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WORKING MATERIAL

The Development of Irradiated Foods for Immuno-Compromised Patients and other Potential Target Groups

REPORT OF THE SECOND RESEARCH COORDINATION MEETING

Manila, Philippines, 21-25 November 2011

FAO / IAEA Division of Nuclear Techniques in Food and Agriculture

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INTERNATIONAL ATOMIC ENERGY AGENCY

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On

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1. Introduction

The second Research Coordination Meeting (RCM) of the Coordinated Research Project (CRP) on the Development of Irradiated Foods for Immuno-Compromised Patients and other Potential Target Groups met in Manila, Philippines, from 20 – 25 November 2011.

The meeting recalled that the overall objective is to utilise irradiation technology to increase the variety, availability and acceptability of foods for immuno-compromised patients and other potential target groups with special dietary needs. This will involve participants working in collaboration with their healthcare community and target groups to research appropriate foods, for example irradiated fresh produce (fruits, vegetables, salads), ready-to-eat meals (ethnic or locally produced) and functional foods. An allied objective is to generate data on the acceptability of irradiated foods in terms of both quantitative factors (microbiological safety, nutritional and organoleptic properties) and qualitative properties (psychological well-being, quality of life). Secondary objectives include the development of microbiological criteria for foods intended for different target groups of patients based on the microorganisms of importance and dietary requirements.

The meeting was chaired by Mr Suresh Pillai and co-chaired by Ms Zeny De Guzman. Mr Arun Sharma agreed to be the rapporteur and Carl Blackburn was the scientific secretary. The list of participants and proposed agenda are attached at Annex A and B, respectively.

The meeting was opened by Dr Alumanda dela Rosa, Director, Philippine Nuclear Research Institute (PNRI), who welcomed the meeting participants, summarized the role and work of the PHRI with emphasis on the irradiation facility and food irradiation research carried out in the Philippines, and noted that this CRP is helping the PNRI to forge links with the medical community. Dr Aileen Riego-Javier, Executive Director, National Kidney and Transplant Institute (NKTI) of the Philippines, also welcomed meeting participants. Dr Riego-Javier outlined the medical expertise at NKTI and introduced Ms Socorro Balderamos, the officer in charge of the Nutrition and Dietetics Division at the NKTI and collaborating partner for this work in the Philippines. Dr Ernesto Que and Dr Romulo de Villa, both consultants at NKTI, also participated in the meeting. Carl Blackburn, IAEA/FAO food irradiation specialist and CRP Technical Officer, informed the meeting of initiatives related to applications of food irradiation, including activities of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (NAFA), and thanked the host PNRI, and particularly Ms. Zeny de Guzman and her team, for the excellent arrangements in place for hosting the meeting.

During the meeting each participant was asked to provide a short written summary that included information on research progress, collaborating partners, details of what went well and what was not as successful and an outline of their plans for the next research phase (Annex C). The CRP research protocol that was produced at the first RCM was reviewed and modified slightly to include guidance on sensory trials and make necessary minor amendments[1]. The revised CRP research protocol is attached at Annex D. The types of foods to be researched were reviewed and are summarized in Annex E. Project outputs gained so far were discussed and are summarized in tabular form in Annex F. Participants also reviewed the perceived strengths, weaknesses, opportunities and threats related to this project from a researchers perspective and a summary of this exercise is provided at Annex G.

2. Background

Food irradiation is one of the few technologies that address both food quality and safety by virtue of its ability to control spoilage and food borne pathogenic microorganisms without significantly affecting sensory or other organoleptic attributes of the food. Foods are irradiated to provide the same benefits as when they are processed by heat, refrigeration, freezing or treatment with chemicals, but irradiation has several advantages:

- It does not significantly raise food temperature and the food does not “cook”.

[1] The guideline microbiological levels for foods intended for immuno-compromised patients and other potential target groups (produced at the first RCM) were not altered.

- Unlike chemical treatments, irradiation does not leave potentially harmful residues.
- It can be used to treat packaged food, which will remain safe and protected from microbial contamination after treatment.

After many years of research and the development of national and international standards, more than 60 countries have regulations allowing food irradiation of at least one product. Commercial food irradiation is normally applied in combination with other food processing technologies at radiation doses of less than 10 kilogray (kGy). This degree of irradiation destroys populations of microorganisms, including disease-carrying bacteria and spoilage organisms. The food is not completely sterilized, but the many-fold reduction in microorganisms helps prevent illnesses and also makes it possible to keep food longer. Using irradiation to completely sterilize food is unusual, but high-dose treatments above 10 kGy have been used to sterilize food for non-commercial applications, for example in space programmes where irradiated, shelf-stable food products are provided for astronauts.

Ensuring food safety is especially important for people who have impaired immune systems, such as those who are immuno-compromised by disease (e.g. neutropenic patients) or who have recently undergone medical treatments (e.g. organ transplant patients). Food is a potential source of infection and even organisms normally considered non-pathogenic may cause problems. Three safety levels of diet are generally recognised by healthcare professionals:

- Sterile diet.
- Clean (low bacterial count or neutropenic) diet.
- Normal common sense food hygiene.

Health care trends have moved away from stringent sterile diets towards clean diets where there are advantages in maintaining exposure to normal microbial flora, with the added advantage of having a greater dietary variety. The clean diet approach ensures good hygienic practices are observed and imposes restrictions on foods that are known to be unsafe. The risk of food borne illness, though not completely eliminated, is minimised to an acceptable degree.

Despite the potential for food irradiation to provide food that is sterile or clean, there is little evidence of its wide-scale use to provide food for patients or other potential target groups who require this level of food safety. Recent research undertaken under a CRP[2] (2002-2006) on the use of irradiation to ensure the safety and quality of prepared meals established that ionizing radiation, in combination with good manufacturing practices and refrigeration, greatly reduces the risk of food-borne diseases in a wide variety of foods, and results in both nutritional and psychological benefits for immuno-compromised patients. However, as this was the first research carried out under a CRP related to the use of food irradiation for immuno-compromised patients, it was concluded that more research should be undertaken to widen the meal variety and to explain this method to the medical community, including patients, health institutes and catering services. In addition, collaboration between food irradiation researchers and nutritionists was considered essential to ensure the acceptance and to advance regulatory initiatives related to the use of food irradiation for these purposes. It was further concluded that the commercial availability of these shelf-stable foods would enable hospitals, without specialist catering facilities, to provide clean diets.

2.1 Consultants Meeting

A Consultants Meeting was held at the IAEA Headquarters in Vienna from 24 – 27 November 2009 in order to consider the application of irradiation technology to foods for patients and other target groups. The purpose of the Consultants Meeting was to advise the Food and Environmental Protection subprogramme of the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture (NAFA) on a proposed Coordinated Research Project (CRP) on the use of irradiation for shelf-stable sterile foods for immuno-compromised patients and other specific target groups. The Consultants Meeting recommended that:

[2] Irradiation to Ensure the Safety and Quality of Prepared Meals, IAEA 2009, ISBN 978-92-0-111108-1

(1) The CRP should primarily concentrate on foods for immuno-compromised patients as well as other potential target groups.

(2) CRP participants should investigate and develop irradiated foods for immuno-compromised patients and other target groups in collaboration with other relevant partners, including medical doctors, nutritionists, other healthcare food industry specialists and relevant international organizations. The title of the CRP should be revised to the "Development of Irradiated Foods for Immuno-compromised Patients and Other Potential Target Groups".

(3) CRP participants must have access to, or be able to undertake:

- Radiation processing (gamma, X-ray or electron beam).
- Quantitative microbiological, nutritional and sensory testing.
- Qualitative psychological assessments.

(4) The CRP should mainly investigate irradiated foods such as fresh produce (fruits, vegetables, salads), ready-to-eat meals (chilled packed meals) and functional foods. Studies should take into consideration ethnic, local and regional foods.

(5) The first RCM should:

- Establish a range of diverse foods for study.
- Agree which organisms are of importance, including viruses, bacteria and parasites.
- Determine appropriate microbial criteria for the foods under development.

(6) Studies should take account of the specific target group of patients and any related factors such as age, additional special dietary requirements (low salt, low protein, low fat), and specific feeding requirements (e.g. orally or nasogastric).

(7) The CRP should include an educational element on irradiated therapeutic food, which should be targeted at medical specialists. The collation and dissemination of appropriate information and data should form part of this activity, as should patient surveys regarding the acceptability of irradiated foods in hospital diets.

2.2 First Research Coordination Meeting

The First Research Coordination Meeting was held at IAEA Headquarters in Vienna, Austria from 23 – 27 August 2010. The objective was to refine work plans and activities to be undertaken during the course of the CRP. It also helped provide a better understanding of the CRP objectives, where participants could agree on a common approach for moving forward. In particular, the meeting discussed the proposed research plans of individual participants, helped facilitate a broader understanding of the relationship each has to the overall objectives of the CRP, promoted interaction between the participants and also prepared a set of recommendations and guidelines to facilitate and promote CRP objectives and project tasks. The first RCM recommended that:

(1) A web-user-group should be established that is dedicated to sharing information between participants. It is recommended that research protocols, educational material, communication media and relevant publications are placed on this web group site and that it is established as early as possible.

(2) CRP participants should interact with their healthcare community to build a working relationship and encourage collaboration. Research should be guided by this collaboration to decide upon the target foods. Healthcare professionals and food suppliers should be encouraged to attend the next Research Coordination meeting. Communicating the benefits of irradiated food is critical to the successful adoption, development, marketing, and commercialization of irradiated foods for patients and other potential target groups. Research should be based on information from commercial food suppliers, as well as the healthcare and medical community, and relevant international organizations.

(3) Foods developed under this research should also be suitable for commercialization. For example, irradiated foods could be developed for in-patients because these foods would have a good chance of being used by hospitals and therefore be of interest to commercial organizations that supply hospital food. The CRP should primarily concentrate on foods for immuno-compromised patients as well as other potential target groups.

(4) Technical Cooperation projects should be sought to transfer this technology to other countries and disseminate information to decision makers on the value of irradiated foods for patients and other specific stakeholders (e.g. building technical capacity and exchange information by means of meetings or seminars involving regulatory and policy officials).

(5) A template form for reporting research progress should be developed and circulated to participants to facilitate interim and final report preparation.

3. Objectives of the Coordinated Research Project

The overall objective is to utilize irradiation technology to increase the variety, availability and acceptability of foods for immuno-compromised patients and other potential target groups with special dietary needs, for example irradiated fresh produce (fruits, vegetables, salads), ready-to-eat meals (ethnic or locally produced) and functional foods. The allied objective is to generate data on the acceptability of irradiated foods in terms of both quantitative factors (microbiological safety, nutritional and organoleptic properties) and qualitative properties (psychological well-being, quality of life).

The specific objective of the CRP is to research a range of simple irradiated foods (fresh fruits, vegetables and salads) and complex irradiated foods (ready-to-eat meals) for immuno-compromised patients and potentially other target groups.

Secondary objectives include the development of microbiological criteria for foods intended for different groups based on the bacterial organisms of importance and dietary requirements as related to different age groups (infants, children, adults and the elderly). The acceptance of irradiated foods by the healthcare and regulatory communities will increase the development, marketing and commercialization of irradiated foods for hospital patients. This project could also lead to the use of irradiated foods by other potential target groups (e.g. space food, civil defence, outdoor activities).

Expected Research Outputs

- Data on the:

  (i) microbiological, nutritional and organoleptic properties of irradiated foods for patients.

  (ii) acceptability of irradiated foods for patients, hospitals, medical professionals and other potential target groups.

  (iii) use of ionizing radiation in combination with other food technologies such as Modified Atmosphere Packaging (MAP).

- The publication of:

  (i) research data on the applicability of food irradiation for medical diets.

  (ii) educational and informational material for healthcare specialists, consumers and other relevant stakeholders.

  (iii) an FAO/IAEA Technical document (TECDOC) for use by the medical community and other relevant parties, including in the development of future Technical Cooperation projects.

Expected Research Outcomes

It is expected that:

- the information provided by this CRP will enable the socio-economic potential of irradiated foods for these target groups to be realized (i.e. the potential to market irradiated foods and for patients to benefit from availability of this food).
- irradiated fresh produce (fruits, vegetables, salads), ready-to-eat meals (ethnic or locally produced) and functional foods will be made available to the medical community, immuno-compromised patients and other potential target groups.
- microbiological, nutritional and organoleptic information generated by this CRP will be available to others and used to develop specific criteria for foods for different patients.
- irradiated food will be accepted by hospitals, medical professionals, patients and other potential target groups.
- there will be increased knowledge on the acceptance of irradiated foods.

The first RCM noted that this CRP provides a unique opportunity to generate benchmark microbiological criteria and data for foods for medical patients and others.

4. Objectives of the Second Research Coordination Meeting

The objectives of the second RCM were to review mid-term research achievements, with special emphasis on the strengths and weaknesses of the project and the progress made towards achieving the CRP objectives to utilize irradiation technology to increase the variety, availability and acceptability of foods for immuno-compromised patients and other target groups with special dietary needs.

5. RCM Presentations

Carl Blackburn gave a presentation on the background of this CRP, the objectives of the meeting, the action-plan, and the expected outputs and outcomes. He also introduced new entrants to the CRP from Bulgaria, China and Portugal. In the second part of his presentation, he reminded participants of the conclusions and recommendations of the First Research Co-ordination meeting, held in Vienna from 23-27August, 2010.

The co-chair, Zeny de Guzman, invited participants to share their experiences of working with the medical community and building collaborative relationships during the course of this CRP. She also invited comments from the medical Consultants and hospital dieticians from Philippines during the discussion session. It was pointed out that, for hospital foods, it is important to ensure that the medical person responsible needs to be consulted on the nutritional and psychological requirements of the immuno-compromised patients and work with patients requires their permission and involvement. There was a long discussion on the potential ways to engage with the medical community and the questions on irradiated food they would be most eager to have answered. The way to provide information and educate the medical community on the technology, as well as the safety and wholesomeness aspects of irradiated foods, was also discussed. The participants felt that education material needs to be developed for outreach / educational purposes, both in English and other languages for use in different countries.

Carl Blackburn, IAEA/FAO food irradiation specialist and CRP Technical Officer, informed the meeting of initiatives related to applications of food irradiation, including activities of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (NAFA), and specifically the Joint Division subprogramme on Improving Food Safety and Consumer Protection. In his presentation he reminded participants of the meeting objectives, the background to this CRP and the conclusions and recommendations of the first RCM.

5.1 Research Contract Holder Presentations

Widening the Meals Variety for Immuno-compromised Persons and Other Target Groups by Ionizing Radiation

Patricia Narvais, Argentina

Patricia Narvais presented her work on widening the meals variety for immuno-compromised persons and other target groups by ionizing radiation. She highlighted her research on the development of nutritious bread that is designed to be a complete meal for use in emergency situations or where poor nutrition needs to be addressed. This bread is fortified with essential amino acids, vitamins and minerals, and retains its sensory and microbiological quality after irradiation at 10 kGy and storage for up to 71 days.

Use of Irradiation for Shelf Stable Sterile Foods for Immuno-compromised Patients and Other Specific Groups

Mohammad Alam, Bangladesh

Mohammad Alam presented his research on the use of irradiation for shelf stable sterile foods for immuno-compromised and other specific groups. He presented data on the microbial profile of different salad vegetables of Bangladesh and their microbial decontamination for patients of renal failure. Of the vegetables tested lettuce was found to have very high microbial load that was difficult to eradicate at doses tolerated by the commodity. Three hospitals had been approached as collaborating institutions and it had taken some time to get appropriate agreement for the hospital work.

Application of Ionizing Radiation: Foods for People with Specific Diets

Susy Frey Sabato, Brazil

Susy Sabato gave a presentation on her work so far. It had taken some time to secure additional funding for three Ph.D. and one M.Sc. students to work on this topic. The research is now being taken forward with one of the main public hospitals in San Paulo and also a cancer hospital. It is taking some time to reach an agreement with the hospitals and although a catering company that supplies hospitals has been identified, it has yet to agree to collaborate or to discuss foods for patients who require specific diets. The foods for inclusion in this work include fruit salads, ice creams, and salad dressings. The importance of packaging was highlighted, especially in the case of a shop bought ice cream where irradiation gave rise to a bad taste if the ice cream was irradiated in its original blue plastic container. The off taste was avoided by removing the ice cream from the blue plastic container and irradiating it in a glass bowl.

Radiation Processing of Traditional Bulgarian Foods to Meet Dietary Requirements of Immuno-Compromised Patients

Tsvetelin Tsrunchev (Bulgaria)

Tsvetelin Tsrunchev is new to the CRP. He made a brief presentation on the plans of Bulgaria on radiation processing of traditional Bulgarian foods to meet dietary requirements of immuno-compromised patients. There was some discussion on the need to recruit suitable collaborating partners and the types of foods to be studied.

Use of Irradiation for Low Salt Chinese Traditional Pickles for Immuno-Compromised Patients

Gao Meixu, China

Gao Meixu, from the Institute for Application of Atomic Energy, Chinese Academy of Agricultural Sciences, informed the meeting about her work concerning the irradiation of low salt content fermented Chinese traditional pickles. The low salt pickles were prepared under laboratory conditions and subjected to radiation processing and stored at low temperature. Irradiated pickles were found to have good sensory and microbiological profile. Discussions with medical professionals are in progress as ethical clearance is required for the sensory trials with patients. Low-salt high-fiber diets are desirable for diabetic patients at the Beijing Number 309 Hospital. The hospital nutritionist has requested irradiated fresh vegetables (high fiber

foods) and in readiness for further irradiation experiments, nine different combinations of fruit and vegetables have been tested for their "normal" microbiological levels (aerobic plate count and total coliforms).

Irradiation and the Preparation of Emergency Food
Min Huang, China

Min Huang presented her research into the utilization of irradiation in the preparation of emergency foods. She has worked in collaboration with the Sichuan Emergency Management Office in order to develop foods typical of the Sichuan area that can be prepared and stored in readiness to be used as emergency rations. The types of foods that can be irradiated in China were discussed, and the need for a complete diet (providing sufficient intake of water, fat, protein and carbohydrates) was highlighted. A type of air dried and fermented pork sausage (typical of Sichuan), dried tofu, pickled vegetables and cooked rice are being investigated as this type of meal when irradiated in suitable packaging could be stored over a long period of time and remain safe to eat. A sensory test (taste panel involving fifty people) has been performed on some of the foods and preliminary results are very encouraging.

Use of Irradiation to Provide a Wider Selection of Safe, Nutritionally and Organoleptically Adequate Foods for Immuno-Compromised Patients
Csilla Mohacsi-Farkas, Hungary

This work is being carried out by Csilla Mohacsi-Farkas at the Faculty of Food Science, Corvinus University of Budapest. It is being taken forward in collaboration with the National Institute for Food and Nutrition Science, Hungary. This partnership has proved to be a very good one and has enabled a survey of 11 hospitals that deal with immuno-compromised / immuno-suppressed patients in Hungary. Of the 11 hospitals, 9 responded and provided very valuable information. Workshops with health professionals have been held and a special leaflet has been produced on irradiated food for patients. Data on irradiated cut fruits and also on a popular chocolate / cream cheese bar was presented. Though the microbiological profile of cut fruits improved, there was a problem of some fruits browning prior to packing (especially with banana and Granny Smith apples). Efforts will be made to overcome this problem by making fruit salads in fruit juice sauce. Radiation processing up to 3 kGy was also found to improve the microbiological profile of a popular chocolate / dairy food (Turo Rudi), without adversely affecting sensory acceptability.

Irradiated Foods For Immuno-Compromised Patients And Other Potential Target Groups In India
Arun Kumar Sharma, India

Food Technology Division (FTD), Bhabha Atomic Research Centre (BARC), is the leading R&D centre in the field of radiation processing of food in India. Arun Kumar reported that foods for immuno-compromised patients have been identified with the help of dieticians and oncologists of a Mumbai cancer hospital have and are being tested for radiation processing and sensory acceptability. Similarly, foods for other potential targets groups have been identified and are being tested to gauge the effects of radiation processing and test acceptability after storage. He has established a research team and involved a number of hospitals in his work. A NGO that prepares low cost enteral food for use in a hospital has been identified and the FTD have worked with this group of volunteers in order to assist them in ensuring the hygienic quality of the food prepared (e.g. the provision of a solar air drier and a microwave oven) and to see if irradiation can offer advantages over the preparation method currently used to prepare this low cost food formulation. In addition to two specially formulated foods, a number of ethnic foods are being included in this research.

Development of Safe Ethnic Foods - Irradiation for Specific Target Groups Including Immuno-Compromised Patients
Zubaidah Irawati Koenari, Indonesia

This work is being taken forward by Zubaidah Irawati Koenari of the Center for Applications of Isotopes and Radiation Technology, part of the National Nuclear Energy Agency. Various type of irradiated ethnic ready

to eat foods based on plant and animal origins have been successfully developed. Gamma irradiation to doses of 8 - 10 kGy in combination with suitable packaging techniques and the application of low temperature along with irradiation processing have been used to develop the irradiated foods of plant origin. High dose (45 kGy) treatments have been used to develop foods of animal origin. Food quality has been examined in terms of objective and subjective parameters (i.e. microbiological assessments, physico-chemical analyses, and sensory evaluations). The foods are now ready for preliminary trials of the specific target group in this research which are HIV-AIDS patients. This work is being conducted in collaboration with other governmental institutions, reputable laboratories, and food industries.

The preliminary studies involving food for residents at National Narcotic board has showed promising results. An Indonesia National Standard regarding irradiated ethnic ready to eat foods is also being developed.

Selection of Irradiation Doses and Packaging Materials to Enhance Market Life of Hygienic Meals for Immuno-Compromised Patients and Other Target Groups

Anwar Ahmad, Pakistan

Anwar Ahmad of the Nuclear Institute for Food and Agriculture (NIFA) outlined work to date that has implemented the plan to prepare special meals for patients and irradiate them to lower the bacterial load (low bacterial diets) to prevent the chances of re-infection in the patients. For better management to serve the meals to patients, it was considered that this research is important in order to extend the shelf life of these diets, using irradiation and other preservation techniques. Meals were prepared and nutritionally enriched according to the RDA guidelines. The prepared/cooked food items were packed in different packaging materials (Polyethylene and multilayer pouches Tetrapack). The packed foods were irradiated at the doses of 6, 8, 10 kGy. The physicochemical, microbiological, parameters and sensory analysis of the diets were conducted using standard procedures at 0 day and fortnightly at extended storage period of 3 months.
Prepared meals are based on chicken, liver, garden pea and bottle gourd ingredients and prepared using sprouted legumes (Mungbean and Kidney Beans) with cooking oil high vitamin E content. Vitamin C fortification has been achieved by adding herbal products to the meals.

Various presentations were made at NIFA, Institute of Radiotherapy and Nuclear Medicine (IRNUM) and to the patient groups, to introduce and update all stake holders about the objectives and modalities of the CRP. After series of meetings with IRNUM authorities and getting consensus on the efficacy study, approval of the NIFA Ethical Committee was also obtained to allow us to carry out the study. The two institutions, NIFA and IRNUM, signed MoU to conduct the efficacy trial of Irradiated diets for immuno-compromised patients.

Development of Safe, Quality and Shelf-Stable Filipino Ethnic Foods for Immuno-compromised Patients and Calamity Victims

Zenaida De Guzman, Philippines

In the Philippines, food irradiation studies have been undertaken on various commodities like spices, dehydrated vegetable products, fruits and grains. The technology has been proven to be an effective intervention method to provide safe and quality food by killing the pathogenic microorganisms and organisms that cause spoilage without significantly affecting food quality. In the Philippines there has been a limited amount of irradiation research on the efficacy of irradiation on shelf-life stable foods like meat and poultry products. The present study will examine the effects of irradiation on the quality safety and shelf-life extension of stable foods for specific target groups.

The proposed research will be towards developing shelf-stable Filipino ethnic foods through the use of radiation technology. The first phase of the study is being carried out to develop ready-to-eat foods and evaluate the effectiveness of the radiation process to treat foods and ensure they are suitable for immuno-compromised patients. The second phase aims to develop shelf-stable foods for calamity victims (i.e. as rations for use in emergency food aid programs). Ethnic food products will be prepared, packaged, irradiated and evaluated for microbial, sensory and nutritional qualities. Protocols will be developed which detail the irradiation parameters necessary to treat these foods and the results of the study will be distributed to medical, scientific and food associations.

Feasibility Study: Irradiation of Fruits & Vegetables for Immuno-compromised Patients

Sandra Cabo Verde, Portugal.

Sandra Cabo Verde is new to the CRP, and she outlined her work in this initial phase of the project. Her research intends to evaluate the irradiation effects on fruit and vegetables and the potential extension of shelf-life. Fresh packed raspberries (Rubus idaeus) were irradiated using a gamma (Co-60) source to several doses (0.5; 1 and 1.5 kGy). Microbiological, physico-chemical and sensorial parameters were assessed after irradiation and during storage time. The characterization of raspberries micro-biota point indicate an average bioburden of 102 cfu/g with a diverse microbial population predominantly of two morphological types of microorganisms [gram-negative, oxidase-negative rods (34%) and filamentous fungi (41%)]. The irradiation inactivation studies on the raspberries mesophilic population indicated a one log reduction of microbial load (95% inactivation efficiency for 1.5 kGy). However after irradiation, the surviving population was mainly constituted by filamentous fungi (79 – 98%), being morphologically identified among the isolates potential pathogenic/opportunistic fungi such as, Fusarium sp. and Alternaria sp. Preliminary results concerning the raspberries physico-chemical properties showed that irradiation caused a decrease in firmness compared with non-irradiated fruit. Nevertheless, non-irradiated and irradiated fruit presented similar physico-chemical and sensory properties during storage time.

Combination Treatments Involving Irradiation in Order to Develop Shelf Stable Sterile Foods for Immuno-compromised Patients and Other Specific Target Groups

Samia Ayari, Tunisia

This work is being carried out by the National Centre of Nuclear Sciences and Technologies in collaboration with Tunisian National Centre for Bone Marrow Transplant (CNGMO). The aim is to develop combination treatments, using gamma irradiation along with conventional preservation methods, and thereby synergistically enhance antimicrobial effects in order to enable lower irradiation dose to be applied than would otherwise be required. This will result in less intense processing treatments which will enhance freshness and quality, whilst ensuring safe food products can be obtained.

In general, the the CNGMO prepare sterile foods for immuno-compromised patients by cooking in a forced air oven at 120 °C for 20 min. The first part of this study examined and compared heat and gamma radiation of couscous. Gamma irradiation treatment to 5, 10 and 15 kGy was carried out to produce sterilized couscous. Microbiological, physic-chemical and sensory analyses were performed. An immediate bactericidal effect of irradiation was found with minimal organoleptic changes. The results showed that the dose of 5 kGy gives the bacteriological quality required (reduce the microbial load from 2.48 log CFU/g to a level below the limit of detection) while preserving the organoleptic qualities of the couscous. The comparison of irradiated (5 kGy) couscous and the heat treated couscous showed them to be very similar, except that the heat treated samples have a high oxidation state.

The second part of the study researched the application of a series of combined physical treatments (blanching, vacuum packaging and irradiation) on carrot puree. Results showed that with sub-sterilization dose of 3 kGy in combination with moderate heat and pressure treatment can be used to produce very hygienic food (levels of bacteria below the level of detection) and preserve antioxidant activity and phenolic content. This study indicates that the combination of mild irradiation doses with other physical or biological preservation methods can be used to develop foods that will add variety to the diet of immuno-compromised patients and other groups.

5.2 Research Agreement Holder Presentations

Irradiation for Shelf Stable Sterile Foods for Immuno-compromised Patients and Other Specific Target Groups

Ju-Woon Lee, Republic of Korea

The Advanced Radiation Technology Institute (ARTI), Korea Atomic Energy Research Institute (KAERI), is studying the use of irradiation technology to extend food shelf-life, improve food safety and enhance international trade. Work at ARTI has developed special purpose irradiated foods (such as space food, hospital patients food, emergency food and rations) using irradiation technology in Korea.

The Food and Drug Administration of Korea allow 26 types of irradiated foods, the treatment doses must be less than 10 kGy for sterilization purposes. The work of KAERI in the food irradiation research area is including food scientists, medical specialists, patients and their relatives, consumer groups, industry and government bodies. As part of this project, KAERI and Korean Institute of Radiological & Medical Science conducted a survey of cancer patients and their diets. According to the survey, more than 40 percent of patients skip meals because they have no appetite and 35 percent would like to eat snack foods. The results also founded 57.5 percent of cancer patients intend to purchase patient meals sterilized by irradiation.

In 2010, KAREI developed a gamma irradiated milk porridge specifically for hospital patients. This porridge is easy to intake and digestion and contains sufficient nutrients. The research is now developing more irradiated food products, such as ice cream, fruit products, red ginseng and chocolate for immuno-compromised patients. Recently, the Institutional Review Board (IRB) has reviewed three food items (ice cream, dried apple slices and red ginseng) for testing in the General Hospital of Aju University and the IRB has approved these for testing trials. The IRB requested a great deal of information about these products and also data on the safety and wholesomeness of irradiated food. It took more than three months to get their approval for the trails. During this approval process, the team at KAERI has worked hard to communicate with others and develop a common understanding between researchers, industries, consumer organisations, patients and their families, and hospital specialists (clinical nutritionists, nurses and doctors). It is important for this type of research to provide information and promote a better understanding of irradiated foods to others concerned in this area. Accordingly, KAERI is planning to hold an “International Symposium on Immuno-compromised patient’s food” in Korea in 2012 to improve understand and communicate this technology and the practical application, and KAERI wishes to co-hold the symposium with the IAEA-CRP.

Ju-Woon Lee informally agreed in principle to host this meeting at ARTI, possibly in September 2013.

E-Beam irradiated diets for neutropenic bone marrow transplant recipients: technology and hospital food supply chain considerations.

Suresh Pillai, USA

The Researchers Suresh Pillai and Karen Moody bring a unique combination of microbiology and paediatric oncology to this project. Suresh Pillai is a microbiologist by training with extensive experience in E-Beam irradiation technology. He heads the National Center for E-Beam Research at Texas A&M University and Professor of Microbiology at Texas A&M University. Karen Moody is the Director, Integrative Medicine & Palliative Care Team Section of Paediatric Haematology/Oncology Children's Hospital at Montefiore, New York. She is also the Assistant Professor of Paediatrics, Albert Einstein College of Medicine, New York

Work over the past year has focused the selection of food items of interest to hospital patients, identifying the Modified Atmosphere Packaging (MAP) conditions appropriate for packaged foods, developing collaborations with medical practitioners with expertise in hospital foods, developing linkages with hospital food suppliers and seeking funds to support laboratory research and clinical studies involving E-Beam irradiated hospital foods.

Food Research / Irradiated Food for Patients

Jayne Woodside, UK

Dr Jayne Woodside is a Reader in Clinical Biochemistry at Queen’s University Belfast, with an interest in conducting whole foods and whole diet intervention studies with clinically relevant endpoints. She has a background in nutrition and epidemiology. She offered an update on the literature surrounding the use of low bacterial diets in the prevention of infection in immuno-compromised patients.

There is still a lack of consensus on the use of low bacterial diets, and current practice is inconsistent. The most recent survey of current practice was Europe-focused, and a broader view of what is going on worldwide would be useful. The current evidence for the benefit of low bacterial diets is still weak, but a Cochrane systematic review of the literature is likely to appear within the next few months. Dr Woodside reviewed her research questions from the 1st RCM, and concluded that these were still relevant. Important questions in relation to irradiated foods include their cost effectiveness, sensory acceptability, and nutritional quality. Irradiated foods must be cost-effective, as this will be essential for acceptance by healthcare systems. The sensory acceptability of any new irradiated foods also needs to be tested, in a blinded way where possible and in both healthy volunteers and patients. The nutritional quality of irradiated foods must also be confirmed, either from the literature or by direct measure of the foods, but also perhaps by the monitoring of nutritional biomarkers post-consumption of irradiated fruit and vegetables to assess bioavailability. Another important question will be the effect of these new foods on overall diet quality and the patients' quality of life and mood.

Dr Woodside emphasized the need for careful study designs, controlled where possible, and careful conduct of intervention studies. The local setting will determine to some extent what is possible. In an ideal world, a survey of current practice with regard to use of dietary restrictions would be useful, as would some educational material / programme development with healthcare professionals / other relevant bodies, which will be important to gain access to patients. Focus group or individual discussions with healthcare professionals and patients will lead to selection of appropriate foods, and sensory testing will be carried out with these foods, firstly in a controlled setting with healthy volunteers, followed by sensory testing with immuno-compromised patients. Dr Woodside encouraged researchers to also consider a longer term study with cost, quality of life, overall diet quality, bioavailability, other health benefits as endpoints, if this was possible. Finally, she discussed suitable data presentation, and the design of sensory acceptability studies.

6. Conclusions and Recommendations of the Second RCM

6.1 Conclusions

1. The participants are working in partnership with their healthcare sector (as many as 35 hospitals in total). Additionally, some of the participants have started collaborating with agencies responsible for other target groups such as those concerning emergency food aid.

2. Based on interactions with the hospital and other target groups there was a re-affirmation of the need and significance of this CRP.

3. The participants have selected a range of foods for immuno-compromised patients and other target groups (Annex E).

4. The participants have started laboratory and pilot scale studies on the microbiological, physical and chemical, packaging and sensory aspects of radiation processing. Based on the research findings to date, the participants conclude that irradiation technologies can meet the criteria established by the CRP as well as the needs for the hospital and other target groups.

5. Three new participants have joined the CRP since the first RCM. This has expended this CRP to include emergency foods, viruses, and provide additional expertise in dosimetry.

6. The participants agree to follow appropriate local and national ethical clearance and consent approvals to perform the pilot-scale studies.

7. The participants agreed that pilot scale studies (involving patients and other target groups) can be performed within the scope of this CRP, and are necessary to support further work, including large scale studies.

8. The scope of work for a technical contract (survey) was discussed. The participants agree to wait for the study report that is expected to be published on the evidence on neutropenic diets on patient health before deciding on a technical contract.

9. The participants have already generated a significant number of work outputs including journal articles, conference abstracts and presentations (Annex F).

10. A large amount of information on current practices on preparing foods for hospitals has been collected by the participants so far and this provides an overview of the global status of such foods. Sufficient data has also been collected on the value of irradiation technologies that could also be published.

11. The participants have agreed to share their survey instruments, ethical clearance documents, outreach educational material for healthcare professionals, patients and other stakeholders that will be required to encourage adoption of the technology.

6.2 Recommendations

1. The CRP should continue to expand and participants strengthen their collaborations and engage with commercial food suppliers. This will ensure the adoption and integration of irradiated foods into the hospital food supply chains and will help promote commercialization of the technology.

2. Participants should continue to develop appropriate outreach and education materials for target audiences including family members, private investors, community groups, NGO's, regulatory agencies, financial and legal industries. The CRP should have a presence in social networking sites such Facebook™, Twitter™, LinkedIn™, You Tube™, Youku™, etc. The participants should continue making presentations whenever possible to the target groups to promote this CRP, its activities and goals.

3. In regard to food for patients the CRP should continue to focus on foods that are generally avoided (in the absence of being irradiated), but are desirable and recommended by nutritionists in hospitals.

4. CRP participants should prepare joint presentations describing the CRP, the microbiological criteria, etc. at appropriate events especially where medical professionals attend. The events should include events in respective countries and regions (e.g. Asian Congress of Nutrition Dieticians (Feb 2012), IFT (June 2012), IUFoST (August, 2012).

5. Participants agreed to share information and resources that could be used by other CRP members, for example their country's hospital questionnaires, ethical clearance and consent approval forms. This would help participants and help the research progress through appropriate local and national ethical clearance and consent approvals in order to perform pilot-scale studies where appropriate.

7. Since the numbers of patients in sensory studies or clinical trials are often limited the participants should refer to these studies as "**pilot-scale studies**". This terminology will assist in the publication of these results in peer-reviewed journals and also facilitate the necessary institutional ethical clearance and approvals.

8. The scope of work for a technical contract (survey) was discussed. The participants agree to wait for the study report that is expected to be published on the evidence on neutropenic diets on patient health before deciding on a technical contract.

9. Participants have already generated a significant number of work outputs including journal articles, conference abstracts and presentations (Annex F), and should continue to keep a good record of their work outputs.

10. Data and information on the status of hospital foods for immuno-compromised patients that have been collected under the CRP should be published in the open literature for example a feature article on the

CRP with emphasis on the microbiological criteria, the accruing benefits, the types of foods being studied, and examples of current practices (Suresh Pillai). A similar article targeting emergency foods should also be prepared for submission (Arun Sharma).

11. It was recommended that the next RCM should be held in the Republic of Korea and Ju-Woon Lee informally agreed in principle to host this meeting at ARTI, but a meeting in July would not be convenient and he suggested September 2013 would be more acceptable to his institute.

7. Agreed Action Plan and Logical Framework

7.1 Action Plan of Activities

Activity	2010	2011	2012	2013	2014 / 2015
Announce CRP (early 2010). Receive proposals	X				
Evaluate proposals and select participants	X				
Award / renew Contracts and Agreements	X	X	X	X	X
Organize 1st RCM (Aug 2010) to establish network and develop overall CRP work plan, agree on specific foods, research protocols, governance, record keeping and reporting.	X				
Phase 1 Work Programme includes the awarding of a technical contract to undertake a survey; initial analyses / sensory testing of irradiated foods (produce microbiological & nutritional data and data on sensory tests), and writing draft research protocols.	X	X			
Organise 2 RCM (28 Nov – 2 Dec 2011 possibly Philippines) Review phase 1 and develop work plan for phase 2		X			
Phase 2 Work Programme includes further analyses / testing and production of data; establishing acceptability (to both medical professionals and patient target groups), and; finalising production protocols.			X	X	
Organise 3rd RCM (~~Jul~~ Sep 2013) to review work and develop work plan for phase 3. Prepare draft TECDOC and / or draft papers.[move to SEP 2013]				X	
Phase 3 Work Programme includes sensory testing; reviewing data; gathering further data to address knowledge gaps, and; publishing production protocols online.				X	X
Organise Final RCM (~~Nov 2014~~ Q2 2015) to review work and prepare final TECDOC and research papers					X
Produce TECDOC					X/X

7.2 Logical Framework

	Project Design Elements	Verifiable Indicators	Means of Verification	Important Assumptions
Overall Objective:	Increase the variety, availability and acceptability of foods for immuno-compromised hospital patients and other target groups.	A range of irradiated foods developed for immuno-compromised patients	Reports provided at RCMs, published in scientific and medical literature and the TECDOC	Hospitals work in collaboration with participating partners
	Generate data on the acceptability of irradiated foods for patients	(i) Quantitative data on microbiological safety, nutritional and organoleptic properties. (ii) Qualitative data on psychological well-being and quality of life	Written reports and published scientific papers	Hospital patients participate in study (required for qualitative assessments)
Specific Objective:	To research and develop a range of simple and complex irradiated foods for immuno-compromised patients and potentially other target groups	Production of irradiated foods for patients i.e. fresh produce (fruits vegetables, salads) ready to eat meals (ethnic or locally produced) and functional foods	(i) Production protocols for the manufacture of irradiated foods for patients. (ii) Microbiological, nutritional & organoleptic criteria for irradiated foods (iii) Data on the use of irradiation in combination with other food technologies	Continued commitment by all participants
Outcomes:	The medical community, immuno-compromised hospital patients and other target groups have access to irradiated foods	Irradiation facilities producing food for the immuno-compromised and other target groups	Inclusion in national regulations; Reports from National authorities for inclusion in FAO / IAEA Food Irradiation Facilities Database	There is interest and up-take by commercial scale irradiation facilities
	Microbiological, nutritional and organoleptic criteria for irradiated foods	Criteria are produced	Criteria are published	There is consensus on a common set of criteria
	Increased knowledge on the acceptance of irradiated foods by patients and specific target groups	Increased number of scientific articles and papers	Literature search and citation index	Medical community is aware of irradiation studies
	Increased acceptance of irradiated foods by hospitals, medical professionals and	Increased interest in irradiated foods for patients	Level of enquiries from Member States and healthcare professionals.	Records of enquiries are maintained

	other potential target groups		(ii) Generation of TC projects	
	Protocols for the manufacture of irradiated foods for patients	Production of protocols	Protocols published and disseminated	A limited number of protocols can be produced to cover a broad range of different foods
	Increased trade in irradiated food products for patients and other target groups	Irradiated foods are produced commercially	Trade data	Trade data are collected and made available

Outputs:	Data	Data on (i) the microbiological safety, nutritional and organoleptic properties, including the acceptability of irradiated foods for patients (ii) the use of irradiation in combination with other food technologies	RCM reports and publication of data in scientific literature	Journals accept submitted material for publication
	Products	Production of irradiated foods for patients and other target groups i.e. fresh produce (fruits vegetables, salads) ready to eat meals (ethnic or locally produced) and functional foods	Availability of irradiated products	Technology is accepted by patients, hospitals and commercial sector.
	Protocols	Production of protocols for the manufacture of irradiated foods for hospital patients and other target groups	Publication of protocols / guidelines on internet	A limited number of protocols can be produced to cover a broad range of different foods
	Publications	Production and dissemination of technical documents, research papers and educational / communication material.	(i) Published papers on the applicability of food irradiation for patients diets. (ii) RCM reports, (iii) technical document (iv) educational / communication material	Continued support and participation of CRP institutions. Participants submit research findings for publication

Activities:	Consultants Meeting	Scope of work developed, range of foods considered and a priority list produced, potential participants discussed	Report of Consultants Meeting	Consultants available to meet
	Research Contract & Agreement Holders	Research Contract & Agreement Holders	Agreement / research contracts signed	Applications forthcoming from a

	identified and recruited	recruited		range of potential participants
	1st RCM Meeting (Aug 2010)	Establish network and develop work programme, agree on specific food items for study; research protocols; governance; record keeping; reporting	First RCM report	Participants can attend meeting
	Review Research Contract and Agreement holders	Award / renew contracts	Agreement / research contracts signed	Continued commitment by institutions and participants
	2nd RCM (28 Nov – 2 Dec 2011)	Review progress of work plan. Consider phase 2 workplan and prioritise tasks for phase 2	2nd RCM report and scientific papers	Continued commitment by institutions and participants
	Review Research Contract and Agreement holders	Award / renew contracts	Agreement / research contracts signed	Continued commitment by participant
	3rd RCM (~~Jul 2013~~) ROK could host in Sep 2013	Review progress of work plan. Consider final phase of work, prepare TECDOC and research papers for publication	3rd RCM report and scientific papers	Continued commitment by institutions and participants
	Review Research Contract and Agreement holders	Award / renew contracts	Agreement / research contracts signed	Continued commitment by institutions and participants
	4th RCM (~~Nov 2014~~) Move to Q2 of 2015	Review work and prepare TECDOC	TECDOC, Scientific papers	Commitment by institutions and participants

Annex A

List of Participants

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Dr. Aileen Riego-Javier Dr. Ernesto Que Dr. Romulo de Villa Ms. Socorro Balderamos Ms. Levelyn Mitos Tolentino Ms. Gina B. Abreva Ms. Mary Letlani T. Mayola Ms. Walama G. Alevgae	National Kidney Transplant Institute of The Philippines

Annex B

Provisional Agenda

2nd RCM of the CRP on the Development of Irradiated Foods for Immuno-Compromised Patients and other Potential Target Groups

21 – 25 November 2011
Philippine Nuclear Research Institute (PNRI), Manila, Philippines
Presidential Suite Room (23rd floor), Richmond Hotel, Ortigas City

Local Organiser: Zenaida De Guzman zmdeguzman@pnri.dost.gov.ph
Scientific secretary: Carl Blackburn c.blackburn@iaea.org

Day 1: Monday, 21 November 2011		
Session 1: Opening		
08:00	Registration [Presidential Suite Room,23rd floor)]	All
09:00	Welcome & Opening Remarks 1. Director Philippine Nuclear Research Institute 2. Executive Director of National Kidney and Transplant Institute 3. Technical Officer, IAEA	Dr. Alumanda dela Rosa, Director PNRI Dr. Aileen Riego-Javier, Executive Director National Kidney and Transplant Institute Carl Blackburn, IAEA
10:00	Introductions & Background of Participants	All
10:15	Administrative information	Zeny de Guzman
10:30	Election of Chair, Co-Chair and Rapporteur(s)	All
10:40	Adoption of Agenda	Chair
10.45	***Break***	
11:15	Meeting Objectives and CRP Background	Carl Blackburn, IAEA
11:30	Conclusions and Recommendations of the First Research Coordination Meeting of 23 - 27 August 2010	Carl Blackburn, IAEA
12:00-13:00	***Lunch***	
Session 2: Presentations – Research Contracts		
13:00	Widening the Meals Variety for Immuno-compromised Persons and Other Target Groups by Ionizing Radiation	Patricia Narvais Argentina
13:45	Use of Irradiation for Shelf Stable Sterile Foods for Immuno-compromised Patients and Other Specific Groups	Mohammad Alam Bangladesh
14:30	Application of Ionizing Radiation: Foods for People with Specific Diets	Susy Frey Sabato Brazil
15:15	***Break***	
15:45	Radiation Processing of Traditional Bulgarian Foods to Meet Dietary Requirements of Immuno - compromised Patients	Tsveteliln Tsrunchev Bulgaria
16:30	Use of Irradiation for Low Salt Chinese Traditional Pickles for Immuno-compromised Patients	Meixu Gao China
17:15	***End of day 1***	

Day 2: Tuesday, 22 November 2011		
Session 2 (Continued): Presentations – Research Contracts		
09:00	Irradiation and the Preparation of Emergency Food	Min Huang China
09:45	Use of Irradiation to Provide a Wider Selection of Safe, Nutritionally and Organoleptically Adequate Foods for Immuno-Compromised Patients	Csilla Mohacsi-Farkas Hungary
10:30	***Break***	
11:00	Irradiated Foods For Immuno-compromised Patients And Other Potential Target Groups In India	Arun Kumar Sharma India
11:45	Development of Safe Ethnic Foods - Irradiation for Specific Target Groups Including Immuno-compromised Patients	Zubaidah Irawati Koenari Indonesia
12:30	***Lunch***	
13:30	Selection of Irradiation Doses and Packaging Materials to Enhance Market Life of Sterile and Hygienic Meals for Patients and Other Specific Communal Groups	Anwar Ahmad Pakistan
14:15	Development of Safe, Quality and Shelf-Stable Filipino Ethnic Foods for Immuno-compromised Patients and Calamity Victims	Zenaida De Guzman Philippines
15:00	***Break***	
15:30	Feasibility Study: Irradiation of fruits and vegetables for Immuno-compromised Patients	Sandra Cabo Verde Portugal
16:15	Combination Treatments Involving Irradiation in Order to Develop Shelf Stable Sterile Foods for Immuno-compromised Patients and Other Specific Target Groups	Samia Ayari Tunisia
17:00	***End***	
19:00	***Dinner followed by Filipino Cultural Show***	

Day 3: Wednesday, 23 November 2011		
Session 3: Presentations from Agreement Holders		
09:00	Irradiation for Shelf Stable Sterile Foods for Immuno-compromised Patients and Other Specific Target Groups	Ju-Woon Lee Republic of Korea
09:45	E-Beam irradiated diets for neutropenic bone marrow transplant recipients: technology and hospital food supply chain considerations.	Suresh Pillai USA
10:30	***Break***	
11:00	Food Research / Irradiated Food for Patients	Jayne Woodside, UK
11:45	Discussion / Review of research and the foods covered - Use of research protocol agreed in 1st RCM (Annex C of 1st RCM report) - What foods are included? (see also Annex D of 1st RCM report)	All
12:00	***Lunch***	
Session 4: Technical Visit		
13:00 – 17:00	Technical Tour of Discussion of the Philippine Nuclear Research Institute	All
17:00	***End of Day 3***	

Day 4: Thursday, 24 November

Session 5: Review of progress		
09:00	Review of results to date and evaluation of progress towards the project objectives and outcomes	All
10:30	***Break***	
11:00	Evaluation of progress towards achieving the Expected Research Outputs Expected Research Outputs • Data on the: (i) microbiological, nutritional and organoleptic properties of irradiated foods for patients. (ii) acceptability of irradiated foods for patients, hospitals, medical professionals and other potential target groups. (iii) use of ionizing radiation in combination with other food technologies such as Modified Atmosphere Packaging (MAP). • The publication of: (i) research data on the applicability of food irradiation for medical diets. (ii) educational and informational material for healthcare specialists, consumers and other relevant stakeholders. (iii) an FAO/IAEA Technical document (TECHDOC) for use by the medical community and other relevant parties, including in the development of future Technical Cooperation projects.	All
12:00	***Lunch***	
13:00	Evaluation of progress towards achieving the Expected Research Outputs (Continued)	All
14:00	Identifying project strengths, weaknesses and opportunities and development of meeting conclusions and recommendations	
15:00	***Break***	
15:30	Review and discussion of planned project activities and consideration of modifications to work plans	All
17:30	***End of day 4***	

Day 5: Friday, 25 November 2011		
Session 6: Finalization and adoption of report		
09:00	Finalization of Meeting Conclusions	All
09:30	Finalization of Meeting Recommendations	
10:00	Discussion and review of meeting report	
10:30	***Break***	
11:00	Discussion and finalization of final draft meeting report	All
12:30	***Lunch***	
13:30	Presentation, of final meeting report, including conclusions and recommendations	All
15:15	Closing remarks and end of meeting	All

Annex C

PARTICIPANTS REPORTS

ARGENTINA

(Patricia Narvais)

Widening the Meals Variety for Immuno-compromised Persons and Other Target Groups by Ionizing Radiation

1. Progress

Experimental work with "highly nutritive bread" has been successful regarding nutritional formulation, sanitary quality, shelf-life extension and consumer acceptance. Some approaches to health services treating immuno-compromised persons have been made.

2. Collaborative Relationships Established with Others

Mainly: related scientific literature exchange, and discussion about microbiological analytical methods.

3. Achievements

Things that have gone well

Design of a highly nutritive bakery product, suitable for people suffering alimentary emergencies and also for the immuno-compromised, which could be successfully treated with ionizing radiation to improve sanitary quality and extend to at least 70 days its shelf life at room temperature.

Things that have not been so successful

- Limited interest found up to now from the health services dealing with the immuno-compromised.
- Few collaborative relationships undertaken towards other participants.

4. Next Phase of Research

- Continue trying to attract the attention of health services that treat immuno-compromised patients, especially those which do bone marrow transplant.
- Perform chemical studies on irradiated "highly nutritive bread" and honey, to evaluate the stability of sensitive compounds at doses needed to assure microbiological security levels for the immuno-compromised.
- Promulgate results of the "highly nutritive bread" research at scientific meetings and others with programmes focusing in malnourishment and other alimentary emergencies.
- Publish this "highly nutritive bread" work.

BANGLADESH

(Mohammad Alam)

Use of Irradiation for Shelf Stable Sterile Foods for Immuno-compromised Patients and Other Specific Groups

1. Research Progress

This work covers the research and developments of vegetable salads, which due to the normal risk of adverse microbiological contamination, are not usually served to immuno-compromised hospital patients. Cucumber, tomato, carrot, green leaf lettuce, green capsicums were purchased from the kitchen market of Dhaka city. Washed, peeled and freshly cut ready-to-eat samples were packed into sterile polyethylene packets (15 kGy irradiated) and treated with 1, 2, 2.5 and 3 kGy radiation with a ^{60}Co gamma irradiator. Changes of the "native" microflora, and some specific nutritional and physical-chemical properties of irradiated salad vegetables were analyzed. From this study, it was observed that generally 1 kGy irradiated samples had less nutritional loss and better sensory score than the samples irradiated with higher doses. But the initial microflora of the samples were so high that, minimum doses required to meet the sanitary microbiological levels as decided by the 1st Research Coordination Meeting (CRP 15052/RO) of IAEA suggested for foods intended for immuno-compromised people and other potential target groups were 2, 2.5, 2.5 and 2 kGy for cucumber, tomato, carrot and green capsicum respectively. In case of green leaf lettuce the criteria were not met at our given radiation doses. Initial microflora of the samples will have to be reduced before irradiation to meet the microbiological sanitary criteria at low dose treatment before recommendation of irradiated salads for hospitalized immuno-compromised people and other potential target groups.

2. Collaborative Relationships

Discussion was made with the haemato-oncologist of Dhaka Shishu (Children) Hospital who deals with cancer unit and thalassemia centre of the hospital. With positive attitude the physician informed he will try to motivate higher authorities to start feeding trial.

3. Achievements

Within radiation dose of 2.5 kGy, vegetable samples met the sanitary standard for the immuno-compromised patients except green leaf lettuce. Some other pretreatments are needed to reduce initial bioburden so that the low doses can ensure the sanitary levels of the vegetable salads.

4. Plan for next Phase of Research

Work Plan-2nd Year

- Pre-treatments of vegetables to reduce initial bacterial loads.
- Investigation of Microbiological parameters of the irradiated vegetables kept at low temperature.
- Development of irradiated Fruits for Immuno- compromised Patients and Other Specific Target Groups**.**
- Trial for making MoU with Dhaka Shishu (Children) Hospital, Dhaka.

Work Plan- 3rd Year

- Preparation and supply of safe vegetables and fruits for the immuno-compromised patients**.**
- Preparation of a guideline of ready to eat and ethnic irradiated foods for the immuno-compromised patients**.**

BRAZIL

(Susy Frey Sabato)

Application of Ionizing Radiation: Foods for People with Specific Diets

1. Progress

Some activities focused on getting structure for the project had to be assumed like: obtain financial support for the team (3 doctorates and 1 master student submitted their individual plans to be approved and get financial supports from external bodies from our Institute); part of the laboratory was recast in order to shelter microbiological activities in a clean and closed environment.

2. Collaborative Relationships

Concerned to hospital interactions, Hospital das Clínicas, main public hospital in São Paulo and the largest health care centre in Latin America, was contacted in a first moment. The Department of Nutrition and Dietetics from Hospital approved the submission of the plan to the Ethics Committee in order to perform the sensory evaluation of irradiated foods with nutritionists and employees. A more recent contact was made with Hospital do Cancer - A. C. Camargo in São Paulo, a public hospital and centre of excellence in cancer treatment in Latin America. Post-graduation coordinator from this hospital reacted favourably but the process is going slowly.

3. Achievements

Scientific activities were developed in different degrees for each established type of irradiated foods: fruit salad, spring salad and ice-creams. Some delay occurred in function of laboratory adequacy and even in post-graduation study obligations (like plan preparation, submission and approval as well as obliged disciplines attendance).

Physical-chemical analysis: Texture measurements for irradiated apples up to 1 kGy resulted in good maintenance of the fruits until 10 days; texture results for baby carrots showed some loss of texture: 24% for 3kGy and 34% for 5kGy; pH results for 10 different salad dressings irradiated at 3kGy and 5kGy remained stable; pH and brix results for irradiated ice-creams showed no significantly differences; small whitish was found for 5kGy irradiated baby carrots. In general, moderate doses (3kGy and 5kGy) did not impair the physical-chemical properties of studied foods.

Sensory evaluation: Sensory evaluation for baby carrots resulted in good acceptance when irradiated at 3kGy or 5kGy with no significantly difference from control; sensory analysis of ice-cream showed that plastic packaging had some effects when samples were irradiated at 3kGy and 5kGy and better results when irradiated in glass bowl. Continuity of sensory evaluation will be essential in future steps.

Microbiological analysis: Fruit salad and spring salad had reduction of 4log for total plate count and lower reduction for yeast and molds (1log for fruit salad and 2log for spring salad); ice-cream irradiated at 3kGy resulted in non-detectable count.

4. Future Research

These preliminary studies indicate a need to investigate further the irradiation dose necessary for the treatment whilst retaining the overall quality of the food; to undertake tests with different packaging; There may be a need to prepare food instead of buying direct from a supplier (if suppliers are unwilling to collaborate with this research); inoculation tests may be necessary (i.e. mainly for ice-creams); It will be necessary to undertake some nutritional studies (specific for certain foods) and to continue sensory and physical–chemical evaluations.

BULGARIA

(Tsveteliln Tsrunchev)

Radiation Processing of Traditional Bulgarian Foods

The research group consist of specialists from National Centre for Radiobiology and Radiation Protection (NCRRP) and National Centre for Public Health and Analyses (NCPHA).

The NCRRP is a regulatory control and research organisation concerned with nuclear applications involving radiation and the effects of radiation on human health. The Food Irradiation Laboratory of the NCRRP deals with registering food irradiation facilities, licensing food irradiation and the detection of irradiated foods in Bulgaria. It is also involved with high dose dosimetry and research in the field of radiation processing.

The NCPHA is a research organisation concerned with human health. The research group consists of microbiologists and nutritionists.

The research plan for the first year includes:

- selecting suitable foods (i.e. foods both required for patients and suitable for irradiation);
- determining the general microbial status of these foods;
- setting requirements on the appropriate microbial status of the food for patients;
- determining the absorbed dose necessary to achieve the desired microbial status;
- irradiating foods and assessing the dose distribution
- reviewing and optimizing the irradiation method;
- evaluating the organoleptic and nutritional quality of the irradiated foods;

CHINA

(Meixu Gao)

Use of Irradiation for Low Salt Chinese Traditional Pickles for Immuno-compromised Patients

1. Progress and Achievements

In the first year of this study, pickles of low salt content (5.04%, 5.71%, 7.84%, 8.15%) and a normal salt content of 12.45% were prepared at the laboratory at room temperature and according to the traditional Chinese pickling procedure (this pickle preparation method takes about 5 weeks). Irradiation of 0, 0.5, 1.0 and 2kGy (dose rate 0.7kGy/h) was applied to the pickle samples, and then the microbiological, chemical and sensory quality of the treated pickles was evaluated. The number of aerobic bacteria was reduced by irradiation and the pickle with salt content 5.71% could reach the requirement of patient' food at the dose of 0.5kGy. Food irradiation did not exhibit significant influence on content of total acids and water activity of pickles. Nitrite content of pickle was raised by irradiation. The sensory quality of pickle, including colour and shape, scent, flavour and texture, was not affected by irradiation up to and including a dose of 2 kGy. The research indicates that irradiation can be used to ensure the quality of pickles with low salt content.

2. Collaboration

It has not been easy to convince the nutritionist, doctor and director of a particular hospital to collaborate in this research into irradiated foods for hospital patients. The MoU with this hospital is still not signed, however another hospital has been interested in this work and has expressed an interest in joining the study. Most of hospital patients eat Chinese foods, which are usually cooked at high temperatures and some foods are steamed or boiled for several hours. In general, the food is not regarded as a big problem for most immuno-compromised patients. However, raw vegetable salads are good for patients suffering from serious diabetes but the microbiological quality of salads need to be improved to ensure that they are safe to eat by these patients. At the suggestion of the hospital nutritionist, raw vegetable salad (specifically for diabetic

patients) will be studied for the second year. Collaboration with another hospital is also under establishment, and the detail plan is under consideration.

3. Future Research

The next phase of research will focus on irradiated fresh-cut vegetables for diabetics. It is envisaged that salad foods will include lettuce, rape, Chinese cabbage, purple cabbage, bell pepper, tomato, balsam pear, cucumber, radish as initial research materials. A pre-irradiation procedure (including washing, cutting, colour protection and packaging methods) will be established first. The effects of irradiation on microbiological, sensory and nutrient qualities will be investigated, and several kinds of vegetable salads will be prepared based on the research findings. The clean vegetables salad by irradiation is planning to be added to the menu of diabetic patients will be checked after a period consumption of irradiated salads.

CHINA

(Min Huang)

Irradiation application on the preparation of Emergency Food

In recent years, natural disasters occurred frequently in China and resulted thousands of people died and injured. The disaster relief used in emergency situation exposed the weakness about the insufficient reserves of emergency food in China and it's necessary to develop it. The irradiation application has the potential use on emergency food.

1. Progress

The first year of research, we investigate and determine the detailed requirements for emergency food in China so that a range of foods for study be selected. We also selected the Sichuan sausage, dried tofu and Sichuan pickle as the experimental materials, these foods were irradiated by Cobalt-60 under different dose, and the sensory evaluation, microbiological and nutritional evaluation were measured during storage at normal temperature. The results showed that 5 kGy is proper to prolong the shelf life, and doesn't change the sensory and nutritional quality of Sichuan sausage, dried tofu and Sichuan pickle. Research has progressed well to the date.

2. Collaboration

Our project collaborates with Sichuan Emergency Management Office. They collected information about the emergency food and provided to us. Also, they will help recommend our products to the government.

3. Future Work

Under the next stage of research we will select several other foods and study the effects of irradiation, MAP and suitable package material on the nutritional adequate, microbiological safety and sensory acceptability of irradiated emergency foods. Optimize the components and the irradiation process. Develop the emergency products and make recommendations to the government.

Hungary

(Csilla Mohácsi-Farkas)

Use of irradiation to provide wider selection of safe, nutritionally and organoleptically adequate foods for immuno-compromised patients.

1. Progress of the Research Work to Date

Based on the results of the survey of Hungarian institutional practices for dietary restrictions for immunosuppressed patients it is concluded that it would be necessary to design and implement a uniform nutritional protocol and increase the variety of foods which can be consumed safely by immuno-compromised patients. Food items selected to meet both the dietary recommendations of medical experts and requirements of patients were fresh-cut fruit (3 apple varieties, orange, banana). Examination of changes of the "native" microflora, nutritional and organoleptic properties of irradiated produce have been performed. Irradiation up to 2 kGy doses did not cause significant differences in sensory properties of fresh-cut apple, orange and banana fruits. Based upon the microbiological critera suggested by the CRP, irradiation with 2 kGy dose could provide appropriate low microbial counts of fresh-cut apple, orange and banana. Refrigerated storage of irradiated cut/sliced fruits is recommended not longer than 5 days. Irradiation with 1 kGy dose caused at least 3 log-cycle reduction in viable cells of *Listeria monocytogenes* strains inoculated onto fresh-cut apple, orange and banana. Cells of *L. monocytogenes* are able to survive on cut apple and orange, and able to grow on banana slices during 7 days of refrigerated storage. Therefore - to achieve appropriate low levels of this psychrotrophic pathogen - 2 kGy irradiation dose is recommended.

To inform health professionals a workshop has been organized in collaboration with OÉTI. Lectures on food irradiation in general, on the aim of the IAEA CRP and on the results of microbiological and sensory evaluation were held. The results of the hospital survey were also demonstrated. Technical background of food irradiation was demonstrated by AGROSTER company. Printed information material (leaflet on food irradiation, in Hungarian) and related scientific papers were also offered to the participants.

2. Collaborative Relationships Established With Others

The research is carried out in close collaboration with the National Institute for Food and Nutrition Science (OÉTI) (which is the Department of Preventive Nutrition at the Faculty of Food Science at the Corvinus University of Budapest). OÉTI is serving as one of the national institutions of the Hungarian National Public Health and Medical Officer Service (ÁNTSZ), responsible for controlling, coordinating and supervising activities concerning food hygiene and nutrition, child and youth health, radiobiology and radiohygiene and chemical safety, epidemiology, health promotion, health service administration, and it also controls the health service.

3. Achievements

Medical community showed great interest in better understanding and use of food irradiation. The potential use of irradiation in preparing patients' diets was demonstrated by microbiological and nutritional/sensory data. Involvement of catering industry is necessary in the future.

4. Next Phase of Research

Sensorially acceptable maximal radiation doses for vegetables (baby carrot, tomato, cucumber) and dairy products/desserts selected according to hospital patients' and dietitians request will be determined. Changes of the "native" microflora of food items and their survival/growth as affected by irradiation and chilled storage will be evaluated. Vitamin C and carotenoid content of vegetable samples will be compared to the untreated ones. Lipid-oxidative effect of the radiation processing will be examined in case of dairy products. Challenge tests with *Listeria monocytogenes* strains will be performed to determine the minimum radiation dose to be applied in each product.

Further training is planned for health care professionals (dieticians, nutritionists, nurses), patients and general public on the use of irradiated food in hospital diets.

INDONESIA

(Zubaidah Irawati Koenari)

Development of Safe Ethnic Foods of Plant and Animal Origin Using Irradiation For Specific Target Groups Including Immuno-Compromosed Patients

1. Progress research work to date

Various type of irradiated ethnic ready to eat foods based on plant and animal origins have been successfully developed. Gamma irradiation at the dose of 8-10 kGy in combination with proper packaging technique and low temperature along the irradiation process have been implemented for the most foods preparation based on plant origin, while at the dose of 45 kGy for animal origins. The qualities were observed according to objective and subjective parameters, i.e. microbiological assessments, physic-chemical analyses, and sensory evaluation. The foods are ready for the treatment of HIV-AIDS patients through food intervention in order to improve their nutrition status.

2. Collaborative relationships

The research works was conducted under collaborate relationships with other governmental institutions, reputable laboratories, and food industries.

3. Achievements

Preliminary studies on the food intervention to HIV residents at National Narcotic board showed promising results. Indonesia National Standard regarding irradiated ethnic ready to eat foods has also been developed. The draft is prepared by national team , i.e. representative of different governmental institutions and private organizations as well as food industries and INS consumer board. The next meeting will be a consensus of the second draft.

To conduct the goal of this work we still need some financial support from the Agency, though the local food industries have partly contributed to prepare the foods. The effectiveness of this study can only be applicable in the hospital based on the data of laboratory analyses such as CD 4 measurement, albumin content, and antrophometry .

4. Research Activities Planned for the Next Phase

Making the irradiated foods available for the patients' intervention; data compilation some clinical status of respondents at NNB will be made.

Republic of Korea

(Ju-Woon Lee)

Irradiation for Shelf Stable Sterile Foods for Immuno-compromised Patients and Other Specific Target Groups

The Advanced Radiation Technology Institute (ARTI) of the Korea Atomic Energy Research Institute (KAERI) is involved in science research and innovation including that involving irradiation technology to extend the shelf-life of food, improve food safety and promote international trade. The ARTI is a world leader in the R&D of special purpose irradiated foods (such as space food, patients food, emergency food and rations).

The Food and Drug Administration of Korea has permitted 26 irradiated items of food and this includes food for patients. In Korea, food is allowed to be irradiated to dose up to 10 kGy.

The KAERI has gathered a national research team for the work of this CRP, the team of approximately 50 includes food scientists, medical professionals, patients and their relatives, consumer unions, industries and government officers.

The KAERI and Korean Institute of Radiological & Medical Science conducted a survey of cancer patients in order to gather information on their eating habits and diet. According to this survey, more than 40 percent of patients skip meals because they have no appetite and 35 percent would like to eat snack foods. The survey also founded 57.5 percent of cancer patients intend to purchase irradiated meals sterilized by irradiation for patients. The survey results indicate that cancer patients suffer not only through sickness but also through their diet.

In Korea, the ARTI developed a gamma irradiated milk porridge in 2010. This porridge is designed to be easy to intake and digest and has balanced nutrients. The ARTI team have also developed other irradiated food items suitable for immuno-compromised patients, such as ice cream, fruit products, red ginseng and chocolate for. Recently, the Institutional Review Board (IRB) was asked to consider three irradiated items (ice cream, dried apple slices and red ginseng) for pilot-scale studies at the General Hospital of Aju University. The IRB has approved to test these three irradiated items at the hospital.

The IRB requested a great deal of information about the irradiated products themselves and also data and information about the safety and wholesomeness of irradiated food in general. It took more than three months to get approve to for the pilot scale tests in the hospital. The three irradiated items (ice cream, dried apple slices and red ginseng) are being tested and if successful Korea has plans to commercialize these irradiated foods and establish a manufacturing system for them.

During this research, the national research team has found that the key issues in developing irradiated food for hospital patients is to build a relationship and common understand between the researchers undertaking the work and key stakeholders such as people in industry, consumer unions, patients, their families, hospital / patient associations, hospital staff (clinical nutritionists, nurse and doctors). It is important that the R&D effort is not only focused on the technical work of developing irradiated food for patients but also makes the effort to communicate and ensure the technology is understand by others. For example it is important to provide information about applied food irradiation technology to medical groups and other stakeholders. Accordingly, KAERI is planning to hold an “International Symposium on Immuno-compromised Patients Food” in Korea in 2012 and KAERI would like to co-host the symposium with the IAEA-CRP.

KAERI has also developed 17 Korean “space-foods” nine of which (Chicken curry rice, Chicken porridge, Manila clam porridge, Ox leg bone cabbage soup, Grilled chicken, Dried persimmon, chocolate, Dried blueberry, Mulberry jam) were newly certified by the Russian Institute for Biomedical Problems in 2011. The KAERI has been innovating and commercializing the technology developed to produce “emergency-food”. The first prototype emergency food-set consisted of 6 space food items (Cooked rice mixed with red pepper paste, Grilled beef marinated with soy sauce, Seaweed soup, Nutrition bar and Cinnamon beverage). The food was tested two times in Korea and in also Sichuan, China for evaluating the convenience and flavour in order to review the utilization and taste of the food. Sensory tests of irradiated, shelf stable foods produced in Korea were also undertaken in India, the Philippines and Korea, where they were performed by exchanging samples. Korea expects that these international collaborations among the member states to develop special purposed foods will lead to improve understanding and acceptance of irradiated food by the general public.

Korea will perform well in this project and is working to the planned schedule with mature collaborative partnerships both nationally and internationally. The participants from Korea will do their best to meet the final goal of this CRP and not only to accomplish a successful launch of the technology developed for special target groups and the related commercialization but also in order to provide safe and high quality foods to patients and other people so that they can eat a wide range of foods without the fear to foodborne disease.

Pakistan

(Anwar Ahmad)

Development of Irradiated Food for Immuno-compromised Patients and other Specific Target Groups

1. Progress

In the proposed project, it was planned to prepare special meals for patients and irradiate them to lower the bacterial load (low bacterial diets) to prevent the chances of re-infection in the patients. For better management to serve the meals to patients, it was considered important to extend the shelf life of these diets, using irradiation and other preservation techniques. Meals were prepared and nutritionally enriched according to the RDA guidelines. The prepared/cooked food items were packed in different packaging materials (Polyethylene and multilayer pouches Tetrapack). The packed foods were irradiated at the doses of 6,8,10 kGy. The physicochemical, microbiological, parameters and sensory analysis of the diets were conducted using standard procedures at 0 day and fortnightly at extended storage period of 3 months.

Meals Ingredients: Meals from sprouted legumes (Mungbean and Kidney Beans) were prepared in the cooking oil having high vitamin E content. Vitamin C was fortified by adding some herbal materials in the meals. Other materials selected in the preparation of diets were Chicken, Liver, Garden pea and Bottle gourd

Meals having high protein, minerals (especially Zn) and vitamins (Vitamin A, C & E) contents were prepared at our laboratories for the patients. Two types of pouches were used in the study. Irradiation technology was employed for preservation, lowering bacterial load and extension in shelf life. Physicochemical and microbiological analysis was performed to ensure the quality of the meals during storage. From the research work conducted till now in this CRP, it can be concluded that 8 kGy irradiation dose and vacuum sealing in multilayer pouches (Retort pouches) is sufficient for safely storage of different diets up to the tested period of 3 months.

2. Collaborative Relationships Established With Others

Various presentations were made at NIFA, Institute of Radiotherapy and Nuclear Medicine (IRNUM) and to the patient groups, to introduce and update all stake holders about the objectives and modalities of the CRP. After series of meetings with IRNUM authorities and getting consensus on the efficacy study, approval of the NIFA Ethical Committee was also obtained to allow us to carry out the study. The two institutions, NIFA and IRNUM, signed MoU to conduct the efficacy trial of Irradiated diets for immuno-compromised patients on April 13, 2011. The efficacy trials were started on April 24, 2011.

3. Things have gone well and where things have not been as successful

Preliminary Efficacy Trials were proposed to be conducted at IRNUM Peshawar. At the first instant 4-5 different disease groups were selected and the study was started to see the effect of irradiated diets prepared at NIFA. However, study on only 2 groups i.e. Breast Cancer and Brain Tumor patients were conducted for one month each at IRNUM. Work on other groups were not conducted and postponed due to lack of funds, which will be resumed after NIFA receive fund from IAEA.

4. Brief outline of research and other work planned for the next phase of research.

In the second year, research work conducted last year will be extended as desired by IAEA, on diets prepared for immuno-compromised patients. It is planned to conduct a more widespread and detailed efficacy trial of the irradiated meals prepared at NIFA. It is also planned that efficacy study will be conducted in some other hospitals of the country. Moreover, some fresh salads with low bacterial counts will be prepared and preserve for reasonable period using irradiation and suitable packaging material. The fresh commodities will then be served to various patients in a sensory/efficacy trial. The following test parameters of the patients will be recorded upon consumption of the irradiated meals and salads:

Physical Measurements:

- Height
- weight

Hematological data:

The blood of volunteer patients will be analyzed at day 0 and at the end of the study for:

- HB
- WBC
- Platelets
- Blood Sugar
- Alanine aminotransferase (ALT)
- Alkaline phosphatase (ALP)
- S. Albumin
- S. urea

Psychological/sensory data

- Appearance
- Color, Flavor, Taste and Acceptability
- Freshness
- Digestibility (and any other patient related attributes as deemed appropriate by medical practitioners).

The Philippines

(Zenaida De Guzman)

Development of Safe, Quality and Shelf-Stable Filipino Ethnic Foods for Immuno-compromised Patients and Calamity Victims

The effectiveness of irradiation to ensure the quality of cooked adobo, a Filipino ethnic food for immuno-compromised patients and calamity victims was investigated. This was carried out in collaboration with the nutrition and dietetics group of the National Kidney and Transplant Institute. The cooked adobo based on the hospital diet formulations was packed, irradiated and evaluated for its storage qualities. Irradiation doses of 0, 2, 4, 6, 8 and 10 kGy were applied to the cooked adobo.

Evaluations were based on the microbiological, sensory, physico-chemical, nutritional and packaging parameters. With the application of 6 kGy dose of radiation a significant reduction (5 log cycles) in the total microbial counts was obtained. The pH and moisture content of the both treated and non-treated samples showed comparable results. The sensory qualities (texture, odor, colour and flavour) exhibited similar values. The majority of the trained and untrained panellists perceived better qualities of cooked adobo in the irradiated samples. Packaging test conducted on two materials (plastic and aluminium pouches)for irradiated samples at 10 kGy did not exceed maximum limits for migration chemical analysis tests hence passed the test for packaging materials for food. There was no reduction in the protein content of the irradiated adobo and a slight change of vitamin B1 content at a dose of 10 kGy.

On the basis of the results obtained, an recommended irradiation dose of 6 kGy is sufficient to maintain the products without significantly affecting the overall qualities of the cooked adobo.

Portugal

(Sandra Cabo Verde)

Ionization radiation treatment of fruits and vegetables for immuno-compromised patients: feasibility study

1. Progress of the research work to date

In this initial phase of the project we intended to evaluate the irradiation effects on fruit and vegetables and the potential extension of shelf-life. Based on that, fresh packed raspberries (*Rubus idaeus*) were irradiated at a Co-60 source at several doses (0.5; 1 and 1.5 kGy). Microbiological, physico-chemical and sensorial parameters were assessed after irradiation and during storage time. The characterization of raspberries microbiota point out to an average bioburden value of 10^2 cfu/g and to a diverse microbial population predominantly composed by two morphological types [gram-negative, oxidase-negative rods (34%) and filamentous fungi (41%)]. The inactivation studies on the raspberries mesophilic population indicated a one log reduction of microbial load (95% inactivation efficiency for 1.5 kGy). However after irradiation, the surviving population was mainly constituted by filamentous fungi (79 – 98%), being morphologically identified among the isolates potential pathogenic/opportunistic fungi such as, *Fusarium* sp. and *Alternaria* sp.. Regarding raspberries physico-chemical properties, irradiation caused a decrease in firmness compared with non-irradiated fruit. Nevertheless, non-irradiated and irradiated fruit presented similar physico-chemical and sensory properties during storage time.

2. Outline of the work planned for the next phase of research.

- Identify the isolated fungi and study its inactivation pattern.
- Optimization and validation of detection method for mycotoxins to study the impact of ionization energy on its degradation.
- Irradiation of other fruit and vegetables in order to select suitable foods to carry out further studies.
- Study the effects of different energy source (gamma *vs* electron beam) and dose rate on fungi and foodborne virus inactivation by ionizing radiation.
- Establish contact with national hospitals.

Tunisia

(Samia Ayari)

Combination Treatments Involving Irradiation in Order to Develop Shelf Stable Sterile Foods for Immuno-compromised Patients and Other Specific Target Groups

This work was carried out by the National Center of Nuclear Sciences and Technologies in collaboration with Tunisian National Center for Bone Marrow Transplant (CNGMO). The aim of this project is to establish a combination of gamma irradiation treatment with conventional preservation methods in order to enhance their antimicrobial effects so that lower process intensities and fresher, higher quality, and safer food products can be obtained.

Usually, the preparation of sterile stable foods for immuno-compromised patients is done in a forced air oven at 120 °C for 20 min by the CNGMO. Gamma radiation treatment at 5, 10 and 15 kGy was carried out to achieve sterilization of couscous. Microbiological, physic-chemical and sensory analyses were performed. An immediate bactericidal effect of irradiation was found and minimal organoleptic changes were ensured. Results showed that the dose of 5 kGy gives the bacteriological quality required (reduce the microbial load from 2.48 log CFU/g to under the limit of detection) while preserving the organoleptic qualities. The comparison between the sample irradiated at 5 kGy and the heat treated seems to be very close, expect that the heat treated has a high oxidation state.

In the second part of this research, we were interested to the application of a series of combined physical treatments (blanching, vacuum packaging and irradiation) on carrot puree. Results showed that with sub-lethal dose of 3 kGy in combination with moderate heat treatment and moderate pressure vacuum we can achieve an undetectable level of bacteria while preserving the antioxidant activity and the phenolic content. The combination of mild irradiation doses with other physical or biological preservation methods can be used to provide more dietary variety for immuno-compromised patients and other groups since it ensures stable sterile foods.

United Kingdom
(Jayne Woodside)

Food Research / Irradiated Food for Patients

Dr Woodside offered an update on the literature surrounding the use of low bacterial diets in the prevention of infection in immuno-compromised patients.

There is still a lack of consensus on the use of low bacterial diets, and current practice is inconsistent. The most recent survey of current practice was Europe-focused, and a broader view of what is going on worldwide would be useful. The current evidence for the benefit of low bacterial diets is still weak, but a Cochrane systematic review of the literature is likely to appear within the next few months.

Dr Woodside reviewed her research questions from the 1st RCM, and concluded that these were still relevant. Important questions in relation to irradiated foods include their cost effectiveness, sensory acceptability, and nutritional quality. Irradiated foods must be cost-effective, as this will be essential for acceptance by healthcare systems. The sensory acceptability of any new irradiated foods also needs to be tested, in a blinded way where possible and in both healthy volunteers and patients. The nutritional quality of irradiated foods must also be confirmed, either from the literature or by direct measure of the foods, but also perhaps by the monitoring of nutritional biomarkers post-consumption of irradiated fruit and vegetables to assess bioavailability.

Another important question will be the effect of these new foods on overall diet quality and the patients' quality of life and mood. Dr Woodside emphasised the need for careful study designs, controlled where possible, and careful conduct of intervention studies. The local setting will determine to some extent what is possible. In an ideal world, a survey of current practice with regard to use of dietary restrictions would be useful, as would some educational material / programme development with healthcare professionals/other relevant bodies, which will be important to gain access to patients. Focus group or individual discussions with healthcare professionals and patients will lead to selection of appropriate foods, and sensory testing will be carried out with these foods, firstly in a controlled setting with healthy volunteers, followed by sensory testing with immuno-compromised patients.

Dr Woodside encouraged researchers to also consider a longer term study with cost, quality of life (QoL), overall diet quality, bioavailability, other health benefits as endpoints, if this was possible. Finally, she discussed suitable data presentation, and the design of sensory acceptability studies.

United States of America
(Suresh Pillai)

E-Beam Irradiated Diets for Neutropenic Bone Marrow Transplant Recipients: Technology and Hospital Food Supply Chain Considerations

Work over the past 12 months focused on the following areas namely, 1) selection of food items of interest to hospital patients, 2) identifying the Modified Atmosphere Packaging (MAP) conditions, 3) developing

collaborations with medical practitioners with expertise in hospital foods, 4) developing linkages with hospital food suppliers and 5) seeking funds to support laboratory research and clinical studies involving E-Beam irradiated hospital foods.

Selection of food items of interest to hospital patients: Food within the hospital environment, more than just providing nutrients and satisfying hunger, is considered to have significant psychological value especially in pediatric patients. Since neutropenic fruit and vegetable salads are unavailable, pediatric cancer patients are currently forced to avoid such foods to reduce their exposure to foodborne pathogens. The test fruits to be studied in this project are watermelon, tomato, strawberries, red grapes and avocados. Unprocessed fruits will be purchased for these studies.. The use of unprocessed fruits also allows the natural bio-burden levels of fruits to be studied rather than having to inoculate such fruits to assess microbial killing.

Modified Atmosphere Packaging Conditions: The MAP conditions to be evaluated in this project will be customized based on the fruit or vegetable. Previously published information will be used as the basis for the choice of the specific MAP conditions

Collaboration with medical practitioners: We have formed an unofficial collaboration with Dr. Karen Moody who is a pediatric oncologist. She serves as the Director, Integrative Medicine and Palliative Care Team Section of Pediatric Hematology/Oncology Children's Hospital at Montefiore in New York. She collaborates on this project by providing guidance on the choice of food items and for performing the clinical studies when warranted.

Developing linkages with hospital food suppliers: We have had a series of exchanges with Morrisons's Management Specialists a unit of the Compass Group. They are headquartered in Atlanta, GA and the CSI has discussed with them their willingness to participate in this project via teleconferences, emails and one face to face meeting. They have been provided with high level documents documenting the value proposition for their involvement on this project.

Seeking funds to support laboratory research and clinical studies: Proposals were submitted to the USDA's grant funding program to seek funds to support the laboratory research part of this project. The submission was, however, not successful. The CSI will continue to seek funds to support the activities associated with this project.

Annex D

RESEARCH PROTOCOL (REVISED)

It is important to involve health professionals or emergency personnel/first responders in the design of the experiment.

1. Materials

1.1. Food
The types of food studied should be chosen in consultation with local healthcare professionals or emergency agencies. The experiments should be carried out on foods that are representative of good quality food and from a reliable source.

Cooked ready to eat meals must be prepared according to a standard recipe so it can be prepared to the same standard repeatedly or ready to eat meals should be bought from a standard food service provider. It is important that the food does not vary to ensure consistency of the product following irradiation.

1. 2 Packaging and Labeling
Packaging material should be suitable for use in radiation processing in the respective countries or regions. It is necessary to demonstrate that the packaging retains its integrity over the usable life of the food product. Participants are advised to consult with national and international documentation regarding (physical/chemical) packaging material properties/stability for irradiated food. The packaged food should meet the requirements of the target group (e.g. hospital kitchen/emergency) and be suitable at the target irradiation dose. Participants are advised to adhere to labeling requirements since these foods will be used in patient trials and specific target groups.

1.3 Reagents
Standard chemicals and media should be used in the research

2. Methods

2.1 Microbiological Experiments
Studies involving the inoculation of food should take care to ensure that the organisms are either deposited in a culture collection or preserved for future reference. All experimental protocols should be recorded.

Inoculation should involve products in their "normal" (non-irradiated / non-sterile) state.

Participants are advised to consider enteric viruses when working with fresh fruits and vegetables Participants are advised to consider the starting bioburden of commodities or ingredients prior to irradiation . All efforts must be made to include GAP, GMP and HACCP principles during the development of irradiated foods for hospital and other target groups.

2.2 Physical, Chemical, nutritional and Sensory Analysis
Analyses should be designed to provide data that is relevant to the experimental objectives

Quality of Life(QoL) scores
If QoL scores are being collected, focus group discussions and other validated instruments should be used.

2.3 Record Keeping
Methods employed to produce the food should be documented (e.g. packaging temperature, atmosphere, storage temperature, irradiation conditions etc.)

3. Dosimetry

The dosimetry system should be calibrated and dose should be traceable to an international standard. Dosimetry should be employed according to recognized international standards. The minimum and maximum doses absorbed by the irradiated product should be determined, striving for dose uniformity. Routine dosimetry should be conducted, and a dosimetry report should be provided for each experiment. Use delivered dose (± std deviation) rather than the target dose. Participants are advised to report data based on actual delivered dose.

International Standards and other guides are available to assist with conducting dosimetry for research on food and agricultural products, including:

ISO/ASTM 51261 Standard Guide for Selection and Calibration of Dosimetry Systems for Radiation Processing.

ISO/ASTM 51900 Standard Guide for Dosimetry in Radiation Research on Food and Agricultural Products.

The key parameters required for dosimetry and reporting dosimetry include the following:

1. Calibration of radiation field inside the product box with confidence interval and traceability to a recognized national standard.

2. A statement or reference to details of the dosimetry system employed.

3. Uncertainty / confidence interval on the dosimetry system.

4. Dose mapping exercise for each configuration used (D_{max}, D_{min}, and dose distribution). The loading pattern for dose mapping should be recorded (a diagram for example).

5. The loading pattern for subsequent treatments should be the same as that used in the dose mapping exercise and should be recorded with reference to the dose mapping exercise.

6. The location for the placement of routine dosimeter(s) and the relationship between the dose received by dosimeter(s) at the routine location and the D_{max} and D_{min} (obtained from dose mapping).

7. The type of radiation and the source used should be recorded. Information related to irradiation treatment should include
i. Source strength.
ii. Radiation type

8. The following information should also be recorded:
- Target dose.
- Measured dose (and confidence interval).
- Dose rate.
- Dose uniformity ratio.
- A statement on how the dose was delivered, for example, was the dose delivered in a single treatment or by multiple exposures.

4. Microbiological criteria

There is an absence of commonly agreed microbiological criteria and the meeting decided to develop criteria that could be used by CRP participants. The following are sanitary microbiological levels suggested for foods intended for immuno-compromised people and other potential target groups. These criteria have been derived from Brazilian guidelines, the International Commission on Microbiological Specifications for Foods (ICMSF)[3] , information in a scientific paper by Pizzo et al [4], European Regulations on food hygiene

[3] www.icmsf.org

and criteria recommended by Ju-Woon Lee that were certificated for use in space flight conditions by the Russian Institute for Biomedical Problems. Participants are strongly urged to follow the Bacteriological Analytical Manual (BAM) for Microbiological Analyses and Data reporting[5].

Aerobic Plate Counts < 500 cfu/g

Listeria spp not detected in 25 g

Salmonella spp not detected in 25 g

Yeast and Mould < 10 cfu / g

Total Coliforms < 10 cfu / g

Staphylococcus aureus < 10 cfu / g

Aerobic spore count < 10 cfu / g

Anaerobic spore count < 10 cfu /g

Detection Limit
The method detection limit should be stated when reporting results. Avoid using 0 CFU as a value in Tables

Sensory Testing
There may be three levels of sensory studies namely within the laboratory, within a wider consumer group and finally the target patients. Participants are advised to perform sensory testing prior to testing on patients. Participants are advised to adhere to the appropriate procedures and approvals. This may include inclusion of "Informed Consent" documents.
Participants are urged to designate their studies as "pilot studies" when performing studies in hospitals because the sample size may be small.

5. Quality Assurance / Good Laboratory Practice

Statistical advice should be sought prior to experimental design and during data analysis.

Data sheets, survey forms and similar documents should be archived so that they can be made available for future reference. All original data should be retained so it can be made available in future.

Records should include details and descriptions of

- The food and preparation recipes
- Packaging material
- Food bioburden prior to irradiation (this should be determined and recorded)
- Inoculation studies (record the organism details and description).
- Conditions of irradiation (see dosimetry)

An active web-site will be used to facilitate information sharing and will be open to CRP members and others involved in the research project.

6 Clinical Studies

[4] Pizzo PA, Purvis DS, Waters C. Microbiological evaluation of food items for patients undergoing gastrointestinal decontamination and protected isolation. J. Am. Diet. Assoc. 1982 Sep;81 (3): 272-9
[5] www.fda.gov/Food/ScienceResearch/LaboratoryMethods/BacteriologicalAnalyticalManualBAM/default.htm

Nutritional advice should be sought wherever appropriate. Studies should be carried out in collaboration with a medical professional, if patients are involved, and appropriate local governance guidelines should be followed (e.g. including ethical approval).

7. Educational Material

Written documents and presentations should be prepared and developed. Information should be shared on the internet forum. IAEA should explore the possibility of hosting these documents on their website platform.

8. Journal Publications

Participants are strongly urged to submit peer-reviewed publications in journals (international and/or national) that are targeted to the hospital medical community. Examples include the American J of Clinical Nutrition, J of Nutrition, Clinical Nutrition, British J of Nutrition, Asian J of Nutrition, Nutrition & Cancer, J. of Hospital Infections, J. Homeland Security, J of Food Protection, J of Food Science, J of Natural Science, J of Food , Radiation Physics and chemistry. J. of Pediatric Hematology and Oncology, etc

9. Scientific Meeting Presentation

Participants are also strongly urged to present papers at suitable scientific meetings; for example, the Annual Meetings of the Institute of Food Technologists (IFT) in June 2012[6].

10. Outputs

Participants are urged to document all items and activities that can be considered as project outputs

[6] At the 2nd RCM Suresh Pillai offered to draft a paper for this meeting. The author byline will comprise the CSI and the rest of the respective teams will be included as part of the acknowledgements.

Annex E

Table 1
A List of Foods Represented in CRP to Develop Irradiated Foods for Immuno-Compromised Patient and Other Potential Target Groups

Country	Food(s)	Target Group	Safety and quality parameters				
			Packaging	Nutrition	Micro-biological safety	Shelf life extension	Sensory
Argentina	Highly nutritive bread , fruit and vegetables	Hospital, Emergency nourishment	X	X	X	X	X
Bangladesh	Cucumber, carrot, capsicum, lettuce, tomato, fresh fruits	Hospital	X	X	X	X	X
Brazil	Fruit salads, spring salad, ice-cream, salad dressing	Hospital	X	X	X	?	X
Bulgaria	Dried red peppers, meat-balls, "Yuvka"	hospital	X	X	X	X	X
China	Pickles, vegetable salad	Hospital	X	X	X	X	X
China	Pickles, tofu, sausage, cooked rice+chicken dish	Emergency	X	X	X	X	X
Hungary	apples, orange, banana, baby carrot, tomato, cucumber, dessert dairy product	Hospital	X	X	X	X	X
India	LCEF(low-cost enteral food), BLF (blenderized liquid food), sugarcane juice, salad and ice-cream Litti, pulav, chicken tikka/kabab	Hospital Other target groups	X	X	X	X	X
Indonesia	Ethnic Prepared meals (Fish, meat, chicken, tempe, tofu, soup, herbal ice-cream and cooked vegetable dressing	Hospital and different target groups (rations).	X	X	X	X	X
Pakistan	Prepared fortified meals (legumes and chicken, fresh veg and fruit salad)	Hospital Calamity victims	X	X	X	X	X

Philippines	Meat products, (Pork and chicken Adobo), mango, banana, papaya, tomato, cucumber and lettuce (PHI Beefsteak)	Hospital Calamity victims	X	X	X	X	X
Portugal	Raspberries, cherries, apricots, tomatoes	hospital	X	X	X	X	X
Tunisia	Vegetable salad, fruit salad, bread, puree, couscousVeg, r	Hospital	X	X	X	X	X
Republic of Korea	Fresh produce, prepared meals (ready to eat, ready to heat meals, one-dish meal)	Hospital Emergency rations Astronauts	X	X	X	X	X
USA	watermelon, tomato, red grape, strawberries, avocado	Hospital, Astronauts	X	X	X	X	X

Annex F

Table 2

Journal Papers and Related Outputs Produced Under the CRP to Develop Irradiated Foods for Immuno-Compromised Patient and Other Potential Target Groups

Country	Journal Articles	Conference presentations	Conference Abstracts	Conference Proceedings	Thesis/ Dissertations (completed and expected)	Workshops	Hospital & Other Presentations	Other
Argentina		3	3		3	1	3	2 (brochures and protocols
Bangladesh			1		1			
Brazil	2	7	7		4			
Bulgaria	-	-	-	-	-	-	-	-
China	1	3	3		2		1	1 (video) 1 fact sheet)
China	1	3	2				1	
Hungary	1	2	2		1	1		1 (brochure) 1 (newsletter)
India							1	
Indonesia	3	4	2	1	4	4 (+1 for halal certification)	3	1 (brochure) 4 (MoU)
Pakistan	1	1				1	4	1 (MoU) 1 (brochure) 1 (report)
Philippines		1						1 (brochure)
Portugal			1		1			1 (lecture module)
Tunisia					2		1	
Republic of Korea					3 (Ph.D.) 2 (M.S)	6	20	
USA							3	5
TOTALS	**9**	**24**	**21**	**1**	**23**	**14**	**37**	**21**

Annex G

Analysis of Perceived Strengths, Weaknesses Opportunities and Threats

Perceived Strengths
Regulations in place in some countries
Strong existing collaborations between participants
Strong expertise among participants having facilities for irradiation technology, microbiology and food processing
Previous expertise in participation in CRP's
Strong expertise in cobalt-60 and E-Beam technologies
Expertise in bacteriology, virology, packaging and food processing
Already developed benchmarks for microbiological criteria
Wide range of target food groups
The target patient groups stand to gain extensively by this project and technology
Strong advancement in project objectives

Perceived Weaknesses
Connection with medical community is time and resource intensive
Funding
Lack of information on current practices
Potential lack of institutional safety review boards (IRB) review
Concerns over use of food irradiation by medical community
Convincing doctors to include this project in their work
Disconnect between physicians and nutritionists
Lack of regulation in some countries
Need more expertise from the medical community
Need more medical community agreement holders
Difficulty in connecting with the governmental agencies involved

Perceived Opportunities
Potential to generate novel information on the benefits of food irradiation
Build upon the growing interest and acceptability of irradiated foods
Ability to build and develop researcher-medical community networks
Participation in this CRP can lead to opportunities to secure funding from other sources
Opportunity to get a technical contract to collate information on current practices globally
Ability to draw upon the experience on dealing with institutional safety review boards eg., sensory testing, pilot studies, etc.
Ability to enhance adoption by approaching medical doctors, nutritionists and hospital food suppliers
The adoption of emergency foods in countries can help stimulate adoption of this technology by other countries
The ability to make a profound change in the quality of life (QoL) of patients
The ability to include the topic into medical school curricula and lectures
Possible commercialization of technology by the private industry
Possible investments by private industry

Perceived Threats
Participants stop working on project
Lack of funds
Lack of public acceptance and support
Availability and cost of technology
Lack of support from the medical community
Lack of support from government
Slow adoption of technology by the commercial sector
Lack of regulatory support by governments
Continued lack of the topic in medical school curricula
Lack of evidence that neutropenic foods impact on patient health