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Irradiation' and its Potential to Food Preservation

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Abstract

In spite of the technologies developed during the last decade, the level of food loss is still high and is reported in many countries. According to the United Nations, more than 30 per cent of the mortality rate world-wide is caused by alimentary diseases. The desire of most countries to make food safer for consumption requires better food preservation and production techniques. In this regard, irradiation is an interesting alternative to be considered Food irradiation is a process exposing food to ionizing radiations such as gamma rays emitted from the radioisotopes ^{60}Co and ^{137}Cs, high energy electrons and X-rays produced by machine sources. Some agricultural products are important commodities in international trade. The trade of these products is often seriously hampered by infestation of several species of insects and mites. The presence of parasites, some microorganisms, yeast and moulds are also the source of problems, sometimes directly or indirectly through toxin formation in the food products. Irradiation alone or combined with others processes can contribute to ensuring food safety to healthy and compromised consumers, satisfying quarantine requirements and controlling severe losses during transportation and commercialization. Depending on the absorbed radiation dose, various effects can be achieved resulting in reduced storage losses, extended shelf life and/or improved microbiological and parasitological safety of foods. However, hindering factors in the way of commercial implementation of the food irradiation process are politics and consumer advocacy. This paper reviews the application of irradiation for preserving some fruit and vegetables.

Keywords: Irradiation, Food, Quality, Gamma Ray, Technology, Preservation.

Introduction

The potential benefits of food irradiation are yet to be realized due to slow progress in the commercialization of the technology (Peter, 2014). Irradiation is the deliberate process of exposing an item to certain types of radiation energy to bring about desirable changes. Ionizing radiation is radiant energy that has the ability to break chemical bonds. The early history of food irradiation is the history of radiation itself (Diehl, 2002). Food irradiation has about 100 years of history and it was developed as a scientifically established technology And safe food process during the second half of the XXth century (Molins, 2001). There are three types of ionizing radiation that can potentially be used in food irradiation: electron beams (machine generated), X-rays-(machine generated), and gamma rays (occur naturally from

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radioactive decay of Cesium 137 or Cobalt 60). Cobalt-60 is most commonly used for food irradiation, though electron beam is finding increasing application. Currently, there are a number of non-food related products being irradiated (cosmetics, wine corks, hospital supplies, medical products, packaging materials) mostly to achieve no thermal sterilization. The radiation dose refers to the amount of these gamma rays absorbed by the product and is measured in Grays (Gy). 1 Gy = 1 Joule of absorbed energy / kg of product. Most treatment levels are on the order of 1 to 10 kGy (1 kGy =1000 Gy) (FDA, 2004). These types of radiation are chosen because (Farkas, 2004):

(a) They produce the desired food preservative effects.

(b) They do not induce radioactivity in foods or packaging materials.

(c) They are available in quantities and at costs that allow commercial use of the irradiation process

The beneficial effects of food irradiation resulted from the ability of radiation to bring about the effects shown in the Table, which also provides some indicative applications. Irradiation is one of many physical processes applied to food, but it has a number of practical advantages that include (Farkas, 2014):

• Versatile (safety, security and trade (insecurity) applications).

• Highly effective and efficient (it has broad-spectrum effectiveness against all nonsmoking bacteria and against insects and many other pests).

• A cold process (advantageous for many foods).

• Penetrating (foods are treated in their final packaging, target organisms are not protected by package shape or position in the package, product distribution is relatively unimportant, and treating pallet loads is possible).
• Solid, raw foods can be treated.
• Treatment does not involve chemicals or chemical residues.
• The process is relatively easy to control (usually dependent only upon conveyor speed and the power/activity of the radiation source)
• Food can be immediately distributed into the food supply chain after treatment.

What Happens When a Food is irradiated?
When ionizing radiation passes through a food product, some energy is absorbed by some chemical bonds. Some bonds rupture and produce free radicals which are highly reactive and unstable. They instantaneously rejoin with neighboring compounds and the results are called radiolysis compounds. These are similar to the compounds produced by heating (thermolytic compounds). There is no significant difference in the compounds generated from ionizing radiation versus those generated from heating. Roughly one bond per million is broken for each kGy of applied ionizing radiation. The uniqueness of irradiation is that DNA (microorganisms and insects have a lot of DNA compared to plant cells) is very sensitive to irradiation. Irradiation of DNA at the approved levels causes base damage, breaking of DNA strands, and cross linking. All of these result in the loss of the organism's ability to reproduce (IFT, 1998).

Reduction of pathogenic microorganisms

Since irradiation does not substantially raise the temperature of food under irradiation, it is of particular importance for the control of food-borne illnesses in seafood, fresh produces, and frozen meat products. Ionizing radiation has been shown to reduce the number of disease-causing bacteria such as *Listeria* monocytogenes, *Escherichia coliO157:H7, Salmonella, Cliostiridium botulinum* and etc. in various food commodities and allow food to be irradiated in its final packaging. However, irradiation alone may not be sufficient to reduce the number of food poisoning outbreaks, it is essential to adhere to good manufacturing practice to prevent subsequent contamination during processing (Edwards and Fung, 2006; Talbot et al, 2006; Jakabi and Gelli, 2003).

Decontamination

Spices, herbs and vegetable seasonings are valued for their Distinctive flavors, colours and aromas. However, they are often contaminated With microorganisms because of the environment and processing conditions under which they are produced. Until the early 1980s, most spices and herbs were fumigated, usually with sterilising gases such as ethylene oxide to destroy contaminating microorganisms. However, the use of ethylene oxide has been banned in a number of countries due to its proven carcinogenicity.

Extension of shelf-life

The shelf-life of many fruits and vegetables, meat, poultry, fish and seafood can be considerably prolonged by treatment with irradiation (ICGFI, 1999).

Depending on the dose of ionizing energy applied, irradiation produces virtually No or minor organoleptic changes to food under irradiation that make it particularly important for the control of postharvest quality of fresh produces (Niemira and Fan, 2006) by modifying the normal biological changes associated with ripening, maturation, sprouting, and aging (WHO and FAO, 1998).

Exposure to a low dose of radiation has been demonstrated to slow down the ripening of bananas, mangoes and papaya, control fungal rot in strawberries and inhibit sprouting in potato tubers, onion bulbs, yams and other sprouting plant foods (Thomas, 2001a; Thomas, 2001b).

Disinfestations

The major problem encountered in preservation of grains and grain products is insect infestation. Irradiation has been shown to be an effective pest control method for these commodities and a good alternative to methylbromide, the most widely used fumigant for insect control, which is being phased out due to its ozone depleting properties. Disinfestations is aimed at preventing losses caused by insects in store grains, pulses, flour, cereals, coffee beans, fresh and dried fruits, dried nuts, and other dried food products including dried fish. It is worth mentioning that proper packaging of irradiated products is required for preventing reinfestation of insects (Ahmed, 2001; ICGFI, 1999).

Other potential applications

Besides the sanitary purposes, irradiation has been studied to reduce or eliminate undesirable or toxic materials including, food allergens (Lee et al, 2000; Lee et al, 2001), carcinogenic volatile N-nitrosamines (Ahn et al, 2002a; Ahn et al, 2002)

And biogenic amines (Kim et al, 2003) On the other Hand, irradiation has been shown to enhance colour of low-nitrite meat products (Byun et al, 1999) and low-salt fermented foods (Byun et al, 2000). In addition, ionizing radiation can be used to destroy chlorophyll b in vegetable oil resulting in protection of oil from photo oxidation and elimination of undesirable colour change in oil processing industry (Byun et al, 2006).

Conclusions

Over the last decade the commercial retail of irradiated food has been growing slowly in a number of countries without any damaging consumer backlash or resistant However, the food trade generally, and retailers particularly, are slow to recognize this fact. If the potential benefits of irradiation for food safety and security and for trade are to be fulfilled, then it is time for irradiation processors to bring these commercial successes to the attention of the food industry in a more concerted and forceful manner. Failure to do so will leave the field open to those quoting surveys of general public opinion which do not appear to be consistent with consumer purchasing behavior.

It is evident from the available literature that radiation technology is a promising technique that could be employed for modification of food protein, especially on the protein films and gelatin properties. Majority of the research works reported in this review are mostly on the effects of irradiation on protein films properties but not on improving protein functionality. Therefore, there is lack of information on the effects of irradiation on other protein functionalities aside from being applied on the production of film. Generally, irradiation is known as the non thermal and cost effective technique for protein films modification. Future studies might be expanded on the other food systems such as spreads, bakeries, emulsions, aerated products, pharmaceuticals, etc. by applying this radiation induced protein modification within the permitted doses. These studies could be designed to ascertain the effects of irradiation on the gelling, foaming and emulsifying properties for different irradiation time or doses within the permitted doses. Furthermore, finding the best conditions, doses, and combination treatments for protein irradiation are crucial in order to achieve the desired functional properties.

References

Ahmed M. (2001). Disinfestations of stored grains, pulses, dried fruits and nuts, and other dried foods. In: Molins RA editor. Food Irradiation: Principles and Applications. New York: John 24 Wiley & Sons, Inc. p.77-112.

Ahn HJ, Kim JH, Jo C, Lee CH, Byun MW. (2002b). Reduction of carcinogenic N-nitrosamines and residual nitrite in model system sausage by irradiation . Journal of Food Science; 67:1370-3.

Ahn HJ, Yook HS, Rhee MS, Lee CH, Cho YJ, Byun MW. (2002a). Application of gamma irradiation on breakdown of hazardous volatile N-nitrosamines. Journal of Food Science; 67:596-9.

Byun MW, Jo C, Lee JW. (2006). Potential applications of ionising radiation. In: Sommers CH and Fan X editor. Food Irradiation Research and Technology. Iowa: Blackwell Publishing;. p.249-262..

Byun MW, Lee JW, Yook HS, Lee KH, Kim KP. (1999). The improvement of colour and shelf life of ham by gamma irradiation. Journal of Food Protection; 62:11626.

Byun MW, Lee KH, Kim DH, Kim JH, Yook HS, Ahn HJ. (2000). Effects of gamma radiation on the sensory qualities, microbiological and chemical properties of salted and fermented squid. Journal of Food Protection; 63:934-9.

Diehl, J.F. (2002). Food irradiation past, present and future, Radiation Physics and Chemistry 63: 211–215.

Edwards JR and Fung DYC, (2006). Prevention and decontamination of Escherichia coliO157:H7 on raw beef carcasses in commercial beef abattoirs. Journal of Rapid Methods and Automation in Microbiology, 14(1): 1-95.

Farkas, 2014. Farkas, J., Ehlermann D.A.E. and Mohácsi-Farkas Cs, Food Technologies: Food Irradiation, In Encyclopedia of Food Safety, edited by Yasmine Motarjemi, Academic Press, Waltham, Vol. 3, Pages 178-186, ISBN 9780123786135, http://dx.doi.org/10.1016/B978-0-12-378612-8.00259-6.

Farkas, J. (2004). Food irradiation. In A. Mozumder, & Y. Hatano (Eds.),Charged particle and photon interactions with matter(pp. 785–812). New York: Marcel Dekker.

FDA. (2004). Irradiation in the production, processing and handling of food. Federal Register, 69(246), 76844–76847.

IFT. (1998). Radiation preservation of foods. A scientific status summary by the Institute of Food Technologists' Expert Panel on Food Safety and Nutrition. J. Food Tech. Vol 52(1):55-62.

International Consultative Group on Food Irradiation (ICGFI), (1999).Facts about food irradiation.

Jakabi M, Gelli DS, (2003) Torre JCMD Rodas MAB, Franco BDGM, Destro MT,. Inactivation by ionising radiation of Salmonella Enteritidis, Salmonella Infantis, and Vibrio parahaemolyticusin oysters (Crassostrea brasiliana). Journal of Food Protection; 66(6): 1025-9.

Kim JH, Anh HJ, Kim DH, Jo C, Yook HS, Park HJ. (2003) Irradiation effects on biogenic amines in Korean fermented soybean paste during fermentation. Journal of Food Science; 68:80-4.

Lee JW, Kim JH, Yook HS, Kang KO, Lee WY, Hwang HJ. (2001) Effects of gamma radiation on the allergenicity and antigenicity properties of milk proteins. Journal of Food Protection; 64:272-6.

Lee JW, Yook HS, Lee KH, Kim JH, Byun MW. (2000). Conformational changes of myosine by gamma irradiation. Radiation Physics and Chemistry; 58:271-7.

Molins,R. A. (2001). Introduction. In R. A. Molins (Ed.),Food irradiation Principles and applications(pp. 1e21). New York: Wiley Interscience.

Niemira BA and Fan X. (2006). Low-dose irradiation of fresh and fresh-cut produce: Safety, sensory, and shelf life. In: Sommers CH and Fan X editor. Food Irradiation Research and Technology. Iowa: Blackwell Publishing;. p.169-84.

Peter B. R, (2014). Food irradiation Is safe: Half A century of studies Radiation Physics and Chemistry, http://dx.doi.org/10.1016/j.radphyschem.2014.05.016.

Talbot EA, Gagnon ER and Greenblatt J (2006). Common ground for the control of Multidrug-resistant Salmonellain ground beef. Clinical Infectious Diseases; 42(10):1455-62.

Thomas P. (2001a). Irradiation of fruits and vegetables. In: Molins RA editor. Food Irradiation: Principles and Applications. New York: John Wiley & Sons, Inc.;. p.213-40.

Thomas P. (2001b). Irradiation of tuber and bulb crops. In: Molins RA editor. Food Irradiation: Principles and Applications. New York: John Wiley & Sons, Inc.;. p.241-272.

World Health Organization (WHO) and Food and Agriculture Organization of the United Nations (FAO). (1988).Food irradiation: A technique for preserving and improving the safety of food. Geneva: World Health Organization.