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Radiation processed food contributed safety and nutritional adequacy

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Abstract

Food preservation has been a chief concern for many over the decades. Contamination of food products with microorganisms and pests forms significant basis for extensive losses of foods in course of storage, transportation and marketing (15% for cereals, 20% for fish and dairy products and up to 40% for fruits and vegetables). Predominantly, pathogenic bacteria are principal causes of human suffering and one of the most remarkably public health problems worldwide. Radiation processing is effectual method in preservation of food as well as serves in control of food-borne diseases. It even annihilates or inactivates organisms that are sources for spoilage, thereby lengthening the shelf life of reliable foods. But foods have to be kept in airtight bags in order to prevent re-invasion. Irradiation process is currently employed to reduce or eradicate the risk of food borne illnesses, thwart or slow down the spoilage, arrest maturation or sprouting and as well as treatment against pests. Therefore, food irradiation augments the shelf life of food as well as its optimum quality is also sustained for longer durations. Therefore in our current review we have focussed on Irradiated food which is regulated all over the country in accordance with the Atomic Energy (Radiation Processing of Food & Allied Products) Rules 2012 and Food Safety and Standards (Food Products Standards and Food Additives) Regulations, 2011.

Keywords: radiation processing, food borne diseases, storage, irradiation, preservation

Introduction

Food irradiation is the procedure of rendering the amount of energy in the form of speed particles or rays for enhancing food safety, purging and reducing organisms that destroy the food products. Food is commonly exposed to ionizing radiations for devastating the microorganisms, bacteria, viruses, or insects. In several cases, food irradiation leads to significant chemical changes [1, 2]. The international bodies embracing the Food and Agriculture Organization (FAO), the International Atomic Energy Agency (IAEA), WHO, FDA and Codex Alimentarius Commission (CAC) examine projects on food irradiation to authenticate the safety and quality of different irradiated products [3-6]. It has displayed that irradiation treated on alone or in combination with other methods could progress the microbiological safety and lengthen the shelf life.

Irradiation is applied to diminish or eradicate the risk of food borne illnesses, preclude or slow down spoilage, detain maturation or sprouting and as a treatment against pests. Depending on the dose, certain or all of the pathogenic organisms, microorganisms, bacteria and viruses existing are destroyed, dawdled, or hindered incapable of reproduction. Irradiation cannot relapse spoiled or matured food to a fresh state. If this food was treated by irradiation, extension of spoilage would be ceased and ripening would dawdle, nevertheless the irradiation would not devastate the toxins or repair the texture, color, or taste of the food [7-9].

Food irradiation is a practical method that renders food to electron beams, X-rays or gamma rays [10-13]. This procedure has a similar result to pasteurisation, cooking or other forms of heat application, but with lesser consequence on appearance and texture. Although many research on irradiation revealed that though irradiated food which has been exposed to radioactivity might not become radioactive itself. The energy absorbed by food when it has been showed to ionising radiation is known as 'absorbed dose', which has been measured in units called grays (Gy) or kilograys (kGy), whereas 1kGy = 1,000Gy. This amount of energy which has been absorbed by the food trigger the formation of short-lived molecules called as free radicals, which has the ability to kill the bacteria that produce food poisoning. They can also hurdle fruit ripening and help stop vegetables, such as potatoes and onions, from sprouting (FSA UK 2012).

Ionizing radiation can alter the quality of food which is common in very high levels of radiation treatment that displays an adverse impact in order to modify nutritional content in addition to the sensory qualities like (taste, appearance, and texture). Generally the Irradiations doses employed commercially to treat food have very less detrimental influence on the sensory qualities and nutrient content in foods. Nevertheless, spoilage microorganisms and food-borne pathogens can distinctively and promptly cultured on nutrient components of meat which required distinctive conservation methods in order to maintain the meat products safety and quality [14-15]. by manipulating the storage temperature, oxygen, endogenous enzymes, moisture, light and, most imperatively, microbial growth, which can delay changes in color, odor, texture and flavour of meat [16-19].

The current review provides an insight on the operational effect of gamma radiation which helps in prolonging the shelf life of food products as well as nutritional adequacy. The impact of this review study was to understand the irradiation dose which is an efficient for the method for lengthening of shelf life and in addition to exploration of the effectiveness of gamma irradiation on physico-chemical, microbiological and sensory qualities of products. Irradiation is promising as well as potential method of food preservation which is being used to prolong the shelf life of raw and processed foods in many countries worldwide.

History of food irradiation

Ionizing radiation has been first documented with the innovation of x-rays in 1895. After the discovery of irradiation method, it has been proposed as a process to kill the microorganisms which were present in all types of food products. In 1920 a patent was offered for a mode of removing the trichinae from pork employing ionizing radiations. Primitively in the 1920's, a French Scientist innovated that irradiation could be utilized to preserve food. This equipment was not adopted in the U.S. until World War II. The U.S. Army supported a sequence of experiments with fruits, vegetables, dairy products, fish and meats. In 1963, the U.S. displayed its first consent of food irradiation when FDA authorized its use to control insects in wheat flour. In 1964, additional further approval was given to inhibit the development of sprouts in white potatoes. In 1983, agreement was granted to kill insects and control microorganisms in an exact list and in this specific list there have been included herbs, spices and vegetable seasoning [20-22].

Fig 1: X-ray Irradiation Unit

Processing of food products by application of radiation

The chief advantages attained by irradiating the food products include hampering of the sprouting of tubers and bulbs, elimination of insect pests in agricultural commodities as well as delayed ripening of fruits and vegetables and also exclusion of microbes which are solely responsible for spoilage of food products. Confiscation of such parasites and pathogens are of major concern to public health [23-26]. Radiation increases safety as well shelf life of food products through considerable decrement in the number of spoilage causing microorganisms. Any kind of food processing has to be exposed to irradiation with dose range of 1-7 kGy depending upon the product [27].

Table 1: Processing of Food products by Irradiation

Type of food	Effect of Irradiation
Meat, poultry	Destroys pathogenic fish organisms, such as Salmonella, Clostridium botulinum. and Trichinae
Perishable foods	Delays spoilage; retards mold growth; reduces number of microorganisms
Grain, fruit	Controls insect vegetables, infestation dehydrated fruit, spices and seasonings
Onions, carrots potatoes, garlic, ginger	Inhibits sprouting
Bananas , mangos, papayas, guavas, other non-citrusfruits	Delays ripening avocados, natural juices
Gram, fruit	Reduces rehydration time

Irradiation treatment for food preservation

In few parts of Africa, insect invasion is accountable for several losses from production to marketing. Irradiation is the most effectual method of physical treatment for disinfesting insects in dried fish with a smaller dose of 0.3 kGy which would be adequate to annihilate insects from the food products [28]. Mostly in the developed countries as well as developing countries this technology of irradiation is superior and authorized by Food and Drug Administration. Radiation in developed countries like US with the approval from Food and Drug Administration can extend shelf life of packaged frozen food products such as red meat, herbs and spices from the attack of pathogens and insects [29-30].

Table 2: Food Items Approved for radiation processing by the Government of India

Name of Food	Purpose	Dose (kGy)	
		Min	Max
Onion	Sprout Inhibition	0.03	0.096
Potato		0.06	0.15
Ginger, Garlic		0.03	0.15
Shallot (Small Onion)		0.03	0.15
Mango	Disinfection (Quarantine)	0.25	0.75
Rice, Semolina (Rava), Whole Wheat flour (Atta) and Maida	Insect Disinfection	0.25	1.00
Raisins, Figs and Dried dates		0.25	0.75
Pulses		0.25	1.00
Dried sea Foods		0.25	1.00
Meat and Meat products including chicken	Shelf life extension and pathogen	2.50	4.00
Fresh Sea Foods	Shelf life extension	1.00	3.00
Frozen Sea foods	Pathogen control	1.00	3.00
Spices	Microbial Decontamination	6.00	4.00

Source: Food items approved for radiation preservation, by the ministry of health and family welfare, under prevention of food adulteration rules, 1995.

Acceptability of irradiated food by consumers
Customers have anxiety regarding the effects of irradiation on the intrinsic quality of food, the consequences of prolonged intake of irradiated food on health, health risk to the employees as well as environmental pollution [31]. Nevertheless, 55.8% of people articulated that they would buy irradiated food as reason for it has the Radura symbol. Consumer surveys have disclosed the satisfactoriness rates varying from 45% to more than 90%, depending on the food commodity and the manner of presentation. At the present time, other authors [32]. stated that consumers would obtain irradiated foods, depending on their level of apprehension and consciousness and the stipulation of sufficient background information.

International Approval
In 1980 a joint FAO/IAEA/WHO Expert Committee on Food Irradiation (JECFI) re-examined the broad data on transparency gathered upto date and inferred that irradiation of any product up to an overall dose of 10kGy represents no toxicological hazards and establishes no particular nutritional or microbiological problems. An Expert Group constituted by WHO in 1994 when again examined the wholesomeness data available up to then and authorized the previous conclusion of JECFI. In 1998 another Expert Group constituted by WHO/FAO/IAEA affirmed the safety of food irradiated to doses above 10kGy. Codex Trade Organization has also recognized the technique. In addition, a number of scientific bodies and associations have also endorsed the safety of radiation processed foods. Various studies had been done on the utilization of irradiation (as an authorized method) to control stored-product pests in wheat, flour and dry legume seeds in several countries [33-35].

Food safety during irradiation
Studies on Food Irradiation revealed on "Effect of Gamma Irradiation on the nutritional quality of grain and legumes" [36]. In his beginning study "Stability of Niacin, Thiamine and Riboflavin" wheat, maize, mung beans and chickpea which was irradiated on a gamma cell at near rate of 0.5, 1.0, 2.5 (or) 5.0 kGy. The seed were then analysed for niacin, thiamine and riboflavin to the control. Loss of thiamine was noteworthy while riboflavin was unchanged. Niacin reduced slightly, but considerable at higher levels. In their further study "Changes in amino acid profiles and available lysine", the same grains were taken and gamma irradiated and comparison of amino acid was radiation liable in the legumes. Significant losses on lysine, tyrosine, isoleucine but percentage available lysine was higher in irradiated seeds. Nevertheless Irradiation doses will be limited by organoleptic changes, and utmost levels are being initiated into legislation for specific foods. On the examination of the several published literature it has been revealed that vitamins C and B_1 are the most sensitive water-soluble vitamins, and that of E and A are the most significant and sensitive fat-soluble vitamins. Although vitamin losses happening on irradiation of permitted foods in western countries shall not be of much nutritional importance.

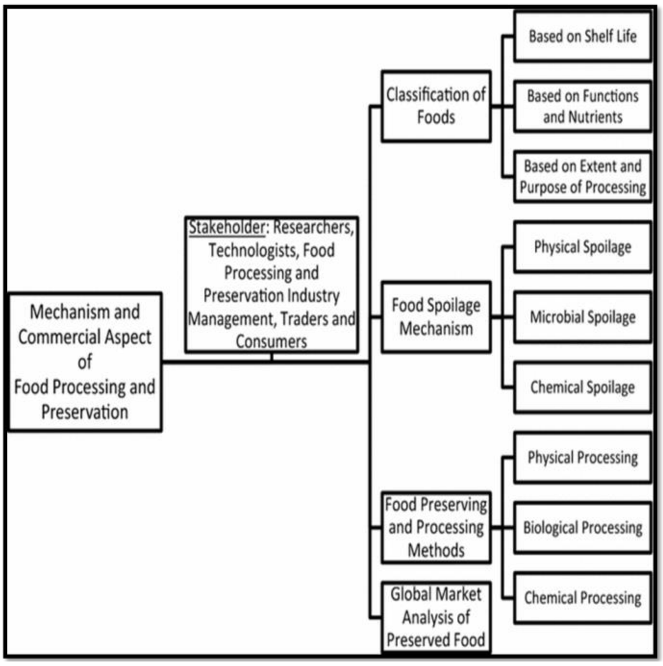

Fig 2: Mechanism and commercial aspect of food preservation

In (1990) opinion was that when foods have been rendered to ionizing radiation under conditions envisaged for commercial application, no major impairment in the nutritional quality of protein, lipid and carbohydrate constituents was perceived [37]. Irradiation was no longer detrimental to vitamins than several additional food preservation methods. Fortification of nutrients is enhanced by clutching the food at low temperature in course of irradiation and thereby diminishing or excluding free oxygen from the radiation milieu. In the most cases of fungi, heat treatment is essential preceding irradiation since it results in a greater antimicrobial effect of the combination process as compared with heating after irradiation. The effectiveness of heat treatment mildly priorly to low-dose irradiation has been recognized for prolonging the shelf-life of certain fruits as well as cereal products. Although preservation of fruit juices and various other processed fruit products have been found to inactivate the toxigenic moulds on nuts, dried fruits, cocoa beans and maize. In major cases instantaneous application of heat and radiation (thermo radiation) would be believed for an augmented destruction of microbes. Thermal stress can also complement or imminent upon the effectiveness of radiation disinfestations.

Challenges & recommendations and current status

Regardless of all these developments, irradiation even now is an issue of apprehension for customers, specifically with regard to food products. A larger attempt is being needed to persuade the consumers with scientific and attributed information about food irradiation. More than 50 counties are using irradiated food products and these radiation processed food items has been labelled with Radura logo which is a distinctive indication of irradiation treatment and safety of the food items with no nutritional loss [38].

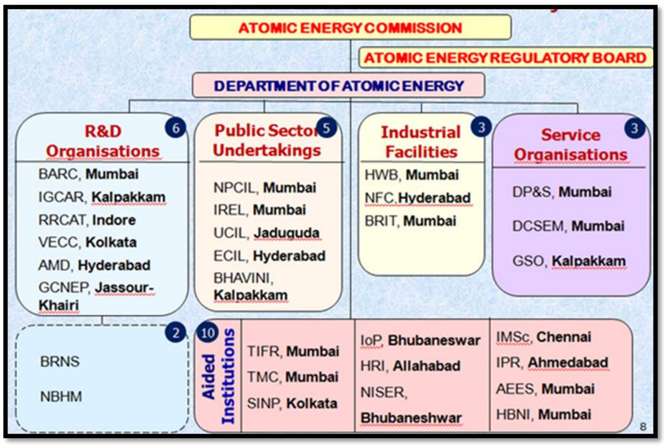

Fig 3: Departments of Atomic Energy Commission in Processing of Food items

Conclusion

All Food items has to be irradiated only in a food irradiation plant, which is recognized by the Atomic Energy Regulatory Board and licensed by the competent Government Authority (Ministry of Food Processing Industries, 2017). In India several efforts are being made to develop nutritional health mixes for different health conditions and also as nutritional supplements. Therefore any food items whether preserved or packaged must have the extended shelf life when gamma radiation process was employed. The satisfactoriness of irradiated products was low previously, but now it has been accepted by consumer after scientific accreditation and proven facts. Hence the present review has shown insight on radiation processed food which contributed safety as well nutritional adequacy.

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Competing Interests

The authors declare that they have no competing interests.

Consent for Publication

Not applicable.

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