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THE IMPORTANCE OF THE IRRADIATION SEAL ON MEAT PRODUCTS

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Abstract

Beef, pork, chicken or fish and their derivatives are the most consumed protein sources in the world, and the main causes of Foodborne Diseases (DTAs), due to their rich substrates for the development of pathogenic colonies, and intrinsic and extrinsic, the most common being bacteria such as; *Salmonella* sp., *Vibrio parahaemolyticus*, *Escherichia coli*, *Pseudomonas*, *Acinetobacter* and *Moraxella*. *Clostridium*, *Bacillus* and Lactic Acid Bacteria (LAB). Generating degradation and contamination in food and harming consumer health and the agricultural market. Irradiation is an alternative for food preservation, through the use of X-rays, Beta radiation, gamma rays and ultraviolet radiation. frozen, without harming the health of the population. This research aimed to compile consumer understanding regarding the use of this conservation method, knowledge of the irradiation seal, and the possibility of purchasing the products. The results demonstrate that 52.2% and 58.6% do not know what irradiation is and what types of radiation are used, respectively; However, 60.6% of those interviewed would perhaps buy a product with the irradiation seal, although 71.7% had never seen it.

Keywords: conservation; food irradiation; microorganisms.

A Importância do Selo de Irradiação em Produtos Cárneos

Resumo

Carne bovina, suína, frango, pescado e seus derivados são as fontes de proteínas mais consumidas no mundo, e as principais causas de Doenças transmitidas por Alimentos (DTAs), devido aos seus substratos ricos para o desenvolvimento de colônias patogénicas, e fatores intrínsecos e extrínsecos, sendo as mais comum as bactérias como; a *Salmonella* sp., *Vibrio parahaemolyticus*, *Escherichia coli*, *Pseudomonas*, *Acinetobacter* e *Moraxella*. *Clostridium*, *Bacillus* e as Bactérias Ácido Lácticas (BAL). Gerando degradação e contaminações nos alimentos e malefícios a saúde do consumidor e ao mercado agropecuário. A irradiação é uma alternativa de conservação de alimentos, através do

uso de Raio X, radiação Beta, raios gama e radiação ultravioleta, se mostra promissora, pois além de conservar o produto viável por mais tempo na prateleira, pode ser utilizado em produtos resfriados ou congelados, sem prejuízo a saúde da população. A presente pesquisa teve como objetivo copilar o entendimento do consumidor quanto ao uso desse método de conservação, o conhecimento do selo de irradiação, e a possibilidade de compras dos produtos. Os resultados demonstram que 52,2% e 58,6% não sabem o que é irradiação e que tipos de radiação são utilizados, respectivamente; porém 60,6%, dos entrevistados, talvez comprassem um produto com o selo de irradiação, apesar que 71,7%, nunca terem o visto.
Palavras-chave: conservação; irradiação de alimentos; microrganismos.

Introduction

Beef, pork, chicken, fish and their derivatives are not only the main sources of protein in the world, but are also among the biggest culprits of Foodborne Diseases (FBDs). This paradox occurs due to the nutritional richness of these foods, which creates an environment conducive to the growth of pathogenic microorganisms. Bacteria, fungi and parasites thrive in ideal conditions, favored by intrinsic factors, such as pH and humidity, and extrinsic factors, such as inadequate handling and storage practices. The result? Accelerated deterioration, dangerous contamination and serious risks to public health, also negatively impacting the economy of the agricultural market (Brazil, 2010).

Among the main causes of FBDs are pathogenic microorganisms such as *Salmonella* sp., present in poultry and oysters, which causes enteric fevers; *Vibrio parahaemolyticus*, found in fish and shellfish, responsible for abdominal pain and vomiting; and *Escherichia coli*, *Pseudomonas*, *Acinetobacter* and *Moraxella*, frequently associated with contaminated meat and milk. In addition, pathogens such as *Clostridium* and *Bacillus* are also commonly identified in animal products, posing significant risks to public health and compromising food safety (Amaral *et al.*, 2021).

The search for effective food preservation methods has led to the development and adoption of radiation as an innovative solution. The radiation used can include different types, such as X-rays, beta radiation (electron beams), gamma rays (generated from cobalt-60) and ultraviolet radiation. Each of these modalities has unique characteristics that make it suitable for different types of food. Gamma radiation, for example, is especially effective in sterilizing and eliminating pathogenic microorganisms, while ultraviolet radiation is commonly used to treat food surfaces. This technology has stood out due to a series of important advantages: significantly increasing the shelf life of products, the possibility of being applied to chilled or frozen foods without compromising their sensory qualities, such as flavor, texture and appearance, and the fact that it does not leave residues in the food, which eliminates concerns about chemical contaminants. Consequently, irradiation emerges as a safe and highly efficient alternative for food preservation, without affecting the health of consumers or the quality of the final product (Souza; Arthur; Canniatti-Brazaca, 2009; Gomes, 2020).

In Brazil, the use of radiation for food preservation is strictly regulated. Decree No. 72,718, of August 29, 1973, establishes general rules on food irradiation, while ANVISA Resolution RDC No. 21, of January 26, 2001, approves the Technical Regulation for Food Irradiation, ensuring that the application of this technology follows food safety and quality standards. These regulations are essential to ensure that irradiated foods are safe for consumption and to guarantee that irradiation processes are carried out within established limits, without causing risks to public health (Brazil, 2010). The search for food preservation techniques has led to the use of radiation, including X-rays, beta radiation (electron manipulation), gamma rays (cobalt-60), and ultraviolet radiation. This approach has been standing out as a promising alternative due to several advantages, such as increasing the shelf life of products, the possibility of application in chilled or frozen foods, maintaining the flavor and appearance of meats, in addition to not leaving residues (Souza; Arthur; Canniatti-Brazaca, 2009).

The use of radiation for food preservation is managed by Decree No. 72,718, of August 29, 1973, which establishes general rules on food irradiation and by ANVISA Resolution – RDC No. 21, of January 26, 2001, which approved the Technical Regulation for Food Irradiation (Brazil, 1973).

The continuous improvement of food irradiation techniques offers a series of benefits for both producers and consumers, especially with regard to reducing food waste. Irradiation extends the shelf life of products, ensuring that fresh food reaches consumers safely without compromising its quality. In addition, this technique helps to dispel the public's fear of radioactivity, since, when applied correctly, it does not pose any health risks. The radiation used is strictly controlled, with specific limits for each type of product. For example, in the case of gamma radiation, the dose does not exceed 50 gray, ensuring effectiveness in eliminating microorganisms without affecting the integrity of the food (Freire; Vital, 2024).

According to Table 1, the effects of gamma radiation vary according to the dose applied. For low doses (up to 1 kGy), the main objective is the disinfection of insects and parasites, being effective in products such as dried fish and raw beef and pork. Medium doses (1 to 10 kGy) focus on the elimination of pathogenic microorganisms and the reduction of sporulating pathogens, and are commonly applied to seafood, chicken or beef, both fresh and frozen. Finally, high doses (10 to 50 kGy) are used for industrial sterilization for commercial purposes, being ideal for beef, chicken and seafood. These parameters are carefully adjusted to ensure food safety without compromising the sensory qualities of the products (Freire; Vital, 2024).

Table 1. Effects of gamma radiation on meat foods.

Radiation dose classification	Objective	Dose ranges (kGy)	Foodstuffs
Low Doses (Up to 1kGy)	Insect disinfestation and parasite disinfection	0.15-0.5	dried fish, beef, raw pork
Average Doses 1 to 10 kGy	Elimination of pathogenic microorganisms and reduction of sporulating pathogens	1.0-7.0	Fresh or frozen seafood, raw or frozen chicken or beef
High Doses 10 to 50 kGy	Industrial sterilization for commercial purposes	30-50	Beef and chicken, seafood

Source; Dina F. Soares, adapted from URBAN, WM Food irradiation. Academic Press, INC. 1986. 351 p.

This study aims to assess consumer knowledge about food irradiation techniques, with an emphasis on products of animal origin. The research seeks to understand the degree of consumer familiarity with the irradiation label (radura), how to identify it, and their willingness to purchase irradiated products. To illustrate this process, an informational brochure will be developed, highlighting the benefits and safety of irradiation in food preservation.

Material and Methods

The data used in this study were obtained through an online questionnaire, developed using the Google Forms tool, and administered to a sample of 99 respondents. The survey instrument consisted of 11 questions, carefully designed to cover both sociodemographic aspects and specific issues regarding the food irradiation technique. The questions addressed a range of relevant topics, with the aim of capturing accurate information about consumers' knowledge and attitudes towards this technology.

The main themes explored in the questionnaire included: age groups and education levels of participants; prior knowledge about food irradiation; understanding of the different types of radiation used in the irradiation process (such as gamma radiation, X-rays, among others); differentiation between the terms “radiation” and “irradiation”; understanding of the purpose of irradiation in food preservation; consumer habits regarding the observation of labels on food products; recognition of the irradiation seal (radura) on products; consumers’ willingness to purchase products treated with irradiation; and, finally, perception of the potential health risks associated with this technology.

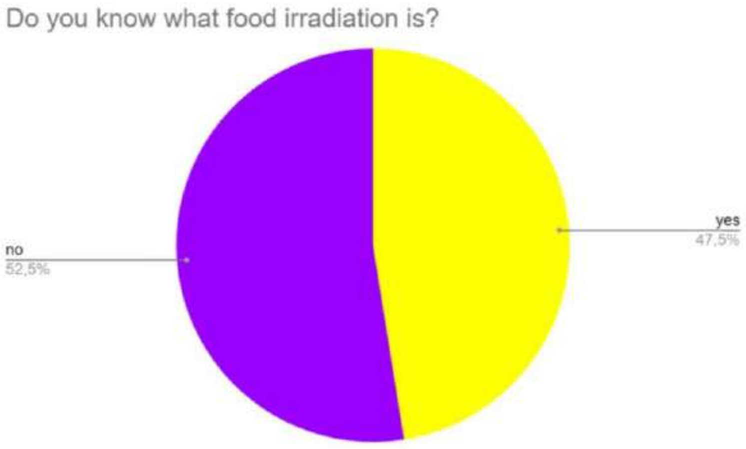
After data collection, a quantitative analysis was performed to identify patterns in the responses, as well as trends in knowledge and perception of irradiation technology among consumers. This analysis allowed for a deeper understanding of the population's level of familiarity with the technique and attitudes toward the safety and acceptance of irradiated products in the market.

Result and Discussion

Analysis of the data obtained from the questionnaire administered to 99 consumers revealed interesting patterns in relation to education, age group and knowledge about food irradiation technology. Although almost half of the participants had higher education (48.5%) and 46.5% were over 40 years old, factors that could theoretically suggest a higher level of information, the results indicate that, in reality, this formal education and age group do not directly translate into greater familiarity with food irradiation. At first glance, this leads us to question the initial assumptions about the correlation between formal education and specialized knowledge, especially in relation to specific technologies such as irradiation.

Figure 1 illustrates that, although a good portion of the participants fall into age groups and educational levels that could indicate greater familiarity with the topic, most consumers are still unaware of the food irradiation process. This suggests that educational level alone is not an effective indicator for measuring the population's knowledge about specific food science issues, such as irradiation, a technique that is relatively little known in consumers' daily lives.

Figure 1. Do you know what food irradiation is?.



Pie chart on knowledge of food irradiation, showing that 52.5% do not know what it is, while 47.5% claim to know.

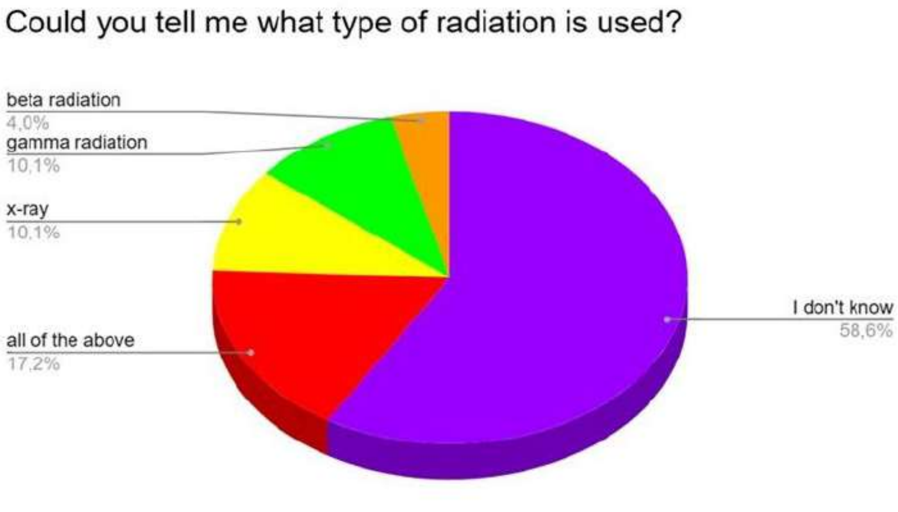
When analyzing the relationship between the level of education and the understanding of the concepts of "radiation" and "irradiation", a positive trend was observed, that is, participants with higher education presented a better understanding of the concept. The research revealed that 92.2%

of the participants were able to correctly define the terms, agreeing with the definition presented by Helerbrock (2025). According to this author, "radiation" refers to the transmission of energy, whether in the form of waves or particles, which propagates through a medium (whether solid, liquid or gas) or in a vacuum. The term "irradiation" is used to describe the process of exposing food to radiation for specific purposes, such as preservation and disinfection. The vast majority of participants demonstrated that they were aware of this distinction, which indicates that, at least in theoretical terms, the population has a good command of the scientific terminology associated with radiation.

However, even with this theoretical understanding, there are still significant gaps in practical knowledge, especially when it comes to radiation categories. Many consumers, regardless of their educational level, have demonstrated difficulty in identifying which types of radiation are used in food irradiation.

Figure 2 shows that while 92.2% of respondents were aware of the differences between the terms “radiation” and “irradiation,” there was a notable lack of clarity when it came to the specific types of radiation used in this process. In particular, confusion about which types of radiation—such as gamma rays, X-rays, and electron beams—are used in food irradiation was evident. Many consumers are unaware that ionizing radiation, such as gamma rays, X-rays, and electron beams, are the most commonly used forms of radiation for food preservation, and there is still confusion about how these radiations interact with food.

Figure 2. Could you tell me what type of radiation is used in food irradiation?.



Pie chart on the type of radiation used, showing that 58.6% do not know, while the remaining responses range from 4.0% to 17.2%.

The lack of knowledge about nuclear energy and its classifications (high energy vs. electromagnetic waves) was a striking aspect in the research. This reflects the lack of information accessible to the general public about the specificities of the irradiation process. This knowledge gap is understandable, given that the topic of radiation is often associated with perceptions of danger and risk, which can create a barrier to a deeper understanding (Zhao; Kang; Zhou, 2021; Santos; Silva; Costa, 2022).

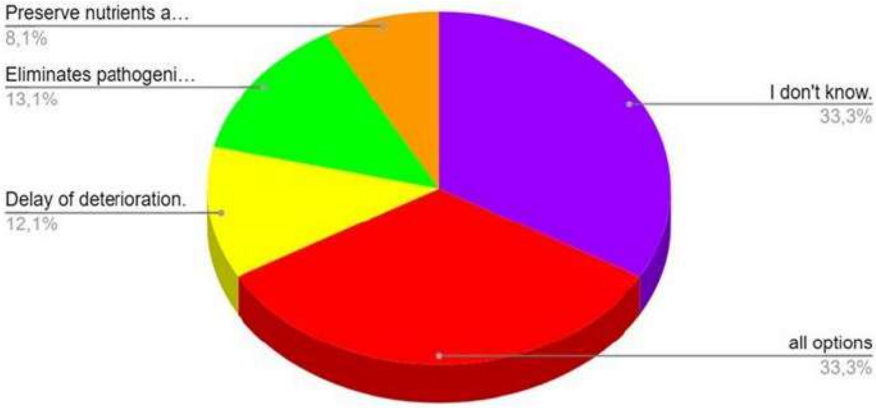
Another important point that emerged from the analysis was the lack of clarity about the benefits and safety of irradiation. Although most participants know what radiation is and the difference between types of radiation, many are still wary of using radiation in food. This fear is a reflection of poor public communication about what actually happens during food irradiation, and a lack of accessible explanation about how the process can be beneficial to health (Singh; Joshi; Thakur, 2020; Griffiths; Young; Parker, 2020). The lack of clear and accessible information may be responsible for the persistence of misconceptions about irradiation and its impact on food safety (Santos; Rosa; Lima, 2021).

The fact that many consumers are unaware of, or uncomfortable with, the presence of radiation in food highlights the need to improve public education about modern preservation processes such as irradiation, and also reinforces the importance of using the irradiation label (radura) as a means of ensuring trust and transparency in the process.

The study revealed that despite the apparently high level of education, there is still a significant lack of knowledge among consumers about irradiation technologies, particularly regarding the different types of radiation used and the safety of the process. This knowledge gap, especially the lack of understanding of the types of radiation, hinders the acceptance of irradiated products, making it essential to strengthen educational campaigns on food irradiation.

Although Figure 3 shows a diversity of opinions on the purpose of irradiation in meat products, the explanation by Bail and Claus (2024) provides a precise and well-founded definition of this technology. According to the authors, the main objective of food irradiation is to prevent microbial contamination and reduce the activity of pathogenic microorganisms, which are responsible for causing foodborne illnesses (FBIs). Through this process, ionizing radiation, such as gamma rays, X-rays and electron beams, are applied to food, deactivating or inhibiting the growth of bacteria, fungi and other microorganisms that can compromise food safety.

Figure 3. What is the purpose of irradiation in food preservation?.



Pie chart on the use of irradiation in meat, highlighting that 33.3% do not know and 33.3% choose 'all options', while other responses range from 8.1% to 13.1%.

In addition, irradiation also plays an important role in preserving the quality of products. The process not only eliminates or reduces pathogens, but also helps prevent spoilage caused by biochemical reactions such as oxidation and moisture loss, which often lead to changes in the taste, texture and appearance of foods. This spoilage-retarding action is crucial to extending the shelf life of meat products, allowing them to remain fresh and safe for longer.

Another important point is that irradiation provides these preservation benefits without significantly compromising the nutritional value or flavor of the food. Unlike other preservation methods, such as the use of chemical preservatives or high temperatures, irradiation preserves the original properties of the food, ensuring that it remains tasty and nutritious (López et al, 2023) .

Thus, irradiation presents itself as an efficient and safe alternative, essential for the food industry. It not only contributes to food safety by reducing the risk of foodborne illnesses, but also helps to reduce food waste by extending its shelf life. For these reasons, irradiation is considered an innovative and promising technology for food preservation, especially in a global context where food safety and waste reduction are issues of increasing importance.

Of the 99 survey participants, 53.5% (equivalent to 53 people) reported that they usually look at product labels when making their purchases. However, none of these people had noticed the presence of the irradiation seal (radura) on the products sold, as illustrated in Figure 4. This data suggests a gap in knowledge or visibility of the irradiation seal, which may indicate a failure in communication or in consumers' familiarity with this conservation technology, despite its growing relevance and benefits.

Figure 4. Irradiation seal (RADURA).

Radura, symbol for identifying foods treated by irradiation.

In a study conducted in the city of Goiânia, Rocha *et al.* (2021) observed that the Brazilian population's perception of irradiated products has not changed significantly over time. This phenomenon can be attributed to the lack of clear and accessible information about the irradiation process, which still generates distrust and resistance among consumers. The lack of broad knowledge about the benefits and safety of irradiation reflects a gap in effective communication, which is in line with the results found in our research, where many participants demonstrated lack of knowledge about the technology, despite being aware of its use.

On the other hand, Lima Filho and Della Lucia (2020) highlight a different scenario in the United States, where the acceptance of irradiated products is strongly linked to the level of knowledge that consumers have about the technology. In the United States, effective information campaigns about irradiation processes have helped to reduce doubts and fears, resulting in greater acceptance of this practice in the market. This shows that, in markets where there is greater transparency and education about the benefits and safety of irradiation, acceptance tends to be higher.

In Brazil, the situation is still contrasting, as illustrated by the data from our survey. Although 60.6% of participants believe that irradiation does not pose a health risk and consider purchasing irradiated products, the actual purchasing attitude does not follow this trend. Only 24.2% of respondents stated that they would actually purchase irradiated products, while 12.2% said they would not purchase them, evidencing a certain contradiction between superficial knowledge and the purchasing decision. This scenario reveals that, although there is a positive perception of irradiation, factors such as misinformation, fear of the unknown and lack of familiarity with the products still influence consumer decision-making (Griffiths; Young; Parker, 2020; FAO/IAEA, 2019).

This contradiction in attitudes points to a phenomenon of resistance that is common in markets where new food technologies are introduced. The lack of clarity about the process and benefits of irradiation contributes to many consumers feeling insecure about adopting this technology, even if they recognize its safety on a superficial level. However, this resistance also indicates a potential for evolution in consumer attitudes, as communication about irradiation becomes more accessible and understandable. By providing more information about how irradiation affects food safety and the preservation of product quality, it would be possible to transform this fear into broader acceptance (Tremonte; Bertoldi, 2022).

Therefore, the contrast between consideration and actual purchase of irradiated products suggests that, although there is a trend towards changing attitudes, the process of full adoption of this technology still requires ongoing efforts to clarify the issue. Consumer education, combined with transparent and informative marketing strategies, can significantly contribute to dispelling doubts and promoting greater acceptance of this technology, resulting in benefits for both public health and the food industry (FAO/IAEA, 2019; Tremonte; Bertoldi, 2022).

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Therefore, the contrast between consideration and actual purchase of irradiated products suggests that, although there is a trend towards changing attitudes, the process of full adoption of this technology still requires continuous efforts to clarify. Consumer education, combined with transparent and informative marketing strategies, can contribute significantly to dispelling doubts and promoting greater acceptance of this technology, resulting in benefits for both public health and the food industry (Li *et al.*, 2021).

Conclusion

Although food irradiation is a proven safe and effective technology for increasing the shelf life and safety of food, consumers' lack of knowledge about the process and the irradiation label represents a significant barrier. To overcome this challenge, it is recommended to implement educational campaigns that address the benefits of irradiation and clarify myths about radiation, increasing public acceptance and trust. In addition, product labels should be more visible and informative, promoting the irradiation label and highlighting its benefits in preserving food health.

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