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BRAZILIAN AND INTERNATIONAL LEGISLATION APPLIED TO FRUIT IRRADIATION

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ABSTRACT

Food irradiation is a physical process that subjects packaged or bulk foods to doses of ionizing radiation, which are energies high enough to displace electrons from atoms and molecules and convert them into electrically charged particles, known as ions. The standards that establish the requirements for approval of food irradiation process represent a technical set of rules for standardizing ideas. Although food irradiation technology is already approved and regulated by Brazilian Health Regulatory Agency (Anvisa), there are still many obstacles that prevent the complete commercialization of irradiated foods in Brazil, among which is the low consumer acceptance of this type of food. The commercial use of food irradiation technology is growing slowly due to misinterpretations by a large part of Brazilian consumers. Because of this lack of knowledge, laws, and experiments are important, as they define the limits of energy that can be employed in the process. In this work, the survey, analysis, and evolution of Brazilian, and international legislation related to ionizing irradiation practices in food will be carried out. A timeline of the evolution of legislation in Brazil will also be described, characterizing the importance of guidelines involving food irradiation. After analysis of the dose values (Gy) and dose rates (Gy/time) recommended by the legislation, samples of tropical fruits separated into two groups will be subjected to gamma radiation. Half of the samples will be kept in the laboratory at 25°C and the other half will be irradiated with gamma rays in the panoramic irradiator of the Gamma Irradiation Laboratory (LIG) of the Nuclear Technology Development Center (CDTN) for two types of samples will be compared and analyzed. The fruits available in our country, such as strawberries, bananas, and papayas, due to the climate, deteriorate very quickly. So, in this project, the behavior of these fruits when subjected to gamma radiation will be researched theoretically and experimentally. It is intended to evaluate the prolongation of their qualities, and useful life when subjected to different doses of radiation. The irradiation of food favors the provision of food security and ensures the increase in the supply of food products of high biological and sanitary quality, contributing to the promotion of a privileged and sustainable nutritional status for all people.

1. INTRODUCTION

In the 1950s, the Agriculture Nuclear Energy Center (Cena) began the first studies related to the use of ionizing radiation for food preservation [1]. Increasing technological advances have allowed that, in addition to the methods commonly employed to increase the shelf life of food, such as freezing and pasteurization, irradiation of these products has become a viable option. According to Mesquita (2023), ionizing radiation is energy capable of dislodging electrons from atoms and molecules and converting them into ions, which are electrically charged particles [2]. In this way, it acts directly or indirectly on the DNA and RNA molecules of microorganisms that can cause the deterioration of numerous foods [3]. Research on dose values in gray (Gy) or kilogray (kGy) is presented in Tab. 1. Using this technique for food preservation produces satisfactory results, as long as the recommended doses are followed. The shelf life of the product is extended without altering its nutritional properties [4, 5].

Tab. 1. Sufficient doses for the treatment of some fruits by ionizing irradiation in Brazil [4].

Fruits	Dose (kGy)
Banana, and strawberry	0.03 to 0.12
Apple, mango, and peach	0.2 to 0.8

1.1. Regulation of the practice of food irradiation

Internationally, regulations regarding the use of ionizing radiation for food preservation are established by the Food and Drug Administration (FDA), the Food and Agriculture Organization (FAO), and the International Atomic Energy Agency (IAEA). Studies carried out to prove the safety of irradiated products for human health allowed the World Health Organization (WHO), in 1997, to authorize the use of the technique for all types of food [6].
In our country, the Brazilian Health Regulatory Agency (Anvisa) is one of the organizations responsible for regulating the practice of food irradiation. Anvisa provides standards that establish the requirements for approval of the food irradiation process and represent a technical set of rules for the standardization of this technique [7].
In addition to establishing the requirements for the irradiation of food products, and the operation of the facilities that perform this service, the standards also describe the labeling of products treated with ionizing irradiation. Since 1986, the FDA has defined the inclusion of the Radura as mandatory (Fig. 1), together with the written text on the labels of foods sold. However, in Brazil, this practice is defined as optional by Anvisa, and only the presence of the phrase "food treated by a radiation process" is compulsory [8]. The word "Radura" is derived from radurization, an acronym that combines the initial letters of the word "radiation" with "durus", the Latin word for duration, lasting (increase in time).

Fig. 1. International symbol for irradiated foods, Radura [8].

2. METHODOLOGY

For the development of this work, documentary and bibliographic research were carried out, including consultations of Brazilian and international legislation, Internet sites, and the collection present in the Gamma Irradiation Laboratory (LIG) of the Nuclear Technology Development Center (CDTN). The theoretical framework and the data collection carried out through the Internet highlight the websites of the Nuclear Information Center (CIN), belonging to the Brazilian Nuclear Energy Commission (Cnen), and the International Atomic Energy Agency (IAEA) as the main means of consultation.
Based on the information found, a timeline was developed regarding legislation in Brazil regarding the practice of food irradiation. The importance of the guidelines involving the conservation process of food products will be highlighted. Dose values and dose rates recommended by institutions and regulatory bodies will also be listed.

In conjunction with the theoretical study, experimental research is being developed using the irradiator with panoramic exposure for research with a cobalt-60 (^{60}Co) source at the LIG, shown in Fig. 2. Samples of tropical fruits will be separated into two groups; the first half will remain in the laboratory at a temperature of 25 ºC, and the other half will be irradiated with gamma rays. After the irradiation process, the two groups of samples will be compared and analyzed to evaluate the extension of the shelf life of these fruits when subjected to different doses of gamma radiation.

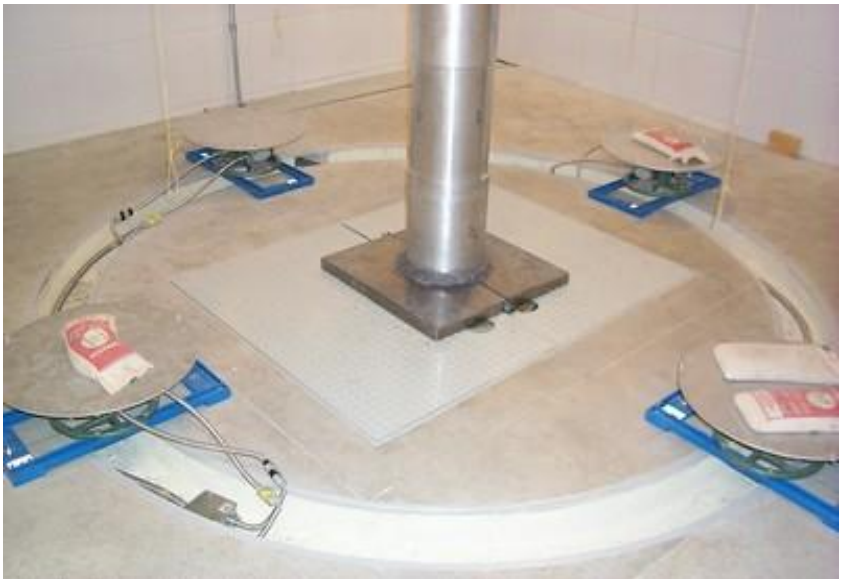

Fig. 2. LIG/CDTN panoramic irradiator [9].

3. RESULTS

The first legal act regarding food irradiation in Brazil was Decree-Law No. 986, of October 21, 1969. It establishes basic standards on food and defines irradiated food as any food that has been intentionally subjected to the action of ionizing radiation, to preserve it or for legal purposes, and provides for indication on the label [10].

In 1973, Presidential Decree No. 72.718 legitimized the use of the irradiation technique through the establishment of regulatory guidelines for the preparation, storage, transportation, distribution, import, export and exposure for sale or delivery for consumption of irradiated food [11]. However, Cnen established the conditions for the operation of the facilities used for the irradiation of food only seven years after the publication of the Presidential Decree, through Resolution No. 5 [12].

The characterization of the types of food, dose values and general conditions for the use of the irradiation technique were specified by Ordinance No. 9, approved in 1985. This ordinance was responsible for specifying the requirements for the use of ionizing radiation to comply with the limits established to ensure the food safety of the population. On October 18, 2000, Anvisa held a Public Consultation No. 83 to approve the Technical Regulation for Food Irradiation, aimed at the regulation of packaged or bulk foods submitted to radiation doses within the established limit and complementing the guidelines related to licensed facilities [4].

In 2001, Anvisa's RDC No. 21 and Resolution No. 9 of the Brazilian Council of Radiology Technicians (Conter) specify the techniques and processes for the operation of the equipment used for irradiation, necessary training and radiological safety and the exclusive attributions of Conter, respectively [13] [14].

The Ministry of Agriculture and Livestock and Food Supply, through Ordinance No. 28 of April 14, 2004, regulates the use of ionizing radiation to carry out quarantine phytosanitary treatments, and describes the specific dose values for each type of pest [15]. The most recently published standard is Normative Instruction No. 9, which is based on international guidelines to establish

the requirements for the use of ionizing radiation in the prevention and dissemination of pests [16].
Tab. 2 presents a chronological summary of the legal acts related to the irradiation of food in Brazil found during the preparation of this work.

Tab. 2. Legal acts related to the irradiation of food in Brazil.

Legal Acts	Year
Decree-Law No. 986/PR	1969
Presidential Decree No. 72.718	1973
Resolution No. 5/Cnen	1980
Ordinance No. 9/SVS	1985
Public Consultation No. 83/Anvisa	2000
Anvisa RDC No. 21	2001
Resolution No. 9/Conter	2001
Ordinance No. 28/SDA	2004
Normative Instruction No. 9	2011

Currently, only RDC No. 21 and Normative Instruction No. 9 remain in force and Decree-Law No. 986/PR and Decree No. 72.718 do not contain express revocation.

4. CONCLUSION

The acceptance of products treated by ionizing radiation still represents a challenge in Brazil, although many industrialized foods currently indicate on their label that they are irradiated by gamma rays or have ingredientes that have undergone this process, as shown in Fig. 3, a large part of the Brazilian population is not aware of this reality.

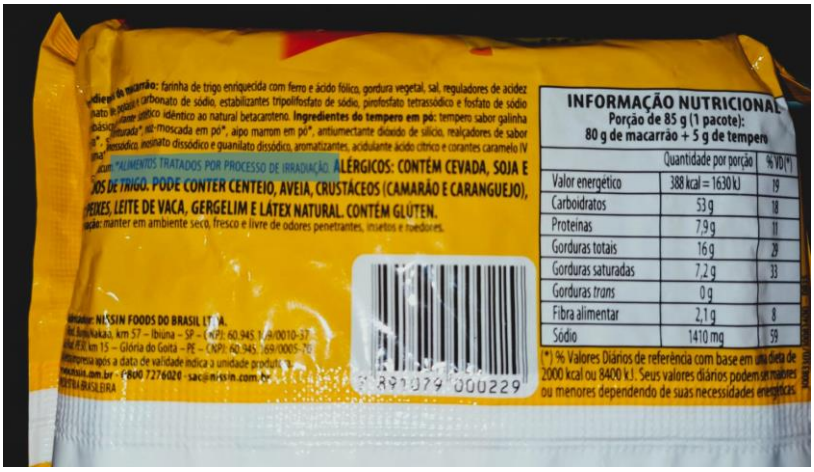

Fig. 3. Packaging containing information on irradiated food.
Source: Author archive

The published studies and norms regarding food irradiation are fundamental for disseminating knowledge to the population and establishing safe dose limits for human health, however, they are overshadowed by news of tragedies, such as the one in Goiânia, by many people without basic knowledge about the various applications of ionizing radiation in society.
Works like this are necessary to develop the critical eye and sense, as well as to stimulate the active participation of students, professors, and researchers in the bills and in the updating of current regulations related to the use of ionizing radiation for food preservation.

The technology used for food irradiation is a clean and safe food processing method, which ensures an increase in the supply of biologically, sanitary, and nutritional quality food, favoring the provision of food, and nutritional security. This promotes a privileged and sustainable nutritional status for all people and, consequently, forming more productive individuals and more competitive countries.
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> "*Research, develop and generate applications of gamma irradiation for the benefit of society*."

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