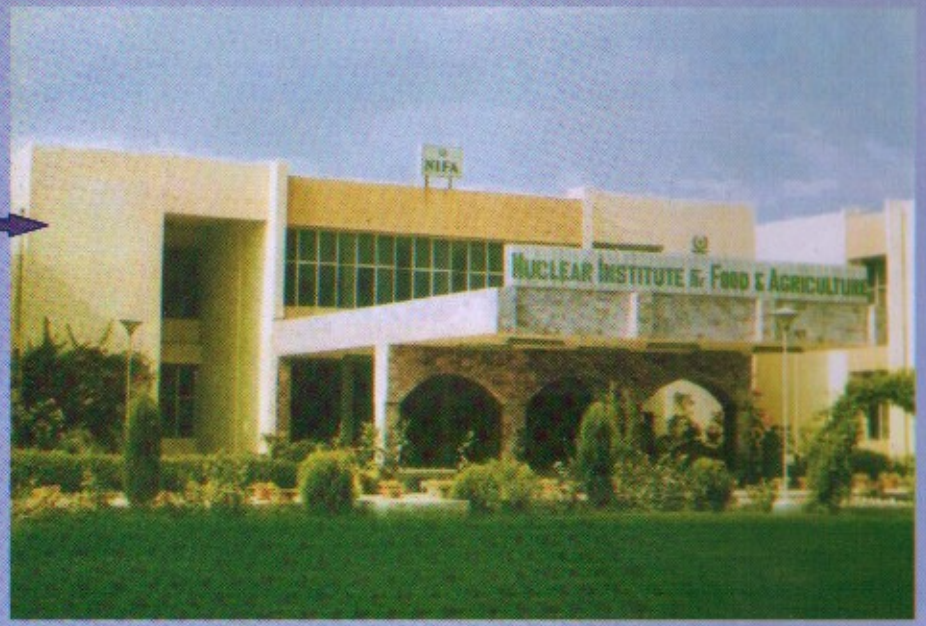
NIFA BULLETIN No. NIFA/FSD/ 1 -2005

Food Irradiation Technology in Pakistan

A Technology of the Future



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Irradiation Technology

Meeting the up-coming Challenges

Regarding

Safety, Security and Trade of Food & Non-Food Items

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2005

Introduction

Food is one of the most important necessities of life. Like men, it is equally relished by bacteria, fungi, insects and rodents etc which leads not only the spoilage and wastage of the major chunk of foods but also make them unhygienic and unpalatable for human consumption. Despite many preservation techniques and precautions to ensure the safe food supply microbial contamination and unhygienic quality is still a great issue of concern. Food irradiation is gaining acceptance worldwide and is considered the technology of future. Food safety, security and benefits through irradiation technology are well documented. Nuclear Institute for Food and Agriculture [NIFA], an organization of Pakistan Atomic Energy Commission (PAEC) is conducting studies on preservation of various food materials by gamma irradiation. Since the inception of NIFA in 1982, intensive work on food irradiation is spread over many fold approaches involving laboratory scale, pilot scale and commercial scale experiments. As a result of the comprehensive research, a package of technology for selected food materials has been developed for commercial application. It has been established that preservation of food by gamma irradiation is technically feasible and economically viable under prevailing climatic and economic conditions in Pakistan.

Marketability and acceptance of irradiated food by the consumers is a vital factor in the success of food irradiation technology. In order to educate the consumers, the programme for dissemination of information regarding food irradiation has been stepped up. Moreover, we are urgently needed to be vigilant and prepare for the WTO standards about the open market economy system. In addition, there is need to educate our technical personnel working in food processing industries and to brief them about the potential, advantages and the economics of food irradiation technology. Besides foods industries, non-food commercial enterprisers such as food packages, tobacco, cotton and manufacturers of pharmaceutical/medical goods can also be the beneficiaries of irradiation technology. A feasibility of establishing multipurpose commercial irradiation plant in Peshawar is already submitted to Pakistan Atomic Energy Commission. Government of Pakistan has approved the Food Regulations through its Gazette Notification in 1996 to control the irradiation processing of food materials in the country.

RADIATION TECHNOLOGY

Radiation: What Is It?

- Radiation is broadly defined as energy moving through space in invisible waves
- Radiant energy has different, nature, origin, wavelengths and degrees of power.
- Radiation may be ionizing or non-ionizing.
- Examples of radiant energy are light, infrared, heat, and microwaves, ultrasound, radio and television, , , , x-rays etc.

Food Irradiation:

- The radiation of interest in food preservation is ionizing radiation (mostly gamma rays or electrons) and the processing with radiation is known as irradiation. Food irradiation is process of exposing food to an ionizing energy to kill harmful microorganisms and to extend shelf life of food.
- Radiations of shorter wavelengths are capable of damaging microorganisms, which contaminate our food or cause food spoilage and deterioration.
- To minimize postharvest losses, scientists have been found irradiation to be a controlled and very predictable process.
- Irradiation is cool process (Cold Pasteurization) and for each 10 kGy irradiation only 4.3 oC rise in temperature is observed in target medium.

UNITS OF MEASURING RADIATION

RAD (Radiation absorbed Dose): RAD is the amount of any type of ionizing radiation that deposits 100 ergs of energy/g of material.

Gy (Gray): The SI unit for radiation is Gray which is equal to amount of radiation which deposits 1 joule of energy/kg of radiating medium. Thus 1 Gray is equal to 100 rad.

HOW FOOD IS IRRADIATED

During the process of irradiation, food passes through closed radiation chamber where it is exposed to ionizing radiation in the form of gamma from Co-60 source, x-rays or accelerated electrons from machine source. All these three types of ionizing energy have the functions to inactivate spoilage and disease causing microorganisms without causing any harmful changes in foods. According to the Codex Alimentarius Commission's general standard for irradiated foods in 1983, the following sources with their status are recommended for food irradiation.

a) Gamma rays from radio nuclides Co-60 and Cs-137
b) X-rays from machine sources at or below an energy level of 5 MeV
c) Electrons from machine source at or below an energy level of 10 MeV

HOW FOOD IRRADIATION IS CATEGORIZED?

Radurization (low doses radiation treatment)	(Equivalent to pasteurization) 1-5 kGy dose. For reduction of spoilage bacteria population thus shelf life is extended.
Radicidation *(medium doses radiation treatment)*	5-7 kGy Dose killing pathogenic bacteria to ensure safety of consumer from food born diseases.
Radappertization *(high doses radiation treatment)*	*More than 7 kGy dose killing all spoilage and pathogenic bacteria to achieve the degree of sterility.*

HOW IS FOOD IRRADIATION REGULATED?

Overall research and development in the field of irradiation is collaborated, monitored and controlled by International Atomic Energy Agency (IAEA), Food and Agriculture Organization (FAO), and World Health Organization (WHO) in collaboration with other international plants and animals protection agencies. Over the past 40 years, several international food control authorities have extensively studied this food process under a variety of conditions and found it to be safe and effective. Worldwide some 170 commercial Co^{60} irradiators and electron accelerators have been processing variety of goods including foods, industrial and medical products. Since 1986, all irradiated products

must carry the international symbol (logo) called a radura, with the statement like *"treated with ionizing radiation"*. Several organizations like US Food and Drug Administration (FDA), US Department of Agriculture (USDA), Department of Defense (DOD) and National Aeronautical and Space Administration (NASA) have approved or established guidelines for food irradiation. In fact the safety record of irradiation process is excellent, environment friendly and the technology is capable to reduce/eliminate the use of harmful pesticide and other chemical fumigants being used for decontamination of foods and as quarantine treatments.

WHOLESOMENESS OF IRRADIATED FOODS

Based on the enormous data generated over the years worldwide, it can be stated that irradiated food is nutritionally adequate, toxicologically and microbiologically safe and fit for human consumption. The chronological order for acceptance of food irradiation process as wholesome by various world bodies is as follows:

- In 1976, the Joint expert committee of FAO/IAEA/WHO recognized irradiation as physicals process for food preservation that is comparable to heating or freezing.
- By 1980, the joint expert committee evaluated that irradiation of any food commodity up to 10 kilo Gray (kGy) causes no hazard or introduces no special nutritional or microbiological problem.
- In 1983, the Codex Alimentarius Commission published an international standard which recognized that food irradiation is safe for general application to an overall average dose of 10 kilo Gray.
- In 1997 a Joint FAO/IAEA/WHO Study Group on this subject again evaluated the wholesomeness of food treated with doses above 10 kGy. The committee concluded that food irradiated to any dose appropriate to achieve the intended technological objectives is both safe to consume and nutritionally adequate.

WHAT HAPPENS WHEN FOOD IS IRRADIATED?

Irradiation is known as a cold process. It is a process of imparting ionizing energy to food, which destroy the harmful microorganisms. It does not significantly increase the temperature or change the physical or sensory characteristics of most of the foods. Foods treated with radiation, remains fresh for example, treated apple will still be crisp and juicy, fresh or frozen irradiated meat remains uncooked and in the raw form after irradiation, while their quality and hygiene are enhanced.

WHY FOODS ARE IRRADIATED?

Foods are irradiated to check the postharvest losses, to enhance hygienic quality, to decontaminate food commodities, to extend shelf life, to inhibit sprouting, to meet quarantine measures, to follow the standards and guidelines of WTO, in replacing the banned chemical fumigants formerly used for quarantine treatment during international trade.

IRRADIATION AS SANITARY & PHYTOSANITARY TREATMENT

Food-born diseases pose widespread threat to human health and are responsible for significant reduction in the economic productivity even in the advanced countries. In developing countries including Pakistan this problem is more severe and more attention is needed to protect the humans and animals (Sanitary) as well as foods of plant origin (Phytosanitary). Imposing effective sanitary & phytosanitary measures, we will be able to ensure supply of wholesome and microbiologically safe food with prolonged shelf life and ultimately will promote stable market distribution of different food items. Irradiation alone or in combination with other preservation techniques can be applied very effectively as sanitary and phytosanitary treatment.

RADIATION AS QUARANTINE TREATMENT

In view of imposing bane on chemical fumigants to satisfy quarantine requirement of horticultural crops an alternative treatment is urgently required. In the present situation of high alert and health consciousness, an ideal alternative should not only be effective against the pest species but should have no adverse effect on the quality of the commodity nor leave any hazardous residue on the treated products. Irradiation can be successfully applied to meet the quarantine requirements for international trade of different materials. Alongside foods, non-food agricultural produce like tobacco, cotton etc can also be treated for the purpose.

TECHNICAL BENEFITS OF IRRADIATION

Irradiation is proved to be technically feasible and economically viable technology worldwide. In Pakistan also, tremendous R&D work on food irradiation is conducted at NIFA and other PAEC establishments since 1976. The technical benefits that can be achieved on irradiating different food materials at the recommended dose levels are described below in brief:

- A dose of 0.30-0.40 kGy is suitable to extend shelf life of fresh fruits like mangoes, bananas, guava and tomatoes for 4-7 days by delaying ripening.
- Radiation dose of 0.1 kGy is established as optimum for complete inhibition of sprouting in potatoes, onions and garlic and the product can be safely kept for 6 months during storage at ambient temperature for onions and at low temperature (18-22 C) in case of potatoes.
- A dose of 1.0 kGy is enough to control insect infestation in pre-packed dried nuts and dried fruits and the irradiated materials can be stored in good conditions for a period of 6 and 9 months respectively.
- A dose of 1.0 kGy is found enough to completely inhibit spoilage in cereals and legumes by insects and the treated material can be stored safely for one year.
- Shelf life of citrus can be extended up to 15 days with irradiation treatment of 1.5 to 3.0 kGy
- Shelf life of raw fish can be prolonged up to 4 weeks with 2.0 kGy dose and subsequent storage at 1-3 C.
- A dose of 3.0 kGy with subsequent storage at 4 C is recommended for prolonging shelf life of raw poultry and meat by partial elimination of spoilage organisms and controlling infections by parasites.
- A dose of 8.0 kGy is proved sufficient for microbial decontamination of all types of spices and the irradiated materials can be stored for one year in good condition.
- Experiments have shown that feeding of 5 kGy irradiated commercial feed increased the live and dressed weights of broiler chicks by 15-20% over control.
- Radiation treatment offers possibility of surface sterilization to minimize losses due to disease.

MARKETING OF IRRADIATED FOODS & CONSUMER RESPONSE

No matters how much a food is technically and scientifically excellent and fine, ultimate assessment and/or acceptance is made in market and it is the consumer who determine whether or not a product is better than pervious one. There will be no technical or market success unless the consumer accepts it. Progress in the commercialization of irradiation technology is slow due to unawareness regarding the technology. Many peoples fear mistakenly that radioactivity or toxic compounds are associated with irradiation and therefore it became difficult for the consumer to think about the benefits of the technology. It is scientific fact that with irradiation no toxic radiolytic products are produced to the toxicity level nor radioactivity is induced in the treated food and there is no doubt about the wholesomeness of the product. Besides playing effective role in minimizing postharvest losses and increasing fruit and vegetable exports in the country, establishment of commercial food irradiators at Lahore, Karachi, Peshawar, Multan and Quetta will surely play as role model/demonstration units for the familiarization of food irradiation technology in the country. There is no doubt about the technical and economical feasibility of food irradiation technology, therefore, these units by proving practical feasibility after operation, will trigger the establishment of such more units in the country.

FOR DETAIL READING:

1. ICGFI, Facts about Food Irradiation, Series of fact sheets 1999.
2. Food irradiation: A Global Safety Tool; International Consultative Group on Food Irradiation May 2002
4. USDA Food and Nutrition Service. Irradiation of raw meat and poultry, Question and Answers 2003.
5. Ten years of NIFA; A Research Report 1982-1992
6. Ten years of NIAB; A Research Report 1972-1982

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