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APPLICATION OF IRRADIATION TECHNOLOGY ON FOOD

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ABSTRACT

Radiation processing of food involves the controlled application of energy from ionizing radiations such as gamma rays, electrons and X-rays for food preservation. Gamma rays and X-rays are short wavelength radiations of the electromagnetic spectrum which includes radiowaves, microwaves, infrared, visible and ultra violet light. Gamma rays are emitted by radioisotopes such as Cobalt-60 and Caesium-137 while electrons and X-rays are generated by machines using electricity. It is a cold process and can be used to pasteurize and sterilize foods without causing changes in freshness and texture of food unlike heat. Unlike chemical fumigants, irradiation does not leave any harmful toxic residues in food and is more effective. It is efficient and can be used to treat prepacked commodities. Radiation technology can complement and supplement existing technologies to ensure food security and safety. It provides effective alternative to fumigants that are being phased out due to their adverse effects on environment and human health.

KEYWORDS: Radiation Technology, Processing, Gamma Rays

INTRODUCTION

Most of the food products are perishable and are easily amenable to deterioration by various extrinsic and intrinsic factors. The prevailing traditional preservation methods majorly used are low temperature storage and heat processing. But adoption of these methods are having varied limitations on commodity wise and operational wise in maintaining bioactive constituents and self stability of products.In this context, adoption of a feasible technology which can tackle a range of problems for better quality assurance of food is in need.Food irradiation is such a non- conventional technology having a spectrum of utility on food that ensure equal quality and safety which is acceptable and can be commercialized.

Food irradiation is a technology by which food is exposed to ionizing and non-ionizing radiation to destroy microorganisms, bacteria, viruses, or insects that might be present in the food,treatment of foods and agricultural products with ionizing radiations (e.g., gamma rays, X-rays etc.).

The technology of food irradiation is gaining more and more attention around the world. In comparison with heat or chemical treatment, irradiation is more effective and appropriate technology to destroy food borne pathogens. Radiation technique makes the food safer to eat by destroying bacteria which is very much similar to the process of pasteurization. Radiation does not leave the food items radioactive for two seasons. First, the gamma rays from cobalt-60 used in food radiation are not energetic enough to make it radioactive. Second, as the food never comes into contact with the source directly, it is not possible for the food to become contaminated with radioactive material. In the changing scenario of world trade, switching over to radiation processing of food assumes great importance. Radiation will be moving fast to the status of a 'wonder technology' to satisfy the sanitary and phyto sanitary requirements of the importing countries. Food once irradiated, can be prone to re-contamination unless appropriately packed Therefore, if radiation treatment is intended to control microbiological spoilage or insect infestation, prepackaging becomes an integral part of the process.

Why irradiation is needed?

- Increasing concern over food borne diseases and uses of certain chemicals in food.
- High post-harvest food losses from infestation, contamination, and microbial spoilage.
- Stringent regulations related to quality and quarantine in international trade in food products.

Applications of irradiation

Radiation processing technology can be used for

- Inhibition of sprouting in bulbs and tubers
- Disinfestation of food grains and pulses
- Extending shelf-life under recommended conditions of storage
- Ensuring microbiological safety
- Overcoming quarantine barriers to international trade

Sources of Irradiation and how it Works

Radiation processing technology has been developed through worldwide R&D efforts of more than four decades. India is one of the few countries in the world having the necessary expertise and know-how for deployment of this technology. Irradiation processing of food involves the controlled application of energy from ionizing radiations such as gamma rays, electrons, and X-rays for food preservation. Gamma rays and X-rays are short wavelength radiations of the electromagnetic spectrum. Gamma rays are emitted by radioisotopes such as Cobalt-60 and Caesium-137 while electrons and X-rays are generated by gaseous discharge using electricity. Gamma rays are a part of the electromagnetic spectrum. They can penetrate deep into food materials and bring about desired effects.

Radiation processing of food is carried out inside an irradiation chamber shielded by 1.5 to 1.8 meter thick concrete walls. Food, either pre-packed or in-bulk, placed in suitable containers is sent into the irradiation chamber with the help of an automatic conveyor. The conveyor goes through a concrete wall labyrinth, which prevents radiation from reaching the work area and operator room. When the facility is not in use the radiation source is stored under 6 meter deep water. The water shield does not allow radiation to escape into the irradiation chamber, thus permitting free access to personnel to carry out plant maintenance.

Cost of Irradiated Food

Any processing will add to the cost of food. In most cases, however, food prices may not necessarily rise just because a product has been treated. Many variables affect food costs, and one of them is cost of processing. But processing also brings benefits to consumers in terms of availability, storage life, distribution, and improved hygiene of food. Irradiation costs may range from Rs. 0.25 to Rs. 0.50 per kilogram for a low dose application such as sprout inhibition of potato and onion, and insect disinfestation in cereals and pulses. It costs from Rs. 1 to Rs. 3 per kilogram for high dose applications such as treatment of spices for microbial decontamination. The costs could be brought down in a multipurpose facility treating a variety of products around the year.

Applications

Radiation decontamination of medicinal plants and spices is a safe and very effective method with negligible losses of the biologically active substances (Andrzej and Wojciech,2005).Gamma irradiation as an alternative treatment to abolish allergeni city of lectins in food (Vaz *et al*.,2011).Carrot -3 kGy Gamma irradiation at 10◦C for 3 days higher in the total phenolic contents (Song *et al*., 2006).Cucumber -3 kGy gamma irradiation all the bacterial contents were reduced to below the limit of detection.(Lee *et al*., 2006). Irradiation of fruits and vegetables imported into the US as a phytosanitary crop protection measure against fruit flies and mango seed weevil (APHIS, 2002).The use of gamma irradiationto generate cross-linked edible coating or biodegradable packaging.(Lacroix.,*et al* 2000).Irradiation doses of up to 2.4kGy can be used with minimum effect on the respiratory physiology of tissues in apple.(Gunes *et al*.,2000). Irradiation as a Critical control point (CCP) in raw or minimally processed products like meat, fish, seafood, fruits and vegetables.(Molins *et al*.,2000).

Rezaee *et al*. (2011) investigated on the potato sprout inhibition and tuber quality after post harvest treatment with gamma irradiation on different dates. Study indicated that early irradiation and higher irradiation levels significantly decreased sprouting, percent weight loss and specific gravity of tubers. The 50 Gy irradiation treatment on the 10^{th} day after harvest resulted in complete sprout inhibition of tubers at 8°C storage.

Fan *et al*. (2008) studied the retention of quality and nutritional value of 13 fresh-cut vegetables treated with low-dose radiation and reported that most fresh-cut fruits and vegetables tested can tolerate up to 1 kGy irradiation without significant losses in any of the quality attributes like vitamin C contents.

Impact of low doses of gamma irradiation on shelf life and chemical quality of strawberry (*Fragariaxananassa) CV. 'Corona'* was studied by Majeed *et al*., 2014.The results revealed that the radiation doses of 1.0 and 1.5 kGy might be used as consumers' acceptable doses for shelf life extension, minimum weight loss and decay, without affecting the chemical quality of strawberry like titrable acidity, TSS etc.

Ghanem *et al*. (2008) investigated on the effect of gamma radiation on the inactivation of aflatoxin B1 in food and feed crops.And found that degradation of AFB1 was positively correlated with the increase in the applied dose of gamma ray and negatively correlated with oil content in irradiated samples for each tested sample.

Effectiveness of radiation processing in elimination of *Salmonella typhimurium and Listeria monocytogenes* from sprouts was studied by Saroj *et al*., 2006.

The results revealed that radiation treatment with a 2-kGy dose resulted in complete elimination of 104 CFU/g of *Salmonella typhimurium* and 103 CFU/g of *L. monocytogenes* from all the four varieties of sprouts.

How Irradiation Works?

- By disrupting the biological processes that lead to decay.
- In their interaction with water and other molecules that make up food and living organisms, radiation energy is absorbed by the molecules they contact.
- The reactions with the DNA cause the death of microorganisms and insects and impair the ability of potato and onion to sprout.

Symbol of Irradiated Food-Radura

Codex Alimentarius Commission has endorsed this green irradiation logo.The term 'RADURA' clearly relates to radurization.

KRUSHAK

This facility is located at Lasalgaon, in Nashik District.KRUSHAK - '**Krushi Utpadan Sanrakshan Kendra**', literally translated in English as '**agricultural produce conservation centre**'. This irradiator is a specially designed technology demonstration unit for low dose applications of irradiation, primarily for controlling sprouting in stored onions and insect disinfestation of agricultural commodities for storage and quarantine. This is a successful example of transfer of irradiation technology in this country.

Analytical Laboratories in India

- Bhabha Atomic Research Center, Bombay
- Analytical Quality Control Laboratory, CFTRI, Mysore
- Central Food Laboratory, Calcutta
- Central Food Laboratory, Pune
- University dept. of Chemical technology, Bombay
- Food Research and Standardization Laboratory, Gaziabad

Irradiation companies in India

- Hindustan Agro Co-operative Ltd., Rahuri, Ahmednagar
- Agrosurg Irradiators Pvt. Ltd., Mumbai
- Innova Agri Biopark Ltd., Bengaluru
- Microtrol Sterilization Services Pvt Ltd., Bengaluru
- Jhunsons Chemicals Pvt. Ltd., Bhiwadi, Rajasthan

Irradiation facilities in India

- 2001 -Board of Radiation and Isotope Technology Department of Atomic Energy BRIT/BARC Vashi -a radiation processing plant at Vashi, Navi Mumbai, was built in order to process spices(for high dose applications like microbial decontamination of spices and dry ingredients)
- 2002-Low dose applications like sprout control in onion and potato, disinfestations of cereals and quarantine treatment at Lasalgaon, near Nasik in Maharashtra commissioned

CONCLUSIONS

The technology of food irradiation is popularly accepted and surely merit serious consideration by public health authorities, industry and consumer group worldwide. Its application potential is very diverse, from inhibition of sprouting of tubers and bulbs to production of commercially sterile food products. This technology can be utilized effectively as a novel postharvest technique to reduce postharvest losses, increase the quality of international trade of food and preserve the quality of food. These potentialities of technology currently driving the worldwide momentum towards commercial use of food irradiation.

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