the Prevention of Fraud,
C. BABUSIAUX

The Minister for Agriculture and Forestry
For the Minister and by delegation:
The Director General for Foodstuffs,
J.-F. GUTHMANN

The Minister-Delegate for Health
For the Minister and by delegation:
The Director General for Health,
J.-F. GIRARD

PUBLICATION

The Preservation of Food by Irradiation - A factual guide to the process and its effects on food.

Because of an oversight, this publication was included among others as published and issued by the IAEA in Food Irradiation Newsletter, Vol. 15, No. 1 (May 1991). This book is in fact published by:

IBC Technical Services
IBC House
Canada Road
Byfleet, Surrey KT14 7JL
United Kingdom.
(Tel. 09323 55244, Fax. 09323 54576).

Orders for this publication can be made directly from IBC Technical Service. We regret for any inconvenience caused due to this error.

COMING EVENTS

1. Eighth Annual Meeting of the International Consultative Group on Food Irradiation (ICGFI), Vienna, Austria; 4-6 November 1991.

2. FAO/IAEA Training Course on Food Irradiation for African Countries, Cairo, Egypt; 9 Nov. - 6 December 1991.

3. ICGFI Workshop on Techno-Economics of Food Irradiation, Dhaka, Bangladesh; 8-19 December 1991.

4. WHO/IAEA/FAO Seminar on Harmonization of Regulations on Food Irradiation in Asia and the Pacific, Kuala Lumpur, 20-24 January 1992.

5. First FAO/IAEA Research Co-ordination Meeting on Irradiation as a Quarantine Treatment of Mites, Nematodes and Insects other than Fruit Fly, Gainsville, Florida, 27 April - 1 May 1992. (Tentative).

6. FAO/IAEA Training Course on Techno-Economics of Food Irradiation for Latin America and the Caribbean, Mexico City, 4-29 May 1992. (Tentative).

QUESTIONNAIRE

Please fill in the form below and return it to us before 31 December 1991, if you are interested in continuing to receive future issues of the FOOD IRRADIATION NEWSLETTER.

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Food Irradiation Newsletter

JOINT FAO/IAEA DIVISION OF NUCLEAR TECHNIQUES IN FOOD AND AGRICULTURE
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA

ISSN 1011-2588

SUPPLEMENT
to
FOOD IRRADIATION NEWSLETTER
Vol. 15, No. 2 – October 1991

LIST OF CLEARANCES (As of 1991-09-19)

(Grouped according to country)

(This List of Clearances has been prepared on the basis of information provided by governments/ institutions/scientists. It may not represent a complete list of clearances of irradiated foods).

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min.(kGy)	PERMITTED DOSE max.	DATE OF APPROVAL
ARGENTINA	strawberries	shelf-life extension	unconditional		2.5	30 April 1987
	potatoes	sprout inhibition	unconditional	0.03	0.15	30 April 1987
	onions	sprout inhibition	unconditional	0.02	0.15	30 April 1987
	garlic	sprout inhibition	unconditional	0.02	0.15	30 April 1987
	spices	decontamination	unconditional		30	November 1983
BANGLADESH	chicken	shelf-life extension/ decontamination	unconditional		7	28 December 1983
	papaya	insect disinfestation/ control of ripening	unconditional		1	28 December 1983
	potatoes	sprout inhibition	unconditional		0.15	28 December 1983
	wheat and ground wheat products	insect disinfestation	unconditional		1	28 December 1983
	fish	shelf-life extension/ decontamination insect disinfestation	unconditional		2.2	28 December 1983
	onions	sprout inhibition	unconditional		0.15	28 December 1983
	rice	insect disinfestation	unconditional		1	28 December 1983
	froglegs	decontamination	provisional		7	
	shrimps	shelf-life extension/ decontamination	provisional		5	
	mangoes	shelf-life extension/ insect disinfestation control ripening	unconditional		1	28 December 1983
	pulses	insect disinfestation	unconditional		1	28 December 1983
	spices	decontamination/ insect disinfestation	unconditional		10	28 December 1983

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min.(kGy)	PERMITTED DOSE max.	DATE OF APPROVAL
BELGIUM	potatoes	sprout inhibition	provisional		0.15	16 July 1980
	strawberry	shelf-life extension	provisional		3	16 July 1980
	onions	sprout inhibition	provisional		0.15	16 October 1980
	garlic	sprout inhibition	provisional		0.15	16 October 1980
	shallots	sprout inhibition	provisional		0.15	16 October 1980
	black/white peper	decontamination	provisional		10	16 October 1980
	paprika powder	decontamination	provisional		10	16 October 1980
	arabic gum	decontamination	provisional		10	29 September 1983
	spices(78 different products) (semi)-dried vegetables (7 different products)	decontamination	provisional		10	29 September 1983
	shrimps	decontamination	provisional	3	5	30 November 1988
	herbal teas	decontamination	provisional		10	30 November 1988
BRAZIL	rice	insect disinfestation	unconditional		1	7 March 1985
	potatoes	sprout inhibition	unconditional		15	7 March 1985
	onions	sprout inhibition	unconditional		15	7 March 1985
	beans	insect disinfestation	unconditional		1	7 March 1985
	maize	insect disinfestation	unconditional		0.5	7 March 1985
	wheat	insect disinfestation	unconditional		1	7 March 1985
	wheat flower	insect disinfestation	unconditional		1	7 March 1985
	spices (13 different products)	decontamination/ insect disinfestation	unconditional		10	7 March 1985
	papayas	insect disinfestation control of ripening	unconditional		1	7 March 1985
	strawberries	shelf-life extension	unconditional		3	7 March 1985
	fish and fish-products (fillets, salted, smoked, dried, dehydrated)	shelf-life extension decontamination insect disinfestation	unconditional		2.2	8 March 1985
	poultry	shelf-life extension/ decontamination	unconditional		7	8 March 1985

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min. (kGy) max.	DATE OF APPROVAL
BULGARIA	potatoes	sprout inhibition	experimental batches	0.1	30 April 1972
	onions	sprout inhibition	experimental batches	0.1	30 April 1972
	garlic	sprout inhibition	experimental batches	0.1	30 April 1972
	grains	insect disinfestation	experimental batches	0.3	30 April 1972
	dry food concentrates	insect disinfestation	experimental batches	1	30 April 1972
	dried fruits	insect disinfestation	experimental batches	1	30 April 1972
	fresh fruits (tomatoes, peaches appricot, cherry, raspberry, grapes)	shelf-life extension	experimental batches	2.5	30 April 1972
CANADA*	potatoes	sprout inhibition	unconditional	0.1	9 November 1960 14 June 19863
	onions	sprout inhibition	unconditional	0.15	25 March 1965
	wheat, flower, wholewheat	insect disinfestation	unconditional	0.75	25 February 1969
	spices and certain dried vegetables seasonings	decontamination	unconditional	10	3 October 1984
	onion powder	decontamination	unconditional	10	12 December 1983

*The Government has recognized food irradiation as a process and will permit the irradiation of specified foodstuffs subject to certain conditions (Registration SOR/89-175, 23 March 1989).

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min. (kGy)max.	DATE OF APPROVAL
CHILE	potatoes	sprout inhibition	experimental batches		31 October 1974
			test marketing		29 December 1982
			unconditional	0.15	
	papaya	insect disinfestation	unconditional	1	29 December 1982
	wheat and ground wheat products	insect disinfestation	unconditional	1	29 December 1982
	strawberry	shelf-life extension	unconditional	3	29 December 1982
	chicken	decontamination	unconditional	7	29 December 1982
	onions	sprout inhibition	unconditional	0.15	29 December 1982
	rice	insect disinfestation	unconditional	1	29 December 1982
	teleost fish and fish products	shelf-life extension decontamination insect disinfestation	unconditional	2.2	29 December 1982
	cocoa beans	decontamination/ insect disinfestation	unconditional	5	29 December 1982
	dates	insect disinfestation	unconditional	1	29 December 1982
	mangoes	shelf-life extension/ insect disinfestation/ control of ripening	unconditional	1	29 December 1982
	pulses	insect disinfestation	unconditional	1	29 December 1982
	spices and condiments	decontamination/ insect disinfestation	unconditional	10	29 December 1982
CHINA	potatoes	sprout inhibition	unconditional	0.20	30 November 1984
	onions	sprout inhibition	unconditional	0.15	30 November 1984
	garlic	sprout inhibition	unconditional	0.10	30 November 1984
	peanuts	insect disinfestation	unconditional	0.40	30 November 1984
	grains	insect disinfestation	unconditional	0.45	30 November 1984
	mushrooms	growth inhibition	unconditional	1	30 November 1984
	sausage	decontamination	unconditional	8	30 November 1984
	apples	shelf-life extension	unconditional	0.4	30 September 1988
CUBA	cocoa beans	disinfestation	unconditional	0.5	September 1988
	potatoes	sprout inhibition	unconditional	0.10	December 1987
	onions	sprout inhibition	unconditional	0.06	December 1987

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min. (kGy)	max.	DATE OF APPROVAL
CZECHOSLOVAKIA	potatoes	sprout inhibition	experimental batches		0.1	26 November 1976
	onions	sprout inhibition	experimental batches		0.08	26 November 1976
	mushrooms	growth inhibition	experimental		2	26 November 1976
DENMARK	spices and herbs	decontamination	unconditional		15 (aver.)10	23 December 1985
FINLAND	dry and dehydrated spices and herbs	decontamination	unconditional		(aver.)10	13 November 1987
	all foods for patients requiring sterile diet	sterilization	unconditional	nolimited		13 November 1987
FRANCE	potatoes	sprout inhibition	provisional	0.075	0.15	8 November 1972
	onions	sprout inhibition	unconditional	0.075	0.15	21 June 1984
	garlic	sprout inhibition	unconditional	0.075	0.15	21 June 1984
	shallot	sprout inhibition	unconditional	0.075	0.15	21 June 1984
	spices and aromatic substances (inclusive powdered onions and garlic)	decontamination	unconditional		11	10 February 1983
	gum arabic	decontamination	unconditional		9	17 May 1985
	cereal flakes and germs for milk products	decontamination	unconditional		10	17 May 1985
	dehydrated vegetatables	decontamination	unconditional		10	17 May 1985
	mechanically deboned poultry meat	decontamination	unconditional		5	6 February 1985
	dry fruits	insect disinfestation	unconditional		1	6 January 1988

...contd..

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min. (kGy)max.	DATE OF APPROVAL
FRANCE(contd.)	dry vegetables	insect disinfestation	unconditional	1	6 January 1988
	strawberries	shelf-life extension	unconditional	3	29 December 1988
	frog legs, frozen	to control microbial contamination	unconditional	4 to 8	3 May 1988
	egg white (liquid, dried or frozen)	disinfestation	unconditional	4	1 October 1990
	frozen or refrigerated peeled, deheaded shrimp	microbial decontamination	unconditional	5	2 October 1990
	animal blood, plasma and cruor	decontamination	unconditional	10	19 November 1986
	rice flour	decontamination	unconditional	5	4 November 1988
	aromatic herbs, (frozen)	decontamination	unconditional	10	15 May 1988
	poultry, ground, chopped or cut	decontamination	unconditional	5	27 August 1990
	arcaceins and caseinates	decontamination	unconditional	6	17 July 1991
	materials and objects in contact with food				12 August 1986
	raisins, dried dates, figs and dry apricots	decontamination	unconditional	6	17 July 1991
HUNGARY	mixed dry(ingredients for canned mashed meat	decontamination	experimental batches	5	20 November 1976
	onions for dehydrated flakes processing	sprout inhibition	test marketing	0.05	18 November 1980
	potatoes	sprout inhibition	test marketing	0.10	2 December 1981
	strawberries	shelf-life extension	test marketing	2.5	15 April 1982
	mushrooms(Agaricus)	growth inhibition	test marketing	2.5	15 April 1982
	mushrooms(Pleurotus)	growth inhibition	test marketing	3	15 April 1982
	grapes	shelf-life extension	test marketing	2.5	15 April 1982
	cherries	shelf-life extension	test marketing	2.5	15 April 1982

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min. (kGy)	max.	DATE OF APPROVAL
HUNGRY (contd.)						
	sour cherries	shelf-life extension	test marketing		2.5	15 April 1982
	red currents	shelf-life extension	test marketing		2.5	15 April 1982
	onions	sprout-inhibition	unconditional	0.05	0.02	23 June 1982
	pears	shelf-life extension	test marketing	1.0 + $CaCl_2$ treatment		24 January 1983
	potatoes(for processing into flakes)	sprout inhibition	test marketing		0.1	28 January 1983
	frozen chicken	decontamination	test marketing		4	3 October 1983
	sour cherries (canned)	shelf-life extension	conditional	(aver.)	0.2	20 February 1984
	spices	decontamination	unconditional	(aver.)	6	19 August 1986
INDIA	potatoes	sprout inhibition	unconditional	(aver.)	0.15	January 1986
	onions	sprout inhibition	unconditional	(aver.)	0.15	January 1986
	spices	disinfection	for export only	(aver.)	10	January 1986
	frozen shrimps and froglegs	disinfection	for export only	*		January 1986
INDONESIA	dried spices	decontamination	unconditional		10	29 December 1987
	tuber and root crops (potatoes, shallots, garlic and rhizomes)	sprout inhibition	unconditional		0.15	29 December 1987
	cereals	disinfestation	unconditional		1	29 December 1987

*No specific limit set; general limit for all foods 10 kGy overal average.

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min. (kGy)	max.	DATE OF APPROVAL
ISRAEL	potatoes	sprout inhibition	unconditional		0.15	5 July 1967
	onions	sprout inhibition	unconditional		0.15	6 March 1985
	garlic	sprout inhibition	unconditional		0.15	6 March 1985
	shallots	sprout inhibition	unconditional		0.15	6 March 1985
	spices (61 different products)	decontamination	unconditional	(aver.)10		17 February 1987
	fruits and vegetables	sprout inhibition/ mould control/ shelf-life extension	unconditional	(aver.)1		17 February 1987
	grains, cereals, pulses, cocoa & coffee beans, nuts, edible seeds	disinfestation	unconditional	(aver.)1		17 February 1987
	animal feed	decontamination	unconditional	(aver.)7		17 February 1987
	mushrooms, strawberries	shelf life extension	unconditional	(aver.)3		17 February 1987
	poultry and poultry sections	decontamination/ shelf-life extension	unconditional	(aver.)7		17 February 1987
	dry and dried vegetables and edible plants	decontamination	unconditional	(aver.)10		17 February 1987
	poultry feeds	decontamination	unconditional	(aver.)15		January 1987
ITALY	potatoes	sprout inhibition	unconditional	0.075	0.15	30 August 1973
	onions	sprout inhibition	unconditional	0.075	0.15	30 August 1973
	garlic	sprout inhibition	unconditional	0.075	0.15	30 August 1973
JAPAN	potatoes	sprout inhibition	unconditional		0.15	30 August 1972
KOREA REPUBLIC OF	potatoes	sprout inhibition	unconditional		0.15	28 September, 1987
	onions	sprout inhibition	unconditional		0.15	28 September, 1987
	garlic	sprout inhibition	unconditional		0.15	28 September, 1987
	chestnut	sprout inhibition	unconditional		0.25	28 September, 1987
	fresh and dried mushrooms	growth inhibition and insect disinfestation	unconditional		1.00	28 September, 1987
	dried spices	decontamination	unconditional		10	1 September 1988

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min.(kGy)	max.	DATE OF APPROVAL
MEXICO	onion powder	disinfestation	unconditional	10		January 1988
	onion paste	disinfestation	unconditional	10		January 1988
	garlic powder	disinfestation	unconditional	10		January 1988
	pepper powder	disinfestation	unconditional	10		January 1988
	chilli powder	disinfestation	unconditional	10		January 1988
	coriander(single seed)	decontamination	unconditional	10		January 1988
	oregano, dehydrated	decontamination	unconditional	10		January 1988
	egg powder	microbi.decontamination	unconditional	10		January 1988
	cocoa powder	decontamination	unconditional	7		January 1988
	cereal products	decontamination	unconditional	7		January 1988
	prepared soup	decontamination	unconditional	7		January 1988
	milk powder	microbi.decontamination	unconditional	7		January 1988
NETHERLANDS	dried vegetables	decontamination	temporary for 2 yrs	10		20 Oct. 1988
	frozen shrimps	decontamination	temporary for 2 yrs	7		
	fresh shrimps	decontamination	temporary for 2 yrs	1		20 Oct. 1988
	spices and herbs	decontamination	temporary for 2 yrs	10		20 Oct. 1988
	poultry	decontamination	temporary for 2 yrs	3		20 Oct. 1988
	fish fillets	decontamination	temporary for 2 yrs		1.0	20 Oct. 1988
	frozen meals for patients who need a sterile diet	decontamination	temporary for 2 yrs		25.0	20 Oct. 1988
NORWAY	spices (dried)	decontamination	permission given on case by case		10	July 1982
PAKISTAN	potatoes	sprout inhibition	unconditional		0.15	13 June 1988
	onions	sprout inhibition	unconditional		0.15	13 June 1988
	garlic	sprout inhibition	unconditional		0.15	13 June 1988
	spices	decontamination/ disinfestation	unconditional		10.0	13 June 1988

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min. (kGy)	PERMITTED DOSE max.	DATE OF APPROVAL
PHILIPPINES	potatoes	sprout inhibition	provisional		0.15	13 September 1972
	onions	sprout inhibition	provisional		0.07	1981
	garlic	sprout inhibition	provisional		0.07	1981
POLAND	onions	sprout inhibition	unconditional		0.06	April 1987
	garlic	sprout inhibition	unconditional		0.15	October 1990
	spices and herbs	microbial control	unconditional		10	October 1990
	potatoes	sprout inhibition	temp. for 3 yrs.		0.10	October 1990
	mushrooms	shelf-life extension	temp. for 3 yrs.		2.5	October 1990
SOUTH AFRICA	potatoes	sprout inhibition	unconditional	0.12	0.24	19 January 1977
	bananas, dried	insect disinfestation	provisional		0.5	28 July 1977
	avocados	insect disinfestation	provisional		0.1	28 July 1977
	onions	sprout inhibition	unconditional	0.5	0.15	25 August 1978
	garlic	sprout inhibition	unconditional	0.1	0.20	25 August 1978
	chicken	shelf-life extension/ decontamination	unconditional	2	7	25 August 1978
	papayas	shelf-life extension	unconditional	0.5	1.5	25 August 1978
	mangoes	shelf-life extension	unconditional	0.5	1.5	25 August 1978
	strawberries	shelf-life extension	unconditional	1	4	25 August 1978
	bananas	shelf-life extension	unconditional			1982
	litchis	shelf-life extension	unconditional			1982
	pickled mangoes (achar)	shelf-life extension	unconditional			1982
	avocados	shelf-life extension	unconditional			1982
	frozen fruit juices	shelf-life extension	unconditional			1982
	green beans		unconditional			
	tomatoes	control ripening	unconditional			
	soya pickle products		unconditional			
	ginger		unconditional			
	vegetable paste		unconditional			
	bananas, dried	insect disinfestation	unconditional			
	almonds	insect disinfestation	unconditional			
	cheese powder	insect disinfestation	unconditional			
	yeast powder		unconditional			
	herbal teas		unconditional			
	various spices		unconditional			
	various dehydrated vegetables		unconditional			

Note: List of authorizations to sell irradiated foods issued to individuals/companies for specific commodities.

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min. (kGy)	PERMITTED DOSE max.	DATE OF APPROVAL
SPAIN	potatoes	sprout inhibition	unconditional	0.05	0.15	4 November 1969
	onions	sprout inhibition	unconditional		0.08	1971
SYRIAN ARAB REPUBLIC	chicken	shelf-life extension (or) reduction of pathogenic micro-organisms like salmonella in dressed chicken	unconditional		7.0	2 August 1986
	cocoa beans	disinfestation and reduction of micro-organisms or bacteria	unconditional		5.0	2 August 1986
	dates	disinfestation	unconditional		1.0	2 August 1986
	mangoes	disinfestation	unconditional		1.0	2 August 1986
	onions	sprouting inhibition	unconditional		1.5	2 August 1986
	papayas	disinfestation	unconditional		1.0	2 August 1986
	potatoes	sprout inhibition	unconditional		1.5	2 August 1986
	legumes	disinfestation	unconditional		1.0	2 August 1986
	rice	disinfestation	unconditional		1.0	2 August 1986
	spices and condiments, dried onions and onion powder	disinfestation	unconditional		10	2 August 1986
	strawberries	shelf-life extension	unconditional		3.0	2 August 1986
	bony fish and fish products	disinfestation	unconditional		2.2	2 August 1986
	wheat and main wheat products	disinfestation	unconditional		1.0	2 August 1986
THAILAND	potatoes, onions & garlic	sprout inhibition	unconditional		0.15	4 December 1986
	dates	disinfestation	unconditional		1	4 December 1986
	mangoes, papayas	disinfestation and delay of ripening	unconditional		1	4 December 1986
	wheat, rice, pulses	disinfestation	unconditional		1	4 December 1986
	cocoa beans	disinfestation	unconditional		1	4 December 1986

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min. (kGy)	PERMITTED DOSE max.	DATE OF APPROVAL
(THA. contd.)	fish and fishery products	disinfestation	unconditional		1	4 December 1986
	fish and fishery products	reduce microbial load	unconditional		2.2	4 December 1986
	strawberries	shelf-life extension	unconditional		3	4 December 1986
	nham	decontamination	unconditional		4	4 December 1986
	moo yor	decontamination	unconditional		5	4 December 1986
	sausage	decontamination	unconditional		5	4 December 1986
	frozen shrimps	decontamination	unconditional		5	4 December 1986
	cocoa beans	reduce microbial load	unconditional		5	4 December 1986
	chicken	decontamination and shelf-life extension	unconditional		7	4 December 1986
	spices & condiments, dehydrated	insect disinfestation	unconditional		1	4 December 1986
	onions and onion powder	decontamination	unconditional		10	4 December 1986
UNION OF SOVIET SOCIALIST REPUBLIC	potatoes	sprout inhibition	unconditional		0.3 (1 MeV electrons)	17 July 1973
	grains	insect disinfestation	unconditional		0.3	1959
	fresh fruits and vegetables	shelf-life extension	experimental batches	2	4	11 July 1964
	semi-prepared raw beef, pork & rabbit-products (in plastic bags)	shelf-life extension	experimental batches	6	8	11 July 1964
	dried fruits	insect disinfestation	unconditional		1	15 February 1966
	dry food concentrates (buckwheat mush, gruel, rice, pudding)	insect disinfestation	unconditional		0.7	6 June 1966
	poultry, eviscerated (in plastic bags)	shelf-life extension	experimental batches		6	4 July 1966
	culinary prepared meat products (fried meat entrecote) (in plastic bags)	shelf-life extension	test marketing		8	1 February 1967
	onions	sprout inhibition	unconditional		0.06	17 July 1973

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min. (kGy)	PERMITTED DOSE max.	DATE OF APPROVAL
UNITED KINGDOM	any food for consumption by patients who require a sterile diet as essential factor of their treatment	sterilization	hospital patients			1 December 1969
	fruit		unconditional		2(**)	
	vegetables		unconditional		1(**)	
	cereals		unconditional		1(**)	
	bulbs and tubers		unconditional		0.2(**)	
	spices and condiments		unconditional		10(**)	
	fish and shellfish		unconditional		3(**)	
	poultry		unconditional		7(**)	
(*)subject to licencing of irradiators for applications of individual process						
(**)overall average dose						
UNITED STATES OF AMERICA	wheat and wheat powder	insect disinfestation	unconditional	0.2	0.5	21 August 1963
	white potatoes	shelf-life extension	unconditional	0.05	0.15	1 November 1965
	spices and dry vegetable seasonings (38 commodities)	decontamination/ insect disinfestation	unconditional		30	5 July 1983
	dry or dehydrated enzyme preparations(includ. immobilized enzyme preparations)	control of insects and/or microorganisms	unconditional		30	10 June 1985
	pork carcases or fresh, non-heat processed cuts of pork carcases	control of Trichinella spiralis	unconditional	0.3	1.0	22 July 1985
	fresh fruits	delay or maturation	unconditional		1	18 April 1986
	dry or dehydrated enzyme preparations	decontamination	unconditional		10	18 April 1986
	dry or dehydrated aromatic vegetable substances	decontamination	unconditional		30	18 April 1986
	poultry	decontamination	unconditional		3	1 May 1990

COUNTRY	PRODUCT	PURPOSE OF IRRADIATION	TYPE OF CLEARANCE	PERMITTED DOSE min. (kGy)max.	DATE OF APPROVAL
URUGUAY	potatoes	sprout inhibition	unconditional		23 June 1970
VIETNAM	potatoes	sprout inhibition	provisional	0.15	3 Nov. 1989
SOC.REP.	onions	sprout inhibition	provisional	0.1	3 Nov. 1989
	garlic	sprout inhibition	provisional	0.1	3 Nov. 1989
	dry green beans	insect disinfestation	experimental batch	1	3 Nov. 1989
	maize	insect disinfestation	experimental batch	1	3 Nov. 1989
	paprika powder	insect disinfestation	experimental batch	1	3 Nov. 1989
	dried fish	insect disinfestation	experimental batch	1	3 Nov. 1989
YUGOSLAVIA	cereals	insect disinfestation	unconditional	10	17 December 1984
	legumes	insect disinfestation	unconditional	10	17 December 1984
	onions	sprout inhibition	unconditional	10	17 December 1984
	garlic	sprout inhibition	unconditional	10	17 December 1984
	potatoes	sprout inhibition	unconditional	10	17 December 1984
	dehydrated fruits & vegetables	sprout inhibition	unconditional	10	17 December 1984
	dried mushrooms		unconditional	10	17 December 1984
	egg powder	decontamination	unconditional	10	17 December 1984
	herbal teas, tea extracts	decontamination	unconditional	10	17 December 1984
	fresh meat and poultry, spices	shelf-life extension/ decontamination	unconditional	10	17 December 1984
TAIWAN*	potatoes, sweet-potatoes, onions, garlic, shallots	sprout inhibition	unconditional	0.15	16 January 1985
	papayas, mangoes	delay ripening	unconditional	1.5	16 January 1985
	rice	control insects	unconditional	1.0	16 January 1985
	small red beans, mungbeans, soybeans	control insects	unconditional	0.2	16 January 1985
	wheat, flour	control insects	unconditional	0.4	16 January 1985
	spices	control insects/ decontamination	unconditional	30	30 November 1987

* not a member of FAO or IAEA

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