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RESEARCH ARTICLE

CONSUMER AWARENESS ABOUT IRRADIATED FOOD: A SYSTEMATIC REVIEW.

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Abstract

Background: Food irradiation is a process used for various purposes, ensuring food safety being its major application. Nevertheless, the great majority of potential consumers of irradiated food are still unaware of the basic concepts of irradiation, misinterpreting information and demonstrating a negative attitude towards the process.

Scope and approach: Despite extensive research in the world on the acceptance of irradiated food, no study has yet been published that contemplates an overview of consumers' awareness of the consumption of irradiated food. Therefore, the objective of this work was to conduct a systematic review to demonstrate the state of the art of consumer awareness about food irradiation.

Key findings and conclusions: Five databases were searched, resulting in 1,192 studies out of which 66 articles have met the inclusion criteria. It was concluded that most consumers are unaware of the benefits of irradiated food. Another finding from this research was the fact that educational actions favorable to irradiated food positively influence changes in consumers' attitudes, while unfavorable information leads to negative ones. Some developed countries, such as the United States, tend to have a better willingness to buy irradiated food, while others tend to impose a stronger resistance. Therefore, new trends in the field of education and dissemination of irradiated food to consumers should be thought of as new ways to foster consumer acceptance and develop new market relations.

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Introduction:-

It is estimated that 600 million – almost 1 out of 10 people – in the world become ill after consuming contaminated food and 420,000 die every year (FAO/WHO, 2015). Food irradiation is a process used for various purposes, mainly to ensure food safety (Mohácsi-Farkas, 2011).

According to Diehl (2002) and Farkas & Mohácsi-Farkas (2011), irradiated food is all food that has been intentionally subjected to the process of irradiation by means of ionizing radiation, whereas food irradiation is the term used to describe the physical process in which food is exposed to ionizing radiation such as gamma photons emitted by ^{60}Co radioisotope (or very rarely ^{137}Cs), X-rays generated by machines with a maximum energy of 5 MeV or accelerated electrons with a maximum energy of 10 MeV (kinetic energy).

The effects of irradiation depend both on the type of food being treated and on the conditions the process is used, such as the dose of ionizing radiation, temperature, physical state of the product and composition of its surrounding atmosphere, among others. Food irradiation can be used for many purposes, including: sprout inhibition; delayed maturation; reduction of microbial load; elimination of pathogenic microorganisms; sterilization and disinfestation (Roberts, 2014).

Despite the benefits of the process, the acceptance of irradiated food by consumers remains as a challenge (Diehl, 2002; FSANZ, 2014; Feng, et al., 2016; Finten, et al. 2017). Research has shown that the great barrier to the consumption of these products is the lack of knowledge or misconceptions by the population and professionals on the safety of irradiation and irradiated products (Resurreccion et al., 1995; Frenzen et al., 2001; Cardello, 2003; Gunes & Tekin, 2006; Ibarra et al., 2010; Feng, et al., 2016; Finten, et al. 2017).

It has been assumed that the population may be consuming irradiated food unawarely due to factors such as inappropriate information presented on food labels. (Resurreccion et al., 1995; ICGFI, 1999; IAEA, 2001; FAO/WHO, 2003; Gunes & Tekin, 2006; Junqueira-Gonçalves et al., 2011; FSANZ, 2014; Palarto et al., 2014).

Many studies have been performed to investigate the acceptance of irradiated food. However, we do not yet have a research, of a bibliographic and inventorizing character, that gathers, maps and discusses the researches carried out, showing its various aspects and dimensions and in what form and under what conditions were produced, in order to produce the state of art. Taking into account the knowledge already built by the studies carried out and driven by the challenge of seeking what has not yet been done, many researchers have been dedicated to the evaluation of such studies based on a methodological strategy that minimizes the biases of the results obtained (Ferreira, 2002).

A systematic review is reported as a method of evidence — based on health care and supported by a peer-reviewed protocol — so that it can be replicated (Khan et al., 2003). Compared to narrative reviews, the systematic literature review technique has the advantage of being based on an explicit and accurate study selection process, which involves a multi-step procedure similar to that used in research surveys (Cooper, 1998; Littell & College, 2006).

According to Higgins and Green (2011), systematic reviews are aimed at gathering all evidences available that meet the pre-specified eligibility criteria in order to answer a specific research question. Phelps & Campbell (2012) emphasize that systematic reviews (SR) have progressively substituted traditional narrative reviews and are recommended to summarize research evidence. Although this kind of protocol originates from studies based on evidences from medical and clinical studies, other fields have also recently begun to apply systematized procedures to find safe evidence to address their own specific questions, including the area of food science and technology, demonstrating the importance of this tool for this area (Bimbo et al., 2017; Jaenke, et al. 2017).

In this context, the objective of the present research, of an innovative nature, is to use an adapted version of the systematic review protocol to demonstrate the state of the art of consumer awareness about food irradiation.

Methods:-

This systematic review follows recommendations provided by Preferred Reporting Items for the Systematic Reviews and Meta-Analyses (PRISMA) Checklist (Moher et al., 2009) and Guidance of European Food Safety Authority (EFSA, 2010).

According to the Guidance of the European Food Safety Authority (EFSA, 2010), in descriptive questions of populations or systems, such as questions about prevalence, occurrence, consumption, and incidence in which the population (P) and the outcome of interest (O) need to be specified. The acronym PO represents the key elements in these questions.

Therefore "Population" has been defined as human population and "Outcome" must be interpreted as the degree of awareness regarding the consumption of irradiated food. Included in this review are descriptive studies on consumer knowledge about irradiated food.

This research project was approved by the Research Ethics Committee/ Faculty of Health Sciences/ University of Brasília on August 08, 2016 (Certificate of Presentation for Ethical Appreciation 57419216.2.0000.0030).

Protocol and Registration:
In the clinic field of health care studies, there is a Prospective Register of Systematic Reviews (PROSPERO), which does not apply to systematic reviews on food science and technology. Therefore, no registration of this protocol in PROSPERO has been required.

Eligibility Criteria:
Inclusion Criteria:
The present review included human studies (both quantitative and qualitative) from all over the world, who participated in surveys by answering electronic questionnaires, interviews or other instruments, providing essential information on their perception regarding the consumption of irradiated food in order to determine the degree of awareness of those who consume irradiated food either treated with ionizing radiation as a whole or that comprise irradiated ingredients. The present study included publications with no restrictions regarding date or language.

Exclusion Criteria:
The following information sources have been applied as exclusion criteria: 1) reviews, letters, personal opinions, book chapters, conference abstracts, case reports; 2) studies that were not related to consumer knowledge about irradiated food; and 3) studies in animals.

Information Sources:
Detailed individual search strategies for each of the following bibliographic databases have been developed: INIS, PUBMED, SCOPUS, SCIENCE DIRECT, and WEB OF SCIENCE. International Nuclear Information System (INIS) hosts one of the world's largest collections of published information on the peaceful uses of nuclear science and technology. It offers online access to a unique repository of non-conventional literature. PUBMED, SCOPUS and WEB OF SCIENCES cover publications in the areas of bioethics, life sciences, physical sciences, health sciences, social sciences, science, technology, among others. SCIENCE DIRECT covers publications in Physical Sciences and Engineering, Biological Sciences, Health Sciences and Social and Human Sciences.

Grey literature search was carried out by using Google Scholar and Proquest. The end date was selected so that the search would include all data in the databases up to October 8, 2016. The references cited in the selected articles were also checked.

According to Falagas et al. (2008), the PUBMED, SCOPUS, WEB OF SCIENCE and Google Scholar databases were practical in use and offered numerous search facilities. PUBMED and Google Scholar are accessed for free. The keyword search with PUBMED offers optimal update frequency and includes online early articles; SCOPUS offers about 20% more coverage than WEB OF SCIENCE, whereas Google Scholar offers results of inconsistent accuracy. PUBMED remains an optimal tool in biomedical electronic research. SCOPUS covers a wider journal range compared to WEB OF SCIENCE (Falagas et al., 2008).

Search strategy:
Appropriate truncation and word combinations were selected and adapted for each database search (Table 1). In addition, all references were managed by Thomson Reuters Endnote™ Web basic software and duplicated hits were removed.

Study selection:
The selection was completed in 2 phases. In phase 1, two reviewers (TR; ERA) independently reviewed the titles and abstracts of all identified electronic database citations. Articles that did not appear to meet the inclusion criteria were discarded. In phase 2, the same reviewers applied the inclusion criteria to the full text of the articles. The reference list of selected studies was meticulously analyzed by the examiners (TR; ERA). Any disagreement in the first or second phase was settled by discussion until a mutual agreement among the reviewers was attained. When consensus could not be achieved, a third author (LLOP) was summoned and asked to make a final decision. HCV was considered the expert on food irradiation to whom any doubt about that subject would be addressed. The coordinator (WMCA) would be responsible for conceptualization and planning of the research, besides data analysis and solving remaining issues.

Data Collection Process:
The following characteristics were gathered from selected articles: authors and year of publication, year of survey application, place of survey application, population, sample size, data collection method, types of question, brief description of irradiated food included in the survey, main results and statistical analyzes. To ensure consistency among reviewers, calibration exercises were conducted before starting the review. Reviewers resolved disagreements by discussion and the second author (2R) adjudicated unresolved disagreements.

Risk of bias (RB):
Risk of bias assessment is a fundamental step that differentiates the systematic literature review process from other types of review. It requires the use of specific criteria so that a score for each identified article is created and a bias risk rating can be implemented (Bimbo et al., 2017).

Based on instructions found in "A Guide to Conducting Systematic Reviews in Agri-Food Public Health" (Sargeant et al., 2005), a specific instrument to evaluate RB has been created for this study by using well-established classical and literature criteria and expert guidance. In this research, the selected criteria for RB assessment were: classification by Impact Factor; year of publication; representativeness of the sample; randomness of the sample; criteria for sample inclusion; use of a validated data collection instrument; and statistical analyzes (Table 2).

A classification by Impact Factor (IF) has also to be used because IF is a measure that reflects the average number of citations of scientific papers published in a particular journal. This indicator was created by Eugene Garfield, founder of the Institute for Scientific Information (ISI) and creator of the bibliographic database Science Citation Index (SCI). Since 1972, the IFs have been calculated annually for journals indexed to ISI and then published in Journal Citation Reports (JCR). Sorting by impact factors allows for the inclusion of many small (in terms of total number of articles published), however influential journals. The impact factor of a journal is based on two elements: the numerator, which is the number of citations in the current year to items published in the previous two years, and the denominator, which is the number of substantive articles and reviews published in the same two years. The impact factor could also be based on the previous year only. That would lead to more rapid changes in the data. An impact factor could also take into account longer periods of citations and sources, but then the measure would be less dynamic (Garfield, 2006; Sharma, et al., 2014).

The year of publication was another criterion established in order to assess the improvement of methods used for research on the subject. Most recent articles have described the best timeliness of information. Consumer's knowledge is known to significantly change with time, so that, the more recent the article, the greater the timeliness of the information obtained.

Representativeness of the sample informs whether the sample is representative of the consumers in the population of interest. The sample needs to be representative of the population it proposes to measure. For example, the Federal sphere must have a minimum percentage of respondents in all States of the Nation. Sample randomness informs its degree of randomness. The study should be based on a random sample in order to reduce the bias of responses. Inclusion Criteria are those that enforce the criteria for selection of the sample. The inclusion criteria for the sample should be clearly defined to reduce the response bias.

A Validated Data Collection informs whether a certain validated instrument of interest has been used for data collection. The instrument for data collection should be validated by using the techniques described by the American Educational Research Association (2014) to ensure the reliability and quality of the collection. Statistical analyzes

have been used to determine whether the statistical techniques selected are indeed appropriate for the task of efficiently retrieving the information in order to interpret and evaluate the quality of the data. Thus, based on such criteria, a scoring method was summarized in Table 2.

Two reviewers (TR and ERA) performed RB analysis of the studies. Reviewers resolved disagreements by discussion and the third reviewer (LLOP) adjudicated unresolved disagreements. Each criterion received scores between 0 and 100 or unclear (U) in the evaluation of the studies. In the calculation of the RB, the unclear (U) cases were not included and an arithmetic mean was calculated. According to the value of frequency, RB can be estimated. The criterion for defining high, medium or low RB was based on the article by Gadioli, et al. (2017). When the frequency was higher than 70%, the RB was considered to be low (L), when the frequency was between 50 and 69%, it was considered moderate (M) and when the frequency was lower than 50%, the RB was considered to be high (H).

Results:-

Selection of relevant studies:

Table 3 presents eligible studies, their characteristics and data gathered from the survey, such as consumption, comprehension and willingness to buy irradiated food. Initially, 1,192 studies were identified in the electronic databases and 1,132 findings remained after duplications were discarded. A comprehensive evaluation of the abstracts was then performed in phase 1 and 61 articles were deemed potentially appropriate, according to the inclusion and exclusion criteria. They were then selected for assessment in phase 2. Moreover, 266 articles were found in an additional search through Google Scholar (n= 30) and ProQuest (n= 236) and only three of them were considered to meet the inclusion criteria. Out of the 64 studies included, 20 were subsequently excluded: Adams (2000), Ahmed (1993), Bruhn (1995a), Bruhn (1995b), Bruhn (1998), Cottee et al. (1995), Derr et al. (1995), Henson (1995), Hunter (2000), Ihsanullah and Rashid (2017), Loaharanu (1990), Marcotte & Kunstadt (1993), for being review articles; Beaulnes (1988), for being case report; Bruhn (1999), Eustice & Bruhn (2013), for being chapters of books; Coates (1990), Engel et al. (1990), Henon (1995), for personal opinion; Goss et al. (1995), for being a conference abstract; Weaver & Marcotte (1988), for not being related to consumer knowledge on irradiated food. Other 22 studies, extracted from reference lists, were added. Thus in the end, 66 studies were retained for this systematic review (Figure 1).

Of the 66 studies selected, the majority were written in English (63 references, 95.5%), Portuguese (2 references, 3.0%) and Arabic (1 reference, 1.5%). The articles were published between 1983 and 2017 and the related data are presented in chronological order in Table 3. The 66 eligible studies in the systematic review are from 12 different countries: United States of America (42), Brazil (7), Japan (4), Scotland (2), Korea (2), Argentina (2), Turkey (2), Mexico (1), Chile (1), England (1), China (1) and Egypt (1). In these studies, the sample size varied between 30 (Behrens et al., 2009) and 17,830 (Furuta et al., 1998) participants.

The studies involving the largest number of participants (N) had been made (in decreasing order) in Japan, N = 17,830 and N = 6,385 (Furuta et al., 1998; Furuta, 2004); United States of America with number of participants being: N = 10,780; N = 4,482; N = 3,104; N = 1,112; N = 1,003 (Frenzen et al., 2001; Teisl et al., 2009; Hoefer et al., 2006; Nayga, 1996; Schutz et al., 1989), respectively; China with N = 2,045 (Qixun et al., 1993); Turkey with N = 1,226 (Mehmetoglu, 2007); and Egypt with N = 1,160 (El-Gameel & Elkhateeb, 2011). In general, the authors evaluated the acceptance of irradiated food, the willingness to buy them, awareness and knowledge mostly with respect to food in general (39.7%), followed by studies involving products of animal origin and their derivatives (38.2%) and food of vegetable origin and derivatives (22.1%).

The analytical methods used for data collection included questionnaire (62.4%), interviews (27.5%), surveys (7.2%) and/or focus group sessions (2.9%) all of them including objective questions, except for the research of Behrens et al. (2009) where open-ended questions were answered as part of a qualitative study. Most of the studies comprised statistical treatments of descriptive analyzes (54 references) and/or regression analysis (30), significance (13), reliability (7), factor analysis (5), variance (5) and correlations (3).

Awareness about Food Irradiation:

United States of America:

The first studies that evaluated consumers' knowledge about irradiated food date as far back as 1983. The level of knowledge on irradiated food is constantly changing worldwide. In addition, it has been found in this work that

American consumers usually exhibit an intermediate level of knowledge on the subject (Frenzen et al., 2001). The trend of the data indicates that the American population has increased their awareness of irradiated food over the years. Further details of the surveys can be better seen in Table 3.

Comprehensive studies such as those by Bord & Connor (1989), Schutz et al. (1989), Malone (1990), Frenzen et al. (2001), Aiew et al. (2003) and Feng et al. (2016) show the trend of increase in awareness over the years, influenced by the greater ease of access to information on the subject.

It is possible to find more specific studies, which corroborate with the omnibus findings. In California, an increase in awareness about food irradiation can be seen through studies by Bruhn & Noell (1987) and Bhumiratana et al. (2007), which corroborate the findings for Wisconsin (Jarosz et al., 1989), Texas (Schutz & Cardello, 1997), Kansas (Fox & Olson, 1998) and Minneapolis (Vickers & Wang, 2002).

The studies conducted in Atlanta (Resurreccion et al., 1995) and Illinois (Spaulding et al., 2007) are in agreement with the earliest study found in the systematic review, Titlebaum et al. (1983), who found that the initial reaction to the irradiation process was unanimously negative. They found that the participants were concerned about the safety of the process and about the chance that any residual radioactivity might remain in the products.

Research shows that educational actions favorable to irradiated food positively influence the change in consumer attitudes, while unfavorable information leads to negative attitudes by consumers. Rodriguez (2007) identified that the respondents who had received the unfavorable information packet were less supportive of food irradiation than those who had not received it. On the other hand, Aiew et al. (2003) found that, after the presentation of positive information about food irradiation, most respondents were willing to buy irradiated ground beef.

Titlebaum et al. (1983), evaluating the acceptance of irradiated food, showed that consumers initially responded negatively to the idea of irradiated food. However, the response would become more encouraging after consumers being properly provided with adequate information about the process. Thus, after some time inspecting and trying irradiated food, in addition to being exposed to straightforward labels on the irradiated food, a significant fraction of consumers would even decide to purchase and consume irradiated food. Bruhn et al. (1986a) and Bruhn et al. (1986b) found similar results among conventional consumers regarding their change of attitude towards irradiated food. An educational program, which would address and explain the irradiation technique to consumers could impact positively consumer response, leading to an increase in the acceptance of irradiated food among conventional consumers, although it may not have an effect on those already opposed to the process (Bruhn et al., 1986a). According to Bruhn et al. (1986b), conventional consumer attitudes toward food irradiation can be positively influenced by an educational effort.

Knowledge about the process as well as keeping a positive attitude toward food irradiation increased as a result of participation in a teleconference on the subject (Johnson, 1990). Hashim et al. (1995), researching the consumer purchase behavior of irradiated beef product, showed that the number of participants who purchased irradiated poultry products increased after the educational program. Similar results were found by Qixun et al. (1993), Byun et al. (2009), Lima Filho et al. (2014) and Finten et al. (2017), who concluded that consumer acceptance of irradiated food increases when he is provided with favorable information on the process.

According to Terry & Tabor (1988), the use of the term “irradiated” causes a substantial decrease in consumer preference for irradiated products. Currently more information is still needed to prevent the negative effect of not providing enough information to consumers (Hashim et al., 2001).

Thompson & Knight (2006) identified that most participants of their interview had not been frequently advised on the food irradiation process. According to Cardello et al. (2007), Teisl et al. (2009) and Mehmetoglu (2007), the majority of consumers naturally present negative attitudes towards irradiated food. Consumer behavior towards irradiated food certainly depends on the levels of awareness and knowledge on the benefits or risks associated to the technology.

Fox et al. (2002) and Hayes et al. (2002), respectively, conducted market trials of irradiated chicken and performed an investigation to evaluate how information affects the demand for food irradiation and, based on the results, they concluded that when both positive and negative information about irradiated food were simultaneously provided, a

negative response prevailed in consumers' decisions. A campaign in favor of irradiation significantly contributes to increase the demand of irradiated products and increases willingness to pay, while negative information causes the opposite effect. Moreover, when subjects were given both the pro- and the anti- irradiation descriptions, the negative description dominated and willingness to pay subsided (Fox et al., 2002).

As Hayes et al. (2002) were studying the effect of simultaneously providing favorable and unfavorable descriptions about the effects of irradiation, they noticed that such strategy had essentially the same effect as that of providing only the unfavorable description. They found clear evidence that the content of information given to consumers directly influenced their response and attitude (positive, negative or neutral) towards the subject.

In his research, Wie et al. (1998) claimed that most respondents agreed that they wanted to know more about irradiated food. Bruhn & Schutz (1999) found that consumers need information on protective technologies such as food irradiation. Deliza et al. (2010) concluded that consumer education regarding the technology is a key factor to its acceptance.

The research by Lusk et al. (1999) demonstrated that women were more concerned about irradiated products than men and also that the more anxious a person is, the more concerned he will be about food irradiation. According to Cardello (2003), concern levels were highly susceptible to the influence of positive marketing. Hoefer et al. (2006) found that there is a general lack of awareness among consumers regarding the availability of irradiated meat leading to misunderstandings about the safety of irradiated meat (Table 3).

Other Countries:

Countries like England (Robson & Payne, 1988), Turkey (Gunes & Tekin, 2006 and Mehmetoglu, 2007), Japan (Furuta et al., 1998; Furuta et al., 2000; Inoue, 2000 and Furuta, 2004), China (Qixun et al., 1993) and Korea (Kwon et al., 1992 and Byun et al., 2009), as well as Latin countries like Brazil (Oliveira & Sabato, 2004; Ornellas et al., 2006; Behrens et al., 2009; Silva et al., 2010 and Deliza et al., 2010), Argentina (Flores & Hough, 2008) and Chile (Junqueira-Gonçalves et al., 2011) have a trend of lower awareness about irradiated food. This fact may be due to the governmental policies of each country and to the level of access and interest on the issue of food irradiation, allied to the sociocultural level of each nation.

In addition, it is important to consider that the consumer does not always read and/or understand the information described on the labels of processed food before or after the purchase. Labeling is an important strategy not only from the point of view of nutritional quality, but it also provides information on the application of new technologies in the processing of that food. Therefore, labeling of irradiated food is of paramount importance for consumers to meet their expectations and preferences during purchases. There is a great gap in the identification of such food and the symbol of Radura is often unknown to the consumer (Robson & Payne, 1988; Terry & Tabor, 1988; Ornellas et al., 2006; Junqueira-Gonçalves et al., 2011, Nayga et. al., 2005 and Spaulding et al., 2007).

It is possible to understand the purchase of food as a sphere in which the relationship between the understanding of the technical information described in the labels and the behavior of the consumer with regard to the decision of whether or not to purchase these products is clearly identifiable. It is based on the information of the labels that the consumer exercises his right of choice and the principles of consumer protection guaranteed by the regulatory systems (Einsiedel, 2002 and Qin & Brown, 2006).

In general, respondents view labeling as necessary information to ensure consumer choice (Crowley et al., 2002). In a study by Lima Filho et al. (2015), consumers identified as the ideal label for irradiated strawberries, which provided the following information: "Food treated by ionization process" or "Food treated by irradiation process", "To ensure freshness and quality for a longer time" and the presence of the Radura symbol.

The willingness to buy irradiated food encounters great resistance on the part of consumers, often due to the lack of knowledge about the process and misconceptions. In the last years, developed countries, such as the United States (Sapp & Downing-Matibag, 2009, Teisl et al. 2009, Bruhn, C. M., 2014 and Feng et al., 2016), tend to have a better willingness to buy irradiated food, while developing countries, such as Argentina (Flores & Hough, 2008 and Finten et al., 2017) and Chile (Junqueira-Gonçalves et al., 2011), show greater resistance.

Risk of Bias (RB):

Table 3 presents a detailed evaluation of each RB criterion for each study. Low RB criteria has been achieved by only 12.1% (8) of the eligible studies, whereas, 42.4% (28) have been classified as moderate RB and 45.5% (30) as high RB. Few studies (24.2%; N = 16) presented representativeness of the population they were meant to analyze; in addition, 84.9% (N = 56) of the articles clearly showed that their sampling was random, whereas 12.1% (N = 8) were not random and for 3% (N = 2) were not clear with regard to their objective.

Most articles (87.9%; N = 58) presented well-defined criteria for inclusion and/or exclusion in the sample of interest, whereas in 9.1% (N = 6) of them the criterion was not clearly defined, causing doubts to the reviewers and in 3% (N = 2) of the cases inclusion criteria were unclear (Table 3).

Most research articles selected (83.3%; N = 55) had used instruments without properly describing the evidences that validated them. In 10.6% (N = 7) of the articles it was not clear whether validated instruments had been used. And only four selected articles 6,1% (N = 4) (Johnson, 1990; Wie et al., 1998; Thompson & Knight, 2006; Thompson et al., 2007) included explicitly validated instruments (Table 3).

Only one research, of qualitative nature, did not use statistical treatment (Behrens et al., 2009). Fifty-four studies used the descriptive analysis; thirty studies adopted regression analysis; thirteen applied tests of significance; seven included reliability tests; five performed factor analysis; five relied on variance analysis and three ran correlations tests, which have often been combined for better interpretation of the results.

The majority of the articles (25.8%; N = 17) included in the present systematic review were published in journals possessing as Impact Factor (IF) between $0.51 \leq IF < 1.12$, followed by 22.7% (N = 15) for $1.13 \leq IF < 1.79$; 18.2% (N = 12) for $IF < 0.50$; 13.6% (N = 9) had $1.80 \leq IF < 2.59$; 10.6% (N = 7) for $2.60 \leq IF < 3.54$; 1.5% (N = 1) had IF $3.55 \leq IF < 5.00$. None of the items included in the systematic review had $IF \geq 5.01$ and 7.6% (N = 5) had no IF records. Most of the articles (66.7%; N = 44) were published between the years 1983 and 2006; 12.2% (N = 8) had been published in periodicals with IF between 2007 and 2008 and 10.6% (N = 7) between 2009 and 2010 (Table 3).

It must be stressed that it is important to assess the potential RB involved in conclusions of studies belonging to a systematic review and how strong evidence based on them most be considered. RB assessment of individual studies is a step for determining the strength of a body of evidence (Viswanathan et al., 2012). In the elaboration of this work in particular, the RB assessment was not a straightforward task due to the high heterogeneity of the methodological approaches employed in this research domain and because of the lack of standardized quality assessment tools for studies belonging to the social science field (Cox et al., 2015).

Figure 1: Flow Diagram of Literature Search and Selection Criteria.

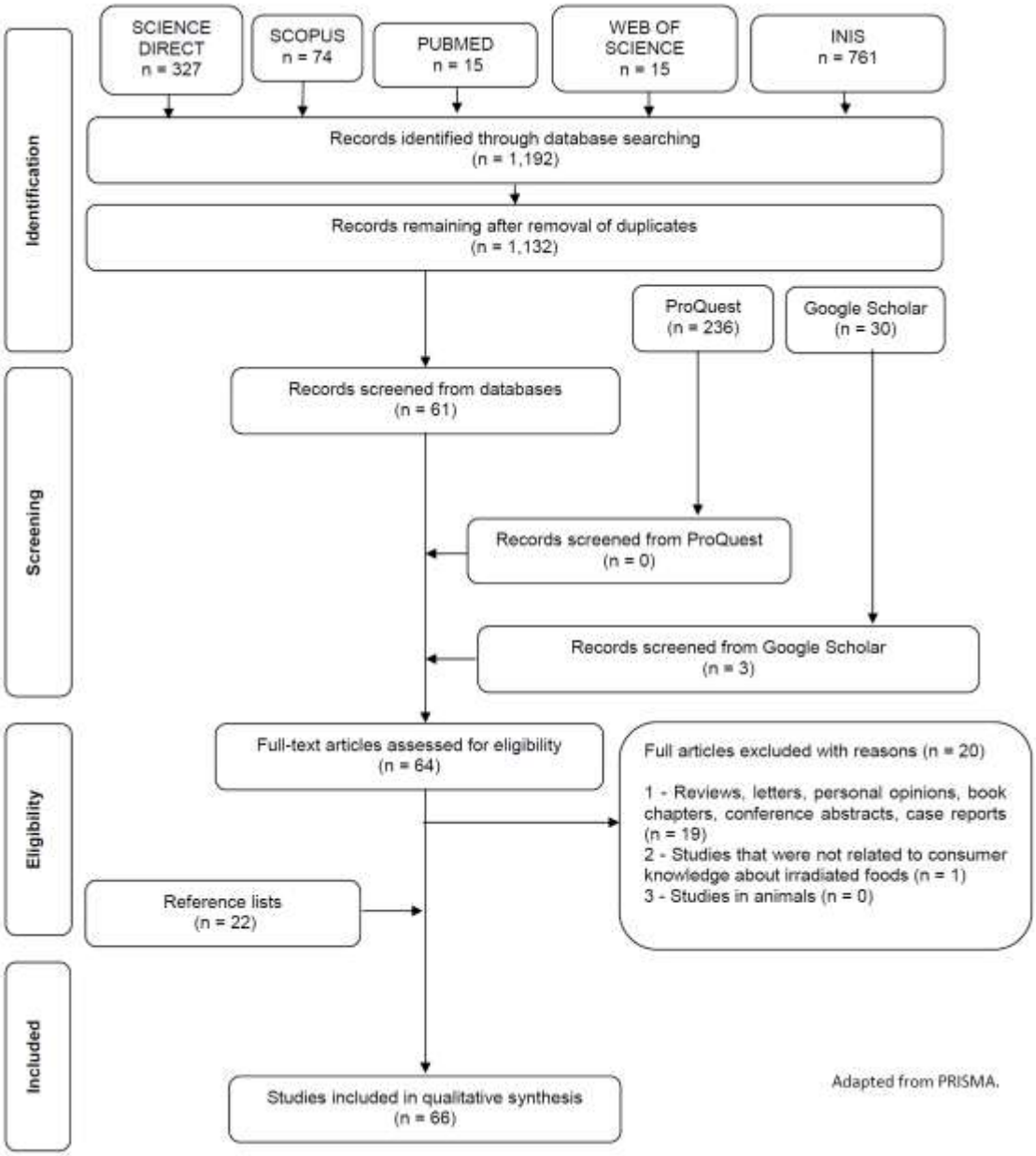

Table 1: Database search strategy

Database	Search
Scopus 74 artigos	(TITLE-ABS-KEY("food irradiation") AND TITLE-ABS-KEY(knowledge) OR TITLE-ABS-KEY(attitude) OR TITLE-ABS-KEY(perception) OR TITLE-ABS-KEY(awareness) AND TITLE-ABS-KEY(consumer))
Pubmed 15 artigos	("Food Irradiation"[Mesh]) AND ("Knowledge"[Mesh] OR "Knowledge of Results (Psychology)"[Mesh] OR "Knowledge Management"[Mesh] OR "Attitude"[Mesh] OR "Perception"[Mesh] OR "Awareness"[Mesh])
ScienceDirect 327 artigos	("food irradiation") AND ((knowledge) OR (attitude) OR (perception) OR (awareness)) AND (consumer) AND ((survey) OR (questionnaire) OR (interview))
Web of Science 15 artigos	("food irradiation" (knowledge OR attitude OR perception OR awareness) consumer (survey OR questionnaire OR interview))
INIS 761 artigos	"food irradiation" AND (knowledge OR attitude OR perception OR awareness) AND consumer AND (survey OR questionnaire OR interview)

Table 2: Criteria adopted for risk assessment of bias

Criteria	Score (points)
1. Classification by Impact Factor	• IF ≥ 5.01 = 100 • 3.55 ≤IF < 5.00 = 85 • 2.60 ≤ IF< 3.54= 70 • 1.80 ≤ IF< 2.59 = 50 • 1.13 ≤ IF< 1.79 = 30 • 0.51 ≤ IF< 1.12= 20 • IF < 0.50 = 10 • Not registered = 0
2. Year of publication	• 2017* = 100 • 2015/2016* = 100 • 2013/2014 = 85 • 2011/2012 = 70 • 2009/2010 = 50 • 2007/2008 = 30 • < Below 2007 = 10
3. Representativeness of the sample	• Representative sample = 100 • Non-representative sample = 0
4. Randomness of the sample	• Random sample = 100 • Non-random sample = 0
5. Criteria for inclusion of the sample	• Criteria defined = 100 • Criteria not defined = 0
6. Validated Data Collection Instrument	• Use of validated instrument = 100 • Use of not validated instrument = 0
7. Statistical analyzes	• Appropriate statistical techniques = 100 • Not appropriate statistical techniques = 0

* Data collection was performed at the end of 2016, so new studies are likely to be included in 2016 and 2017.

Table 3: Extraction table with the summary of eligible studies on consumer awareness about irradiated food and evaluation of Risk of Bias

Author (s) and Year	**Titlebaum et al. (1983)**
Place and Year of Applica	Cities not specified (United States of America), year uninformed; General consumers: Focus group (N_1) Questionnaire (N_2); $N_1 = 60$; $N_2 = 400$.

tion of the Survey; Population and; Sample size (N)									
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Focus group and questionnaire; Objective; General food; Descriptive statistics.								
Main Results:	Participants considered information on the sterilizing action of irradiation of food, its impact on human health, the increase in the shelf life of the products and the labeling information to be of fundamental importance for the purchase and consumption decision on irradiated food. They also reported a pronounced sensitivity to the term "radiation" by considering accidents with nuclear reactors. 98% of questionnaire respondents are interested in food products that stay fresher longer. The spices received the lowest percentage of consumer interest (38%). The participants were wary about the safety of the process, whether there would be any residual radioactivity in the products, and whether the appearance and the taste of the products would be changed.								
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 0.915)	Year of publication – 10	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 47.1	**Risk of Bias (RB) = H**
Author (s) and Year	**Bruhn et al. (1986a)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	California (United States of America), year uninformed; Leaflet: Lay persons trained to teach gardening through the University of California Cooperative Extension Master Gardener program. Poster display: Group 1 was obtained during a Campus Annual Spring Open House (OH) and group 2 was obtained from a Whole Earth Festival (WEF); N = 452.								
Data Collecti	Questionnaire; Objective; General food; Regression analysis.								

on Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	The techniques used to inform the consumer about food irradiation, leaflet and posters, were effective in generating changes in the consumer's attitude towards the purchase and consumption of food irradiation. Consumers appeared to be more concerned with the use of "chemicals" in food than with irradiation itself, although they were concerned about the effects after irradiation. Resistance to the consumption of irradiated food was greater among ecologically sensitive consumers and among the younger ones. Although there were concerns about the safety of irradiated food, consumers were willing to buy the products.
Evaluation of Risk of Bias	Classification by Impact Factor – 0 | Year of publication – 10 | Representativeness of the sample – U | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 51.7 | **Risk of Bias (RB) = M**
Author(s) and Year	**Bruhn et al. (1986b)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Sacramento, Yolo County, California (United States of America), 1984 to 1985; Conventional consumers (N_1=35) and ecologically conscious alternative consumers (N_2=31); N = 66.
Data Collection Method; Types of Questions; Irradiated Food	Questionnaire; Objective; General food; Descriptive statistics and regression analysis.

Included in the Survey and; Statistical Analysis	
Main Results:	Alternative consumers had a higher level of concern than conventional consumers. Initially about 53% of both conventional and alternative consumers were undecided about the safety of irradiation. Following a discussion, undecided conventional consumers shifted primarily to "minor concern" (46%) with an equal number (15%) to "major" and "no concern". Alternative consumers shifted primarily to "major concern" (80%). For all subjects, 73% who considered irradiation a major concern initially, maintained that attitude. 20%, however, shifted from a major to a minor concern. Half of those who initially felt a minor concern maintained that stance. Conventional consumers' attitudes toward food irradiation can be positively influenced by an educational effort.
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF_{2015} = 0.04) | Year of publication – 10 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 45.7 | **Risk of Bias (RB) = H**
Author(s) and Year	**Bruhn & Noell (1987)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Irvine (N_1=86) and Anaheim (N_2=126), Orange County, California (United States of America), 1987; General consumers; N = 212.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; Papayas; Descriptive statistics.

Main Results:	More people had heard of irradiation in the Irvine market (58%,) than the Anaheim location (47%). 66% of the participants from Anaheim and 80%, from Irvine said they would buy a picked ripe/irradiated papaya in the future. Consumers from the upscale market showed greater acceptance of the irradiated product. Although about 50% of the sample had heard of irradiation, few of the people were aware that the process was FDA approved.								
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF_{2015} = 0.04)	Year of publication – 10	Representativeness of the sample – 100	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 60.0	**Risk of Bias (RB) = M**
Author (s) and Year	**Robson & Payne (1988)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	Cities not specified - Large town and a city in the North (England), 1987; General public; N = 371.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Survey; Objective; General food; Descriptive statistics.								
Main Results:	Almost half of respondents (41%) were aware of food irradiation, with TV being their major source of information (47%). Considering the process of safe irradiation, 24% of the interviewees expressed preference for irradiated food. The majority of the respondents insisted that all irradiated food should be labeled and a large proportion expressed a preference for a picture label, although 49% said that Radura's emblem did not suggest anything to them. In the end, 27% of the public would buy irradiated food.								
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF_{2015} =	Year of publication – 10	Representativeness of the sample – U	Randomness of the sample – U	Criteria for sample inclusion – 0	Validated Data Collection Instrume	Statistical analyzes – 100	Result (%) = 24.0	**Risk of Bias (R**

	0,44)			nt – 0				**B) = H**
Author (s) and Year	**Terry & Tabor (1988)**							
Place and Year of Application of the Survey; Population and; Sample size (N)	Kansas City, Blue Springs and Warrensburg, MO (United States of America), 1987; Households; N = 436.							
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Interview; Objective; Beef products; Descriptive statistics, discriminant analysis and chi-square analysis.							
Main Results:	The most of the respondents did not associate the identified symbol with the process of irradiation, only 2.8% knew what the irradiation symbol truly represents. At equal prices, 33% of the food buyers preferred the products with the irradiation symbol, 12% preferred the product without the Radura symbol, and 55% were indifferent. The use of the term "irradiated" causes a substantial decrease in consumer preference for irradiated produce, however the presentation of additional information to the respondents resulted in a dramatic increase in both the acceptance of irradiation and the willingness to pay.							
Evaluation of Risk of Bias	Classification by Impact Factor – 0	Year of publication – 10	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 44.3	**Risk of Bias (RB) = H**
Author (s) and Year	**Bord & Connor (1989)**							
Place and Year of Applica	State of Pennsylvania (United States of America), year uninformed; Only women; N = 195.							

tion of the Survey; Population and; Sample size (N)	
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; focus-group discussion; General food; Descriptive statistics and correlation analysis.
Main Results:	The number of willing to try irradiated food increases significantly after the presentation of information about food irradiation. The intense majorities neither want nor oppose irradiated food. Only 32% of sample report having heard anything about the topic prior to participation in this study. The women of sample were quite uninformed about the food irradiation issue. The extent to which the public ultimately accepts or rejects irradiated food may well be predicated on the presence or absence of information about the topic and the type of information that reaches the public.
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF_{2015} = 0.04) Year of publication – 10 Representativeness of the sample – 0 Randomness of the sample – 100 Criteria for sample inclusion – 100 Validated Data Collection Instrument – 0 Statistical analyzes – 100 Result (%) = 45.7 **Risk of Bias (RB) = H**
Author (s) and Year	**Jarosz et al. (1989)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Wisconsin (United States of America), 1986; Individual designated by restaurant staff as the appropriate respondent (owner, manager, or a purchasing agent); N = 42.
Data Collection	Interview (telephone interview); Objective; Shellfish; Descriptive statistics and chi-square analysis.

Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	More than half of the respondents (57%) had not heard of food irradiation. 60% of all respondents were unfamiliar with the process of irradiating food. Without the information on food irradiation, more than half of the respondents were undecided about the possibility of an irradiated seafood product being served in a higher restaurant. Respondents' confidence in the approval of food irradiation by the American government showed great potential for positive change in the position of respondents. Food and public health professionals interested in food irradiation need to take an active role in communicating about the process with the public.
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 0.915) Year of publication – 10 Representativeness of the sample – 0 Randomness of the sample – 0 Criteria for sample inclusion – 100 Validated Data Collection Instrument – 0 Statistical analyzes – 100 Result (%) = 32.9 **Risk of Bias (RB) = H**
Author (s) and Year	**Schutz et al. (1989)**
Place and Year of Application of the Survey; Population and; Sample size (N)	National survey (United States of America), 1988; General consumers; N = 1,003.
Data Collection Method; Types of Questions; Irradiated Food Included in the	Mail survey, questionnaire; Objective; General food; Descriptive statistics.

Survey and; Statistical Analysis	
Main Results:	More than half of the respondents (59.7%) had heard about food irradiation, while 37.5% had never heard of it and 2.8% did not know it. A quarter of the population shows major concern with regard to irradiation, but better educated respondents were less likely to feel FDA approval would increase their concern. About half of the respondents indicated that it would be likely or very likely to purchase irradiated food in the marketplace. The "irradiated to control microorganisms" label results in the most positive connotation. Respondents had a good acceptance for irradiated poultry and pork. Almost half of the respondents (43%) opted for irradiated fruits over non irradiated ones.
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF_{2015} = 0.04) | Year of publication – 10 | Representativeness of the sample – 100 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – U | Statistical analyzes – 100 | Result (%) = 70.0 | **Risk of Bias (RB) = L**
Author (s) and Year	**Johnson, F. C. S. (1990)**
Place and Year of Application of the Survey; Population and; Sample size (N)	California (United States of America), 1988; Before the teleconference (N1): Home economists. After the teleconference (N2): home economists, dietitians, educators, and students; N1 = 485 N2 = 311.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; General food; Cronbach's Alpha, descriptive and inferential statistics.
Main Results:	More than half of the respondents (57.9%) reported that they had consumed irradiated food, but it is likely that some of the respondents confused the irradiated products with other processing methods, as almost four-fifths of respondents did not know the definition of "radurization" and almost half responded

	incorrectly to the question about the availability of shelf-stable irradiated food in the United States. The population generally had a positive attitude toward the irradiation of food. The home economists lacked knowledge about the irradiation process, although they had a positive attitude toward it and desired to learn more about it. Knowledge of and a positive attitude toward food irradiation increased as a result of participation in a teleconference.
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF_{2015} = 0.101) | Year of publication – 10 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 100 | Statistical analyzes – 100 | Result (%) = 60.0 | **Risk of Bias (RB) = M**
Author (s) and Year	**Malone, J. W. (1990)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Cities not specified - Nationwide survey (United States of America), 1987; Households; N = 800.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Interview (telephone interview); Objective; Fresh food products; Descriptive statistics, chi-square analysis and Probit analysis.
Main Results:	A quarter of the respondents (25.2%) had heard about the irradiation process, demonstrating that consumer knowledge about irradiation is scanty. About 36% were willing to purchase such products, a high percentage of those not willing to purchase have not heard of irradiation, 77.1%. There has been an increase in the number of consumers willing to pay more for irradiated food when informed of the reduction of foodborne disease.
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = | Year of publication – 10 | Representativeness of the sample – U | Randomness of the sample – 100 | Criteria for sample inclusion – | Validated Data Collection Instrume | Statistical analyzes – 100 | Result (%) = 66.0 | **Risk of Bias (R**

	0.738)			100	nt – U				**B) = M**
Author (s) and Year	**Kwon et al. (1992)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	Seoul and Taejon (Republic of Korea), 1990; General public and radiation workers; N = 700.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; Dried anchovy; Descriptive statistics.								
Main Results:	Most respondents (82%) have already heard of the treatment of food with ionizing radiations. With regard to the contaminated food by radionuclides, 75% of consumers distinguished it from irradiated food. Irradiated food was more acceptable (35%) than chemically-treated food (13%). Providing some information to consumers regarding the benefits which could be achieved through irradiation resulted in a more positive response (60%) with regard to potential purchase of irradiated anchovies. About 71% of respondents implied that insufficient public information and incorrect understanding of food irradiation were major reasons for retardation of commercial utilization of this technology.								
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF2015 = 0.12)	Year of publication – 10	Representativeness of the sample – 0	Randomness of the sample – U	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 36.7	**Risk of Bias (RB) = H**
Author (s) and Year	**Qixun et al. (1993)**								
Place and	Chengdu (China), year uninformed; General consumers; N = 2,045.								

Year of Application of the Survey; Population and; Sample size (N)	
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; Seasonings; Descriptive statistics.
Main Results:	About 67% of consumers heard about food irradiation. After information on irradiated food, 72% of respondents believed that irradiated food were better than non-irradiated food. Approximately 72% of persons and 67% of families were willing to buy irradiated seasonings. Most consumers hoped that the food irradiation technology should be applied to markets as soon as possible so that they could buy more food in markets, however, a few consumers did not believe that the Irradiated food are safe.
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2015} = 1.207) | Year of publication – 10 | Representativeness of the sample – 0 | Randomness of the sample – U | Criteria for sample inclusion – 0 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 23.3 | **Risk of Bias (RB) = H**
Author (s) and Year	**Hashim et al. (1995)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Griffin, GA (United States of America), 1994; General consumers; N = 126.
Data Collecti	Questionnaire; Objective; Poultry products; Descriptive statistics and chi-square analysis.

on Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	The number of participants who purchased irradiated poultry products after an educational program increased by more than 20%. Using a label or poster did not increase the number of participants who bought irradiated poultry products. Most of the participants who evaluated the irradiated chicken during the domestic use test were satisfied with it. About 84% of the participants would like all chicken served in restaurants or fast food places to be irradiated. Almost half of respondents (47%) were willing to pay more for irradiated chicken.
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2014} = 1.672) | Year of publication – 10 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 48.6 | **Risk of Bias (RB) = H**
Author (s) and Year	**Resurreccion et al. (1995)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Atlanta (United States of America), year uninformed; General consumers; N = 446.
Data Collection Method; Types of Questions; Irradiated Food Included in the	Questionnaire (mail questionnaire); Objective; General food; Descriptive statistics and regression analysis.

Survey and; Statistical Analysis	
Main Results:	About 72% of consumers are aware of irradiation and, among these, 87.5% indicated that they have heard about irradiation but do not really know that much about it. The low level of real information that consumers have about food irradiation was observed, because 33% of consumers believe that irradiated food is radioactive. The label of irradiated food was important to 81% of consumers. The international logo and the statements were considered by half of the respondents to be insufficient to inform consumers that the food is irradiated. After being informed about the importance of irradiation, 50% of respondents said they would prefer to buy irradiated meat or poultry. Nearly 38-42% of the consumers who would purchase irradiated food were willing to pay 1-5% more, and over 10% would pay up to 10% more than they now pay.
Evaluation of Risk of Bias	Classification by Impact Factor – 50 (IF_{2015} = 1.849) | Year of publication – 10 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 51.4 | **Risk of Bias (RB) = M**
Author (s) and Year	**Donaldson et al. (1996)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Aberdeen North (Scotland), 1994; Random sample; N = 144.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire (postal survey); Objective; Poultry-meat; Regression analysis.

Main Results:	Half of respondents would be willing to pay extra for poultry-meat which had been irradiated. Only 6% would buy irradiated poultry-meat if there was no additional cost. About 34% expressed concern about safety of poultry-meat processed by irradiation. Nearly 17% thought irradiation to be unnecessary, this suggest that food irradiation has still not gained full public acceptance.								
Evaluation of Risk of Bias	Classification by Impact Factor – 50 (IF_{2015} = 2.515)	Year of publication – 10	Representativeness of the sample – 100	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 65.7	**Risk of Bias (RB) = M**
Author (s) and Year	**Nayga, R. M. (1996)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	Cities not specified - 48 States (United States of America), 1991; Main meal preparers or planners in households; N = 1,112.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Interview (computer-assisted telephone interviews); Objective; General food; Logit and probit analysis.								
Main Results:	Only 16% of the respondents considered the use of irradiation at approved levels to be safe. The most important economic factors that affect the probability that a main meal planner will consider irradiated food to be safe are: gender, urbanization, income, education, and to some extent race and age.								
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF_{2015} = 0.482)	Year of publication – 10	Representativeness of the sample – 100	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – U	Statistical analyzes – 100	Result (%) = 70.0	**Risk of Bias (RB) = L**
Author	**Giamalva et al. (1997)**								

<table>
<tr><td>(s) and Year</td><td></td></tr>
<tr><td>Place and Year of Application of the Survey; Population and; Sample size (N)</td><td>Cities not specified – Arkansas (United States of America), 1992; General consumers; N = 60.</td></tr>
<tr><td>Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis</td><td>Questionnaire; Objective; Meat sandwich; Descriptive statistics and Tobit analysis.</td></tr>
<tr><td>Main Results:</td><td>More than 57% of the subjects stated they were seriously concerned about the irradiation of food. There is a willingness to pay for elimination of disease-causing bacteria through irradiation for the majority of respondents, the participants were Willing To Pay (WTP) an average of $0.71 for the right to exchange a typical meat sandwich for a sandwich irradiated to eliminate the potential risk of foodborne bacteria. There was a positive relationship between WTP and the perceived risk of foodborne disease, and a negative relationship between WTP and years of education.</td></tr>
<tr><td>Evaluation of Risk of Bias</td><td>Classification by Impact Factor – 20 (IF_{2015} = 0.915) | Year of publication – 10 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 47.1 | Risk of Bias (RB) = H</td></tr>
<tr><td>Author (s) and Year</td><td>Schutz & Cardello (1997)</td></tr>
<tr><td>Place and Year of Application of the Survey; Populati</td><td>Fort Hood, Texas (United States of America), year uninformed; Military consumers; N = 248.</td></tr>
</table>

on and; Sample size (N)	
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; General food; Descriptive statistics.
Main Results:	There is a relatively low level of awareness of irradiation as a preservation food process among military personnel, only 16.9% of respondents heard of irradiation as a food preservation method. The willingness to consume irradiated food to both military dining facilities and field situations is low prior to information presentation, as is willingness to consume specific food classes that have been irradiated. However, the results on the effect of the various treatment conditions revealed a strong positive effect for one treatment, the Purdue University video, and a smaller effect for the 20/20 video. It does appear that there is more willingness to consume irradiated food in the field than in the military dining facility, which may indicate that of irradiated food the introduction to the military may occur more easily with field rations than with dining hall food.
Evaluation of Risk of Bias	Classification by Impact Factor – 0 | Year of publication – 10 | Representativeness of the sample – 0 | Randomness of the sample – U | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 35.0 | **Risk of Bias (RB) = H**
Author (s) and Year	**Fox & Olson (1998)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Manhattan, Kansas (United States of America), 1995, 1996 and 1997; Mail Survey (N_1): households Retail Trials (N_2): two grocery stores Market Experiment (N_3): households; N_1 = 229, N_2 = Uninformed and N_3 = 98.
Data Collection Method;	Mail Survey; Objective; Chicken breasts; Descriptive statistics.

Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	About 81% of respondents to the mail survey indicated that they would choose the irradiated poultry product if it were available at the same price as non-irradiated. Just over half of respondents (55%) of respondents who indicated they had heard of food irradiation prior to the survey, 82.5% chose irradiated and of those who had not heard of irradiation, 78.5% chose irradiated. In retail trials, when irradiated and nonirradiated chicken were equally priced, the irradiated product accounted for 43% of total sales, significantly lower than the mail survey result of 81%. Results from the market experiments suggest that shoppers' unawareness of the benefits of food irradiation was a major factor accounting for the differences between the mail survey and the retail trials. 80% of participants purchased irradiated chicken in the market experiment.
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2015} = 1.207) | Year of publication – 10 | Representativeness of the sample – U | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 56.7 | **Risk of Bias (RB) = M**
Author(s) and Year	**Furuta et al. (1998)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Osaka (Japan), 1994, 1995 and 1996; Radiation fair visitors; N = 17,830.
Data Collection Method; Types of Questions; Irradiated Food	Questionnaire; Objective; Potatoes; Descriptive statistics.

Included in the Survey and; Statistical Analysis	
Main Results:	The ratio of visitors who had heard something about radiation increased with increasing age. The ratio reached 94.6% at the ages of 13-15 years. After viewing an exhibition, kids visitors answered "understand well" (22.6%) and "understand a little" (47.5%) about radiation. Participants found that "Roentgen" (48.5%) and "atomic power generation" (29.5%) were the closest words associated with "radiation". After viewing the display and description of irradiated potatoes, 14.5% indicated that they wanted to taste the irradiated potatoes. About 85% of respondents who knew potato irradiation indicated that they also knew the existence of natural radiations.
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2015} = 1.207) Year of publication – 10 Representativeness of the sample – 100 Randomness of the sample – 100 Criteria for sample inclusion – 100 Validated Data Collection Instrument – 0 Statistical analyzes – 100 Result (%) = 62.9 **Risk of Bias (RB) = M**
Author (s) and Year	**Wie et al. (1998)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Iowa (United States of America), year uninformed; Registered dietitians residing in Iowa; N = 269.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; General food; Cronbach's Alpha, descriptive statistics and chi-square analysis.

Main Results:	Almost all respondents (92.9%) of respondents believe that shelf life of food can be extended through irradiation treatment. About 87.4% believe that irradiation can reduce or eliminate microorganisms, insects and parasites that live in food and 61.3% do not believe that all food are approved for irradiation treatment, while 61.3% understand that irradiation of food involves the use of ionizing energy applied to food. Most respondents agree that they want to know more about irradiated food.								
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF_{2013} = 0.03)	Year of publication – 10	Representativeness of the sample – 100	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 100	Statistical analyzes – 100	Result (%) = 74.3	**Risk of Bias (RB) = L**
Author (s) and Year	**Bruhn & Schutz (1999)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	California (United States of America), 1993; General consumers; N = 605.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaires (mail survey); Objective; General food; Descriptive statistics.								
Main Results:	Food irradiated to reduce spoilage was considered a major concern by 33% of respondents. Only 36% recognized that irradiation of meat or poultry destroys bacteria that causes foodborne illness. About 33% knew irradiated food are considered safe by health and safety organizations. Consumers considered university scientists and health professionals to be a more reliable source of food safety information than family or friends. Consumers need information on protective technologies such as food irradiation.								
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 0.915)	Year of publication – 10	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 47.1	**Risk of Bias (RB)**

	= H
Author (s) and Year	**Lusk et al. (1999)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Iowa (United States of America), 1994 and 1995; General consumers; N = 171.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Interview; Objective; Pork; Descriptive statistics and regression analysis.
Main Results:	The concern of food irradiation is less than that of other food safety concerns and other bacterial prevention methods such as preservatives and chemicals. The average concern for irradiation was 3.228 on a scale of 1 to 5, which means that consumers on average still displayed somewhat of a concern for irradiation. The information about the irradiation process decreases the concern with food irradiation. The more beef a person consumes, the less concerned they are with irradiation.
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF_{2015} = 0.04) Year of publication – 10 Representativeness of the sample – 0 Randomness of the sample – U Criteria for sample inclusion – U Validated Data Collection Instrument – 0 Statistical analyzes – 100 Result (%) = 24.0 **Risk of Bias (RB) = H**
Author (s) and Year	**Rimal et al. (1999)**
Place and Year of Application of the Survey;	Cities not specified Georgia (United States of America), year uninformed; General consumers; N = 207.

Population and; Sample size (N)	
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Interview (telephone survey); Objective; Beef products; Descriptive statistics and Poisson regression.
Main Results:	The households who are likely to purchase irradiated beef packages are more likely to store it for a longer period before cooking or freezing it. Of those who chose all irradiated packages of the ground form of beef, 62.07% stored for two or more days before cooking. The respondents who stored ground beef for several days before cooking were likely to choose irradiated packages. Every additional day of refrigeration before cooking or freezing increased the selection of irradiated ground beef by 0.25 packages during each supermarket visit.
Evaluation of Risk of Bias	Classification by Impact Factor – 0 | Year of publication – 10 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 44.3 | **Risk of Bias (RB) = H**
Author (s) and Year	**Furuta et al. (2000)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Tokyo, Hiroshima and Osaka (Japan), 1997 and 1998; Youngster's Science Festival visitors; N = 773.
Data Collection Method; Types of	Questionnaire; Objective; Potatoes; Descriptive statistics.

Questions; Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	About 79% of respondents from Tokyo, 59% from Hiroshima and 77% from Osaka know about the existence of natural radiations. Nearly 31% of respondents from Tokyo, 27% from Hiroshima and 35% from Osaka know irradiated potatoes. More than 10% of children participants in elementary school age answered they have never heard the word "radiation". Worse images toward radiation would be formed after junior high school days while the word, "radiation" is initially recognized during elementary school days irrespective of different cities in Japan.
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2015} = 1.207) | Year of publication – 10 | Representativeness of the sample – 100 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 62.9 | **Risk of Bias (RB) = M**
Author (s) and Year	**Inoue, H. (2000)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Cities not specified - four colleges in Japan (Japan), 1999; Students aged 19±1.4 years who attended four colleges in Japan; N = 536.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistic	Questionnaire; Objective; General food; Descriptive statistics.

al Analysis									
Main Results:	About 37.3% of young students said they had already learned about radiation. Only 22.8% have already heard about irradiation of food and 39% believe that irradiated food are contaminated with radionuclides. Only 3.7% of young people would buy irradiated food, 62.7% would buy normal food and 33.6% would make a price consideration.								
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 0.61)	Year of publication – 10	Representativeness of the sample – 0	Randomness of the sample – U	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 38.3	**Risk of Bias (RB) = H**
Author (s) and Year	**Frenzen et al. (2001)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	Connecticut, Georgia, Minnesota, Oregon, and selected counties in California, Maryland, and New York (United States of America), 1998 to 1999; Residents of the Foodborne Diseases Active Surveillance Network (FoodNet) covering 11% of the U.S. population; N = 10,780.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Interview - FoodNet survey (telephone survey); Objective; Meat and poultry; Logistic regression model and chi-square analysis.								
Main Results:	Almost half of adults (49.6%) in the FoodNet sites were willing to buy irradiated meat or poultry. Only 48.3% had heard of food irradiation, so a majority (51.6%) were uninformed about irradiated food products.								
Evaluation of Risk of Bias	Classification by Impact Factor – 50 (IF_{2014} = 1.849)	Year of publication – 10	Representativeness of the sample – 100	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – U	Statistical analyzes – 100	Result (%) = 76.7	**Risk of Bias (RB)**

	= L
Author (s) and Year	**Hashim et al. (2001)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Griffin, Georgia (United States of America), 1998; General consumers; N = 207.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; Beef products; Descriptive statistics and chi-square analysis.
Main Results:	The percentage of consumers who purchased all irradiated packages based on the poster information was about 15%. The poster was effective in causing a change in beef purchase behavior. Nearly 28% of the participants who purchased mixed packages of ground beef exclusively during the first shopping trip purchased all irradiated samples during the second shopping trip. The store-level information concerning the benefits of irradiation, made available at the point-of-purchase, was sufficient to motivate some of the consumers to shift towards irradiated products and discouraged some consumers from purchasing irradiated beef.
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 1.086) Year of publication – 10 Representativeness of the sample – 0 Randomness of the sample – 100 Criteria for sample inclusion – 100 Validated Data Collection Instrument – 0 Statistical analyzes – 100 Result (%) = 47.1 **Risk of Bias (RB) = H**
Author (s) and Year	**Crowley et al. (2002)**
Place and Year of Application of	Cleveland, Ohio (United States of America), 2000; Chefs attending the North-east Regional Conference of the American Culinary Federation; N = 115.

the Survey; Population and; Sample size (N)	
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; Ground beef; Descriptive statistics.
Main Results:	About 85% of respondents were aware of irradiated ground beef technology. Over 70% were very willing to purchase irradiated ground beef. Willingness to purchase increased for all food when chefs' considered potential health and safety benefits. The respondents saw labeling as an information issue to provide consumer choice. When technical alterations offered improved flavor and improved shelf life for the irradiated beef, willingness to purchase was 71%.
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 0.60) | Year of publication – 10 | Representativeness of the sample – 100 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 61.4 | **Risk of Bias (RB) = M**
Author (s) and Year	**Fox et al. (2002)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Cities not specified (United States of America), year uninformed; Households; N = 87.
Data Collection Method;	Interview; Objective; Pork sandwich; Descriptive statistics and Probit analysis.

Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	Providing positive information about the irradiated product increased its value, shifting out the demand curve, while negative information about the product has decreased its value. A favorable description of irradiation increased willingness-to-pay, and an unfavorable description decreased willingness-to-pay. When subjects were given both the pro- and anti-irradiation descriptions, the negative description dominated and willingness-to-pay decreased. The combined positive and negative descriptions resulted in 56,3% subjects downgrading their safety assessment for irradiated pork.
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2015} = 1.426) Year of publication – 10 Representativeness of the sample – 0 Randomness of the sample – 100 Criteria for sample inclusion – 100 Validated Data Collection Instrument – 0 Statistical analyzes – 100 Result (%) = 48.6 **Risk of Bias (RB) = H**
Author (s) and Year	**Hayes et al. (2002)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Iowa (United States of America), year uninformed; General consumers; N = 87.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and;	Questionnaire; Objective; Pork products; Descriptive statistics and Probit analysis.

Statistical Analysis	
Main Results:	When the same favorable and unfavorable descriptions are presented simultaneously, the net impact is a significant reduction in bids for the irradiated product, with the median bid falling to zero. The favorable information reinforces the perception that the irradiated product is safe. In the negative treatment, participants downgrade their safety assessments. In the both treatment, the net effect is a downgrading in the relative safety assessment. The effect of providing both the favorable and unfavorable descriptions had essentially the same effect as that of providing only the unfavorable description.
Evaluation of Risk of Bias	Classification by Impact Factor – 50 (IF_{2015} = 2.044) Year of publication – 10 Representativeness of the sample – 0 Randomness of the sample – 100 Criteria for sample inclusion – 100 Validated Data Collection Instrument – 0 Statistical analyzes – 100 Result (%) = 51.4 **Risk of Bias (RB) = M**
Author (s) and Year	**Vickers & Wang (2002)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Minneapolis, MN (United States of America), year uninformed; General consumers; N = 218.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; Fresh ground beef; Descriptive statistics, ANOVA and chi-square analysis.
Main Results:	About 63% of respondents had heard of food irradiation and only 9% of the panelists had knowingly consumed irradiated food. If cost were equal, 42% of the subjects indicated they would be more likely to buy irradiated fresh food.
Evaluation of	Classification by publication – Year of publication – Representativeness of the sample – Randomness of the sample – Criteria for – Validated Data – Statistical – Result – **Risk of**

Risk of Bias	Impact Factor – 30 (IF_{2015} = 1.649)	on – 10	sample – 0	sample – 100	sample inclusion – 100	Collection Instrument – 0	analyzes – 100	(%) = 48.6	**Bias (RB) = H**
Author (s) and Year	**Aiew et al. (2003)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	Austin, Houston, San Antonio, and Waco, TX (United States of America), 2002; General consumers; N = 484.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Interview (face-to-face interviews); Objective; Beef products; Descriptive statistics.								
Main Results:	About 45% of sample had no knowledge of food irradiation, 51% would not buy irradiated ground beef, and only 8.5% considered themselves strong buyers. After the presentation of Information about food irradiation, 94% of the respondents were willing to buy irradiated ground beef. The willingness-to-pay experiment on the first bid values show that 97.3% responded yes to receiving 10 cents more per pound of irradiated ground beef.								
Evaluation of Risk of Bias	Classification by Impact Factor – 0	Year of publication – 10	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 44.3	**Risk of Bias (RB) = H**
Author (s) and Year	**Cardello, A. (2003)**								
Place and Year of	Natick MA (United States of America), year uninformed; Employees at the US Army Natick Soldier Center, Natick, MA; N = 88.								

Application of the Survey; Population and; Sample size (N)	
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; Chocolate pudding; Descriptive statistics, ANOVA and linear regression.
Main Results:	Irradiation has raised concern among more than 65% of the consumer test population. The term 'ionizing energy' elicited somewhat lower levels of concern than the term 'irradiation'. The willingness to try food processed by one novel or potentially 'risky' technology is associated with a lower level of concern about the risks associated with a broad range of novel food processing technologies. The concern levels had the greatest potential to be positively influenced by the information treatments.
Evaluation of Risk of Bias	Classification by Impact Factor – 70 (IF_{2015} = 3.125) | Year of publication – 10 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 54.3 | **Risk of Bias (RB) = M**
Author (s) and Year	**van der Pol et al. (2003)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Aberdeen (Scotland), year uninformed; General public; N = 200.
Data Collecti	Interview; Objective; Poultry-bourne; Descriptive statistics, chi-square analysis and regression analysis.

on Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	About 61% of the respondents would buy irradiated poultry and 50% would be willing to pay more for these products. The respondents indicated that they are willing to pay 10% more for irradiated poultry.
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 0.806) | Year of publication – 10 | Representativeness of the sample – U | Randomness of the sample – U | Criteria for sample inclusion – 0 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 26.0 | **Risk of Bias (RB) = H**
Author (s) and Year	**Furuta, M. (2004)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Osaka (Japan), 1996 to 2002; Radiation fair visitors; N = 6,385.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical	Questionnaire; Objective; Potatoes and spices; Descriptive statistics.

Analysis									
Main Results:	Almost 70% of the participants indicate an improvement of the image of ‘‘radiation’’ and 40% point out that the display of the irradiated products is the cause of the improvement. Only less than 5% indicated " Irradiation " as being one of the major concerns about food safety issues for respondents. The ratio of the respondents still persisting in the idea that irradiated potatoes were hazardous remained only 5.2%.								
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2015} = 1.207)	Year of publication – 10	Representativeness of the sample – 100	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 62.9	**Risk of Bias (RB) = M**
Author (s) and Year	**Nayga et al. (2004)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	Austin, Houston, and San Antonio, TX (United States of America), 2001; General consumers; N = 270.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; Beef products; Probit analysis.								
Main Results:	About 58% of the respondents are willing to pay a premium for irradiated beef. Nearly 68.3% of the respondents who would consider a food irradiation label as a symbol of warning are not willing to pay a premium. Approximately 45.6% of the total sample indicated that they trust the technology and they are willing to pay a price premium for irradiated beef. Those who trust the irradiation technology are more likely to pay a premium of between 5 and 25 cents per pound for irradiated beef.								
Evaluation of Risk of Bias	Classification by Impact Factor – 20	Year of publication – 10	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusi	Validated Data Collection	Statistical analyzes – 100	Result (%) =	**Risk of Bias**

	(IF_{2015} = 1.086)			on – 100	Instrument – 0		47.1	**(RB) = H**
Author (s) and Year	**Oliveira & Sabato (2004)**							
Place and Year of Application of the Survey; Population and; Sample size (N)	Educational trial (N_1): Uninformed Tasting test and Opinion poll (N_2): Rio de Janeiro and São Paulo (Brazil), 2002; N_1: Students from "Terceiro ano do Ensino Médio" of a public school N_2: International Nuclear Atlantic Conference (INAC) and 15[a] Annual Meeting of Biological Institute (RAIB); N_1 = 119 and N_2 = Uninformed.							
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaires; Objective; Educational trial: General food and, Tasting test and Opinion poll: tangerines, papayas and honeys; Descriptive statistics.							
Main Results:	After a video exhibition, the students' perception about food irradiation process switched from normal to comfortable. In the tasting test, it was verified a good acceptance of irradiated fruits and honey. Although 83% of the respondents had already heard about food irradiation, only 17% had seen/known the radura symbol that showed the low level of dissemination and information on food irradiation process.							
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2015} = 1.207)	Year of publication – 10	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 48.6	**Risk of Bias (RB) = H**
Author (s) and Year	**Nayga et. al. (2005)**							
Place and Year of Application of the	Austin, Houston, San Antonio, and Waco, TX (United States of America), 2002; General consumers; N = 484.							

Survey; Population and; Sample size (N)	
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Interview (face-to-face interviews); Objective; Beef products; Descriptive statistics and Probit analysis.
Main Results:	About 67.1% considered the radura symbol an assurance of quality and were more inclined to purchase irradiated food. After the brief presentation of nature and benefits of food irradiation, the proportion of respondents willing to buy irradiated food increased from 50% to 89%. The information about the nature and benefits of food irradiation has a positive effect on perceived segment shifts and willingness to buy. Respondents who have a perceived knowledge of food irradiation are 17.6% more likely to buy irradiated ground beef than those who do not, prior to the presentations.
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2011} = 1.33) Year of publication – 10 Representativeness of the sample – 0 Randomness of the sample – 100 Criteria for sample inclusion – 100 Validated Data Collection Instrument – 0 Statistical analyzes – 100 Result (%) = 48.6 **Risk of Bias (RB) = H**
Author (s) and Year	**Gunes & Tekin (2006)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Istanbul (Turkey), year uninformed; General public; N = 444.
Data Collection Method; Types	Questionnaire; Objective; Raw red meat and poultry; Descriptive statistics.

of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	Only 29% of respondents indicated that they had heard food irradiation before. Only 11% of respondents reported that food irradiation is safe. About 62% of consumers indicated that they would buy irradiated food. Near 64% of the respondents who were uncertain about safety of irradiated food indicated that they would buy irradiated food upon hearing the benefit statement. About 23% of respondents indicated that they would pay 5% premium price for irradiated food.
Evaluation of Risk of Bias	Classification by Impact Factor – 70 (IF_{2015} = 2.711) | Year of publication – 10 | Representativeness of the sample – 100 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 68.6 | **Risk of Bias (RB) = M**
Author (s) and Year	**Hoefer et al. (2006)**
Place and Year of Application of the Survey; Population and; Sample size (N)	New York State (NYS) and Connecticut (United States of America), 2002 to 2003; Residents of the Foodborne Diseases Active Surveillance Network (FoodNet); N = 3,104.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistic	Interview - FoodNet survey (telephone survey); Objective; Fresh meat; Logistic regression model.

al Analysis									
Main Results:	Only 37% of respondents knew that irradiated fresh meat was available for purchase, however, only 2% found the product where they shopped. About 62% were unsure about the safety of irradiation. There is a general lack of awareness among consumers regarding the availability of irradiated meat and misunderstandings about the safety of irradiated meat.								
Evaluation of Risk of Bias	Classification by Impact Factor – 50 (IF_{2014} = 1.849)	Year of publication – 10	Representativeness of the sample – 100	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – U	Statistical analyzes – 100	Result (%) = 76.7	**Risk of Bias (RB) = L**
Author (s) and Year	**Ornellas et al. (2006)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	Belo Horizonte, MG (Brazil), year uninformed; General public; N = 218.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Interview; Objective; General food; Descriptive statistics.								
Main Results:	About 59.6% did not know that irradiation is a method of food preservation, and could not answer whether they would consume irradiated products and only 16% believe that irradiated food mean the same as radioactive food. Most respondents (92%) do not know the symbol of irradiation, radura, and 16% would buy food irradiated by the influence of the symbol, even without knowing its meaning, informing that radura transmits confidence, security and quality, by the image of the flower in green coloration. Nearly 81% of respondents believe that the label with the radiation symbol and additional information on the label are important. Approximately 89% of respondents would consume irradiated food if they knew that irradiation increases food safety.								
Evaluati	Classificati	Year of	Representative	Randomn	Criteri	Validate	Statistic	Resu	**Ris**

on of Risk of Bias	on by Impact Factor – 20 (IF_{2015} = 0,75)	publicati on – 10	ness of the sample – 100	ess of the sample – 100	a for sample inclusi on – 100	d Data Collecti on Instrume nt – 0	al analyze s – 100	lt (%) = 61.4	**k of Bia s (R B) = M**
Author (s) and Year	**Thompson & Knight (2006)**								
Place and Year of Applica tion of the Survey; Populati on and; Sample size (N)	Texas (United States of America), year uninformed; All Family and Consumer Sciences (FCS) county extension agents; N = 134.								
Data Collecti on Method; Types of Questio ns; Irradiate d Food Include d in the Survey and; Statistic al Analysi s	Interview (telephone Survey); Objective; General food; Exploratory factor analysis, Cronbach's Alpha, logistic and multiple regression analysis.								
Main Results:	Most participants did not provide education on food irradiation (53%). Results suggest that educators' beliefs about the safety and their understanding of food irradiation are predictors of the educational outreach they provide about it, indicating the potential value of professional development regarding food irradiation. Perhaps professional development for community nutrition educators, such as FCS county extension agents, might improve not only their beliefs about their understanding of food irradiation and its safety, but also the amount of education they provide on this food safety topic.								
Evaluati on of Risk of Bias	Classificati on by Impact Factor – 50 (IF_{2015} = 2.253)	Year of publicati on – 10	Representative ness of the sample – 100	Randomn ess of the sample – 100	Criteri a for sample inclusi on – 100	Validate d Data Collecti on Instrume nt – 100	Statistic al analyze s – 100	Resu lt (%) = 80.0	**Ris k of Bia s (R B) = L**
Author (s) and Year	**Bhumiratana et al. (2007)**								

Place and Year of Application of the Survey; Population and; Sample size (N)	Carmichael, Vacaville, Auburn, Roseville, Placerville, Sacramento, Floresta, e San Bernardino, California (United States of America), 2004; General consumers; N = 300.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; General food; Descriptive statistics.								
Main Results:	Although 49% of respondents had heard of food irradiation, most (70%) reported that they had little or no knowledge about the process. After participating in the program, over 80% of respondents agreed with the statement that irradiation is an effective method to destroy harmful bacteria in food and supported the availability of irradiated food at the supermarket. Intent to purchase irradiated meat and fruits increased significantly as a result of participating in the program. About 36% of total respondents specified that they would be willing to pay a 10% premium for irradiated meat.								
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 0.68)	Year of publication – 30	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 50.0	**Risk of Bias (RB) = M**
Author (s) and Year	**Cardello et al. (2007)**								
Place and Year of Application of the Survey; Population and;	Fort Polk, LA and Natick, MA (United States of America), year uninformed; Civilian lab employees, shoppers in a mall and, U.S. military troops on training exercises; N = 225.								

Sample size (N)	
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; General food; Conjoint analysis.
Main Results:	Irradiation presented one of the highest negative utility values for all consumer groups. "Ionizing energy", a synonym for irradiation, was viewed more favorably than the term "irradiation" among all respondent groups, although this difference only reached significance among the shopping mall respondents. For all consumer groups tested, the food processes/production methods that were perceived most negatively were genetic modification and irradiation.
Evaluation of Risk of Bias	Classification by Impact Factor – 70 (IF_{2015} = 2.997) | Year of publication – 30 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 57.1 | **Risk of Bias (RB) = M**
Author (s) and Year	**Huang et al. (2007)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Cities not specified - Georgia (United States of America), 2003; General consumers; N = 212.
Data Collection Method; Types of Questions;	Interview (telephone survey); Objective; Poultry and pork; Descriptive statistics, Probit analysis and regression analysis.

Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	Georgia consumers had a good chance of buying irradiated poultry (65%) and pork (58%) products. About 77%, considered that irradiation process is somewhat necessary and more than 55% of the respondents indicated they would support the use of food irradiation. The respondents would be willing to pay a higher price for irradiated chicken breast meat for an average of about $1.17/lb. For pork, those respondents would be willing to spend an additional $8.45 per month for irradiated pork.
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 0.94) | Year of publication – 30 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – U | Statistical analyzes – 100 | Result (%) = 58.3 | **Risk of Bias (RB) = M**
Author (s) and Year	**Mehmetoglu, A. C. (2007)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Cities not specified - Northwest of Turkey (Turkey), year uninformed; General consumers; N = 1,226.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; General food; Descriptive statistics, ANOVA and correlation analysis.

Main Results:	Almost half (47%) of the participants did not have knowledge about food irradiation. About 12% of respondents bought irradiated food and 73% did not check irradiation sign on the package and did not have conscious about whether they consumed irradiated food or not. Consumer acceptance or refusal of irradiated food certainly depends on the awareness and the knowledge of the benefits or risks of these technologies.								
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF_{2015} = 0.26)	Year of publication – 30	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusion – U	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 40.0	**Risk of Bias (RB) = H**
Author (s) and Year	**Rodriguez, L. (2007)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	Minneapolis, Minnesota (United States of America), 2000; Households; N = 223.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; Beef patties; Cronbach's Alpha and regression analysis.								
Main Results:	Those who did receive the information packet expressed acceptance of food irradiation nearly at the midpoint of the response scale. Most respondents thought they had control over whether they ate irradiated food. The respondents who received the unfavorable information packet were less favorable about food irradiation. The factor that most influenced opinion change was trust in scientists and in respected health-related organizations.								
Evaluation of Risk of Bias	Classification by Impact Factor – 10 (IF_{2015} = 0.41)	Year of publication – 30	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 48.6	**Risk of Bias (RB)**

<table>
<tr><td></td><td>= H</td></tr>
<tr><td>Author (s) and Year</td><td>Spaulding et al. (2007)</td></tr>
<tr><td>Place and Year of Application of the Survey; Population and; Sample size (N)</td><td>Central Illinois (United States of America), year uninformed; Consumers of 18-24 age for irradiated beef products in Central Illinois; N = 159.</td></tr>
<tr><td>Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis</td><td>Questionnaire; Objective; Ground beef products, poultry, vegetables and spices; Descriptive statistics, chi-square test, factor analysis, Cronbach’s Alpha reliability and logistic regression.</td></tr>
<tr><td>Main Results:</td><td>About 64.6% of participants said they had heard of food irradiation before taking the survey and 74.7% said that they would buy irradiated ground beef. Most respondents (88%) said they would be likely to purchase a food item labeled with “Treated by Irradiation” or “Treated by Cold Pasteurization”. Most of the participants reported that they would buy irradiated poultry (72.2%), vegetables (63.3%), and spices (59.5%). Only 20.3% of participants said they would pay additional cost if the shelf life of the product was extended with irradiation. Nearly 38,6% of the participants were concerned that irradiation process would make food radioactive.</td></tr>
<tr><td>Evaluation of Risk of Bias</td><td>Classification by Impact Factor – 20 (IF_{2015} = 0,95) | Year of publication – 30 | Representativeness of the sample – 0 | Randomness of the sample – 0 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 35.7 | Risk of Bias (RB) = H</td></tr>
<tr><td>Author (s) and Year</td><td>Thompson et al. (2007)</td></tr>
<tr><td>Place and Year of Application of</td><td>Texas (United States of America), year uninformed; Family and consumer sciences high school teachers; N = 121.</td></tr>
</table>

the Survey; Population and; Sample size (N)	
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire (web); Objective; General food; Exploratory factor analysis, Cronbach's Alpha, descriptive and correlation analysis.
Main Results:	About 79% of respondents indicated they had never attended a workshop or other educational training on food irradiation. The participants perceived their understanding of food irradiation to be limited. The educators' attitudes regarding the safety of food irradiation were positively correlated with their perceived understanding of food irradiation, knowledge of it, participation in previous food irradiation learning experiences, and their perceived competence to teach about it.
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2015} = 1.649) Year of publication – 30 Representativeness of the sample – 0 Randomness of the sample – 100 Criteria for sample inclusion – 100 Validated Data Collection Instrument – 100 Statistical analyzes – 100 Result (%) = 65.7 **Risk of Bias (RB) = M**
Author (s) and Year	**Flores & Hough (2008)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Nueve de Julio and Buenos Aires (Argentina), 2005; Argentine students and nonstudent adults; N = 400.
Data Collection Method;	Questionnaire; Objective; General food; Descriptive statistics and ANOVA.

Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	Only 29% of respondents had heard or read about irradiation as a method of food preservation. Not considering food science students, only 15% of respondents had read or heard about food irradiation. About 14% of respondents consider that irradiated food are radioactive and 92% of respondents answered that irradiated food should be labeled as such. Only 14% said they would buy irradiated food. The Argentine consumers' initial knowledge about food irradiation was very limited.
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 0.894) Year of publication – 30 Representativeness of the sample – 0 Randomness of the sample – 100 Criteria for sample inclusion – 100 Validated Data Collection Instrument – 0 Statistical analyzes – 100 Result (%) = 50.0 **Risk of Bias (RB) = M**

Author(s) and Year	**Behrens et al. (2009)**
Place and Year of Application of the Survey; Population and; Sample size (N)	São Paulo (Brazil), 2006; Three focus groups: Group 1: housewives, college degree, high income and most of them employed; Group 2: housewives, primary or secondary education, lower income and most of them unemployed; Group 3: male individuals, high school or college degree, income varying from medium to high and all of them employed; N = 30.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistic	Interview; Open questions; General food; Qualitative.

al Analysis	
Main Results:	Most of the participants stated that they had never heard about food irradiation. The expression food irradiation initially evoked negative feelings among housewife's in both groups, whose primary associations were with nuclear plants, Chernobyl, X-rays and cell destruction. After reading the written information and listening to the explanation about the process, most participants seemed to get a better understanding about irradiation. Participants did not observe significant differences between the irradiated food samples and their nonirradiated in sensory analysis with lettuce salad, roast chicken and mango in slices.
Evaluation of Risk of Bias	Classification by Impact Factor – 70 (IF_{2015} = 2.997) Year of publication – 50 Representativeness of the sample – 0 Randomness of the sample – 100 Criteria for sample inclusion – 100 Validated Data Collection Instrument – 0 Statistical analyzes – 0 Result (%) = 45.7 **Risk of Bias (RB) = H**
Author (s) and Year	**Byun et al. (2009)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Cities not specified (Korea), 2007; Korean housewives; N = 600.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Survey; Objective; General food; Descriptive statistics and chi-square analysis.
Main Results:	Before education about irradiated food, 37.6% of housewives never heard of irradiated food. There have been good changes in understanding about irradiated food before and after education, using different channels of information. The major changes in the intention to buy irradiated food were caused by the video information channel, followed by the book and lecture.
Evaluation of	Classification by publication – Year of publication ness of the sample – Representative ness of the sample – Randomness of the sample – Criteria for sample – Validated Data – Statistical – Result – **Risk of**

Risk of Bias	Impact Factor – 30 (IF_{2015} = 1.207)	on – 50	sample – 0	sample – 100	sample inclusion – 0	Collection Instrument – 0	analyzes – 100	(%) = 40.0	**Bias (RB) = H**
Author (s) and Year	**Sapp & Downing-Matibag (2009)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	Minneapolis, Minnesota (United States of America), 2000; Households; N = 116.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; General food; Factor analysis, Cronbach's Alpha and descriptive statistics.								
Main Results:	Initially, acceptance and trust in proponents were negative, three months later, acceptance still was unfavourable but was no longer significantly lower than the scale mid-point. Exposure to diverse perspectives forced consumers to develop a more moderate stance towards food irradiation and made them less fearful of the technology. The changes in trust and perceived risk significantly affected changes in acceptance.								
Evaluation of Risk of Bias	Classification by Impact Factor – 50 (IF_{2015} = 1.806)	Year of publication – 50	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – U	Statistical analyzes – 100	Result (%) = 66.7	**Risk of Bias (RB) = M**
Author (s) and Year	**Teisl et al. (2009)**								
Place and	Cities not specified (United States of America), 2001; General consumers; N = 4,482.								

Year of Application of the Survey; Population and; Sample size (N)	
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Telephone interview; Objective; General food; Descriptive statistics, factor analysis and logistic regression.
Main Results:	Attitudes toward irradiation are generally negative. Consumers see a positive value of irradiation in that it reduces the danger of bacterial contamination in food, but they are concerned about its effects on nutritional quality. The number of people who consider themselves informed about irradiation is still low. Food irradiation becomes more acceptable as consumers become more informed, principally because their concerns about its effects on the environment and nutrition are eased.
Evaluation of Risk of Bias	Classification by Impact Factor – 85 (IF_{2015} = 3.688) | Year of publication – 50 | Representativeness of the sample – U | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 72.5 | **Risk of Bias (RB) = L**
Author (s) and Year	**Deliza et al. (2010)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Rio de Janeiro (Brazil), year uninformed; Urban Brazilian consumers; N = 168.
Data Collecti	Interview; Objective; Papaya fruit; Choice-based conjoint analysis and regression analysis.

on Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	About 60% of participants had never heard of food irradiation. The consumers who had some knowledge about food irradiation tended to prefer higher priced nonirradiated products, but rated low priced irradiated papayas similarly to low priced nonirradiated ones. It may be possible to increase purchase probability by providing information about food irradiation. Consumer education regarding the technology is a key factor to its acceptance.
Evaluation of Risk of Bias	Classification by Impact Factor – 70 (IF_{2015} = 2.63) | Year of publication – 50 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 60.0 | **Risk of Bias (RB) = M**
Author (s) and Year	**Ibarra et al. (2010)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Mexico City (Mexico), year uninformed; Consumers who voluntarily agreed to participate; N = 44.
Data Collection Method; Types of Questions; Irradiated Food Included in the	Questionnaire; Objective; Fresh iceberg lettuce and water; Descriptive statistics and Student's t-test P value.

Survey and; Statistical Analysis	
Main Results:	Consumers demonstrated differences in willing to pay for irradiated lettuce, depending on the information given at the beginning of the questionnaire. About 51% of subjects declared they would accept paying the random price presented for an irradiated iceberg lettuce. Most respondents considered that the water quality in Mexico City is rather poor and represents health risks, this perception might have had a role in the acceptance of food irradiation as a way of preventing water-borne diseases.
Evaluation of Risk of Bias	Classification by Impact Factor – 50 (IF_{2015} = 2.076) | Year of publication – 50 | Representativeness of the sample – 0 | Randomness of the sample – U | Criteria for sample inclusion – 0 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 33.3 | **Risk of Bias (RB) = H**
Author (s) and Year	**Silva et al. (2010)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Belo Horizonte, MG (Brazil), 2006; Nutritionists who teach in higher education institutions in Belo Horizonte/MG, Brazil; N = 66.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; General food; Descriptive statistics.
Main Results:	About 12.1% of the teachers stated that irradiated food are radioactive and 71.2% are unaware of the process of food irradiation. Nearly 21.2% are unaware of the purposes of irradiation. Approximately 10.5% of respondents who initially claimed to know what irradiated food are, erroneously classified them as radioactive products, as well as 77.8% of those who reported not knowing the meaning of irradiated food. Most of teachers (98.5%) interviewed believe it is necessary to print on labels if food is irradiated

	or formulated with irradiated ingredients.								
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 0,75)	Year of publication – 50	Representativeness of the sample – 100	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 67.1	**Risk of Bias (RB) = M**
Author (s) and Year	**El-Gameel & Elkhateeb (2011)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	Al kahera Elqubra (Alkahera- aljeza- Alkaylobia) and Masr Aloulia (Almeina- Aseut- suhaj) (Egypt), year uninformed; Egyptian family; N = 1,160.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; Wheat, dried onion and garlic, dried date, dried legumes and yamish Ramadan; Descriptive statistics and regression analysis.								
Main Results:	About 68% of the total sample size accepted to buy irradiated fresh vegetables if its available in the markets. Acceptance by irradiated food is inversely proportional to the level of education of Egyptian respondents, with the increase of the level of education of the respondents, the level of rejection for irradiated food increases. Acceptance of irradiated food increased with the respondents' age.								
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2015} = 1.136)	Year of publication – 70	Representativeness of the sample – U	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 66.7	**Risk of Bias (RB) = M**
Author (s) and	**Junqueira-Gonçalves et al. (2011)**								

Year	
Place and Year of Application of the Survey; Population and; Sample size (N)	Santiago (Chile), year uninformed; Randomly selected people at supermarkets, metro stations, offices, malls and university campuses, in the city of Santiago de Chile; N = 497.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Interview; Objective; General food; Descriptive statistics.
Main Results:	About 76.5% of interviewed people did not know that irradiation could be used as a method for food preservation and they could not reply on the question whether they would or would not consume irradiated products. Approximately 45.9% expressed their belief that irradiated food means the same as radioactive food. Nearly 55.8% of the consumers affirmed, that they would not buy irradiated food and most (90.7%) claimed that they would become consumers of irradiated food if they knew that ‘‘irradiated’’ is not ‘‘radioactive’’ and that proper irradiation enhances food safety. Almost all (95.8%) were not familiar with the ‘‘Radura’’ symbol.
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2015} = 1.207) | Year of publication – 70 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 57.1 | **Risk of Bias (RB) = M**
Author (s) and Year	**Bruhn, C. M. (2014)**
Place and Year of Application of the Survey;	Los Angeles, San Francisco, Portland, and Seattle (United States of America), 2013; General consumers; N = 120.

Population and; Sample size (N)	
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire; Objective; Poultry; Descriptive statistics.
Main Results:	One-third of the preparers were aware that irradiation could be used to reduce harmful bacteria and thereby reduce the risk of foodborne illness. When favorable information was passed, almost half, 48%, said they would be interested in buying irradiated chicken.
Evaluation of Risk of Bias	Classification by Impact Factor – 20 (IF_{2015} = 0.68) | Year of publication – 85 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 57.9 | **Risk of Bias (RB) = M**
Author (s) and Year	**Lima Filho et al. (2014)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Alegre, ES (Brazil), year uninformed; Students and staff of the Centre of Agricultural Sciences of the Federal University of Espírito Santo and residents of Alegre, ES, Brazil; N = 88.
Data Collection Method; Types of Questions;	Questionnaire; Objective; Strawberries; Descriptive statistics and ANOVA.

Irradiated Food Included in the Survey and; Statistical Analysis	
Main Results:	About 52.27% of respondents say they know what food irradiation is, 28.41% say they have ever consumed irradiated food and 78.41% say they buy irradiated food. The knowledge of the interviewees regarding food irradiation was very superficial. Providing an explanatory text on the irradiation process increased the acceptance of the irradiated strawberry in a positive way. The results indicate that a lack of information by consumers regarding the irradiation process has limited their higher acceptance of irradiated food.
Evaluation of Risk of Bias	Classification by Impact Factor – 70 (IF_{2015} = 2.997) | Year of publication – 85 | Representativeness of the sample – 0 | Randomness of the sample – 100 | Criteria for sample inclusion – 100 | Validated Data Collection Instrument – 0 | Statistical analyzes – 100 | Result (%) = 65.0 | **Risk of Bias (RB) = M**
Author (s) and Year	**Lima Filho et al. (2015)**
Place and Year of Application of the Survey; Population and; Sample size (N)	Alegre/ ES (Brazil), year uninformed; Strawberry consumers who had the habit of shopping in supermarkets; N = 144.
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysi	Questionnaire; Objective; Strawberries; Ratings based conjoint analysis (RBCA), modified-choice based conjoint analysis (MCBCA) and regression analysis.

s									
Main Results:	The optimal package for irradiated strawberries carries the following information according to the RBCA and MCBCA results: "Food treated by ionization process" or "Food treated by irradiation process", "To ensure freshness and quality for a longer time" and the presence of the radura symbol.								
Evaluation of Risk of Bias	Classification by Impact Factor – 70 (IF_{2015} = 3.182)	Year of publication – 100	Representativeness of the sample – 100	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 81.4	**Risk of Bias (RB) = L**
Author (s) and Year	**Feng et al. (2016)**								
Place and Year of Application of the Survey; Population and; Sample size (N)	San Francisco and Chicago (United States of America), year uninformed; San Francisco and Chicago consumers; N = 765.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Survey (online); Objective; Ground beef and poultry; Descriptive statistics and chi-square test.								
Main Results:	About 41% of the participants said they had heard about food irradiation. When provided with the basic information about irradiation, interest in purchase increased to 55%. Only 27% of participants chose not to buy irradiated food, even if it was 10% cheaper than nonirradiated food.								
Evaluation of Risk of Bias	Classification by Impact Factor – 50 (IF_{2014} = 1.849)	Year of publication – 100	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusion – 100	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 64.3	**Risk of Bias (RB) = M**
Author	**Finten et al. (2017)**								

(s) and Year									
Place and Year of Application of the Survey; Population and; Sample size (N)	Cities not specified (Argentina), 2015; Argentine consumers; N = 384.								
Data Collection Method; Types of Questions; Irradiated Food Included in the Survey and; Statistical Analysis	Questionnaire (web-online-survey); Objective; Spinach leaves; Descriptive statistics.								
Main Results:	About 57% of respondents know that food can be irradiated for several purposes, 13% said they had consumed irradiated food and 31% of the respondents stated that they would consume irradiated food. After receiving informational material on Food Irradiation, 44% of the respondents answered that it is a safe technology for food processing. An increase in acceptance by 90% was found after providing informative material. Approximately 42% would consume/purchase ready-to-eat spinach leaves that were subjected to an irradiation treatment.								
Evaluation of Risk of Bias	Classification by Impact Factor – 30 (IF_{2015} = 1.207)	Year of publication – 100	Representativeness of the sample – 0	Randomness of the sample – 100	Criteria for sample inclusion – 0	Validated Data Collection Instrument – 0	Statistical analyzes – 100	Result (%) = 47.1	**Risk of Bias (RB) = H**

Legend: **U**: unclear; **H**: high; **M**: moderate; **L**: low.
When the frequency was higher than 70% the risk of bias (RB) was considered to be low (L), when the frequency was between 50 and 69% the RB was considered to be moderate (M), and when the frequency was lower than 50% the RB was considered to be high (H).

Discussion:

A systematic literature review technique was used to identify consumer knowledge on food irradiation and the data obtained answered the hypothesis constructed for the development of this study (the "Outcome"). The data obtained in the 66 selected studies showed that: a) must consumers are aware of the benefits of irradiated food; b) in older researches, levels of knowledge and acceptance of irradiated food tended to be lower for both developed and developing countries, but over the years a trend can be noted with developed countries tending to have higher rates

of knowledge and acceptance than developing countries; c) favorable or positive information about irradiated food positively influence consumer attitudes, while unfavorable information leads to negative consumer attitudes towards irradiated food.

However, from the methodological point of view, when the criteria for RB assessment are applied, the reproducibility of some studies may be complex. This is owing to the: absence of validated psychometric instruments, complexity of target populations, use of small sample size, lack of follow-up of behavioral variations and positive information effects as well as negative ones in the short, medium and long terms on the knowledge, and acceptance of consumers regarding irradiated food. Reproducibility is the ability of other researchers to obtain the same results when they reanalyze the same data (Kepes et al., 2014).

Attitudes are important psychological constructs because they have been found to influence and rule many behaviors. Brewer et al. (1994) proposed that six factors dominated respondents' attitudes towards the safety of their food: (1) chemical issues, as food additives and hormones; (2) health issues, such as cholesterol content; (3) spoilage issues; (4) regulatory issues; (5) deceptive practices; and (6) ideal situations, such as time required for pesticide safety assessment. Awareness, knowledge and judgment can also be affected by habits and perceptions that result from social, cultural and economic influences, philosophical perspectives, etc. (Wilcock & Ball, 2014).

As for the validation of the research instruments used, it has been observed that most of the instruments (83.3%; N = 55) applied in the researches of the selected articles did not present any description of evidence of validity for their construction, that would enhance the reliability of their research findings. Only in 6.1% (N = 4) of the total articles (Johnson, 1990; Wie et al., 1998; Thompson & Knight, 2006; Thompson et al., 2007) validated instruments were used explicitly, greatly improving the reliability of their results and conclusions.
The instrument proposed by Johnson (1990) was developed following a review of the pertinent literature and consultation with professionals knowledgeable about food irradiation (content validity). They performed a pilot study and presented the Cronbach alpha coefficients (reliability). In the instrument of Wie et al. (1998), the content validity was assessed by three faculty members knowledgeable about the topic area. A pilot test was conducted, with several questions modified in order to enhance clarity and conciseness. Cronbach's alpha test was run to examine reliability.

Thompson & Knight (2006) developed an instrument, called the Food Irradiation Educator Survey (FIES), to determine food irradiation beliefs and educational outreach of family and consumer sciences county extension agents. To define the constructs to be measured, a research review was performed and the judgment of experts was required. In order to establish content validity, three identified experts in the field of food safety and food irradiation reviewed each item for accuracy, appropriateness and adequacy. The face validity was also performed. To determine validity and reliability of the instrument, exploratory factor analysis (construct validity) and the Cronbach's alpha (reliability) test were conducted.

Thompson et al. (2007) modified the instrument already validated by Thompson & Knight (2006), the FIES. The modified instrument was called the Food Irradiation Teacher Assessment (FITA). Construct validity was determined through exploratory factor analysis. Construct validity was also established through theoretical fit. Three experts associated with the field of food irradiation and food safety reviewed all items of the FITA for content validity and three educators reviewed it for face validity. Cronbach's alpha (reliability) test was performed.

According to Messick (1989), validity is an integrated evaluative judgment of the degree to which empirical evidence and theoretical justifications support the adequacy of inferences and actions based on test results or other modes of evaluation.

According to the American Educational Research Association (2014), validity refers to the degree to which evidence and theories support interpretations of test scores for certain uses proposed for it. The validation process thus requires gathering a substantial amount of relevant evidence to provide a sound scientific basis for interpretations of the proposed scores. Then, there is a need for methodological adequacy for the construction or adaptation of psychometric instruments in order to ensure that future research uses validated instruments.

Findings from this work confirmed that positive information tends to improve the image of irradiated food while negative information tends to impair this image. At the same time, negative information becomes stored in the consumer unconscious, prevailing over positive information.

Recent research has suggested that information about the fundaments and benefits of food irradiation leads to positive changes in consumer perception and buying decision (Nayga et al., 2005). The acceptance of new technologies of food production and processing by the consumers is directly related to the credibility and trust in the sources of information. When adequately informed about the food irradiation technology, most consumers will react positively towards irradiated food (Frewer et. al., 1995 & 1996).

Thus, it is important to evaluate new strategies to be used in the dissemination of information about irradiated food. In addition, the use of the Radura symbol on the label of irradiated food is important to ensure the sense of food safety for the consumer. It is important for consumers to believe in the referendum of the regulatory bodies, since the approval of any raw material, ingredient, food additive and unitary operation, related to the processing and conservation of food passes through compliance with specific protocols that guarantee food sanitation by part of the manufacturing industry. This study showed of meeting consumer expectations and preferences during purchases and that the disclosure of the Radura symbol meaning is crucial, corroborating with studies showed that this symbol brings a sense of confidence and security to the consumer, while the simple writing that the food was irradiated can bring a sensation of insecurity to the consumer (Junqueira-Gonçalves et al., 2011; Lima Filho et al., 2015).

Studies in the United States, France, China, Brazil, Argentina, Canada, Chile, England, Thailand and Turkey have shown that the use of marketing information tools, such as videos, folders, addressing the benefits of food irradiation, such as information material from government agencies and/or consumer protection organizations, tend to boost consumer confidence, positively impacting the acceptance of irradiated food (Modanez et al, 2016).

The flow of positive and negative information directly influences the knowledge about irradiated food causing impacts on the willingness to purchase them. In addition, when informed about the benefits of irradiated food, consumers tend to accept them better, even at higher prices. In contrast, consumers in developing countries are less willing to buy irradiated food.

Pillai & Shayanfar (2017) believe that Radura's presentation would add value to irradiated food, and may be a market differential. Moreover, in the context of transparency, consumers should be provided with information about the processing type applied to food, such as food irradiation.

Although the studies were conducted with a statistically significant number of participants, only 24.2% (N = 16) of them presented representativeness of the population that they meant to analyze, considering the high diversity of the sample and its unique characteristics, which severely limit the extraction of the sample of interest. It is a matter of good sense to admit that the sample from a city within a given country significantly represents the entire population of the country under analysis. Thus, more cities should be surveyed in order to conclude that the national population is indeed represented by the people surveyed in the study, as in the study of Frenzen et al. (2001), who sampled the residents included in the Foodborne Diseases Active Surveillance Network (FoodNet), covering 11% of the US population.

While most articles analyzed (70.8%; N = 50) cannot be considered representative of the sample and some do not even have a clear methodology to define their representativeness, in 84.9% (N = 56) of the articles, sampling was proved to be clearly random. Randomness of the sample reduces the bias of responses. Regarding the criteria for including articles in this systematic review, it has been observed that most of them (87.9%; N = 58) presented well-defined criteria for inclusion and/or exclusion of the sample of interest. Others, neither presented clearly defined criteria, causing doubts to the reviewers, nor such criteria were clearly defined. Inclusion criteria of a sample should be clearly defined, so as to reduce the response bias.

Statistical inference, in its classical approach, is based on the simple random sample, a method that requires each member of the population to have an equal and independent chance of being selected (Zar, 1996). However, most surveys do not use simple random sampling, in part because of budget constraints, in part because of time limits associated with collecting a large amount of information over a large geographic territory. As a result, other probabilistic methods are generally used in population-based surveys, such as stratified sampling and multi-stage

cluster sampling with unequal probabilities of selection to ensure sample representativeness (Cochran, 1977). Therefore, by ignoring sample representativeness, traditional statistical analysis, under the assumption of simple random sampling, can produce inaccuracies for both the average estimates and the respective variances, compromising results, hypothesis tests and research findings.

With respect to data processing, it has been verified that statistical analyses provide the information needed for data interpretation, according to EFSA (2010), which recommends that findings from research works should be reported regardless of the statistical significance of their results.

Finally, the eight articles classified as low RB were published in journals with IF greater than 5.01 and only the work by Teisl et al. (2009) had an impact factor of 3,688. The Impact Factor is an indicator used by development agencies, although the use of citations metrics is questionable, because the number of journals per area of knowledge is very different from area to area, as well as self-citation, variation in the number of references per article in each area, regionalism in some areas and journals, among others (Garfield, 1994 & 1996). In addition, it is known that IF alone does not qualify the study from the scientific point of view.

In the 34 years since first article on 1983 was published, the average number of publications corresponds to approximately one per year, but it is worth mentioning that there was a time gap of 6 years with no publications (1984, 1985, 1991, 1994, 2012 and 2013). The year of publication is another parameter to be considered, because the most recent articles describe more detailed timelines of information as consumer knowledge is linked to time. Thus, the more recent an article is, the greater the timeliness of the information provided will be. It is likely that this scenario reveals that the topic "food irradiation" is not on the agenda of most researchers, even researchers in related fields, or that "irradiated food" is a subject treated with some restrictions the repercussion and misconceptions conveyed both in academia and in the media.

The major findings from the present systematic review support the claim that developed countries are more acquainted with the topic “food irradiation” and consequently tend to consume more irradiated food. The degree of awareness concerning the benefits of food irradiation in the USA is, in general, fairly good among the American population. In Asia, knowledge about irradiated food tends to be better than in other countries, especially in Japan, due to the socio-cultural scars that the atomic bombs of Hiroshima and Nagasaki left on the population in August 1945. In contrast to the findings for US and Asia, the results found in Brazil, in Latin America and the Turkish were indicative of the low level of information disseminate and poor knowledge a regarding irradiated food.

Conclusion:-

A systematic review is a viable tool to assess consumer knowledge and this one is focused on how potential consumers view irradiated food. Most consumers are unaware of the benefits of irradiated food and developed countries tend to exhibit higher levels of knowledge on food irradiation and acceptance of irradiated food than developing countries. Researches have showed that educational actions favorable to irradiated food positively influence consumer attitudes, while unfavorable information leads to negative responses towards them, including rejection. In the last years, developed countries, such as the United States, tend to have a better willingness to buy irradiated food, while developing countries show greater resistance.

The importance of the use of validated psychometric instruments for data collection is emphasized and new research on consumer knowledge on irradiated food in developed, underdeveloped and developing countries is suggested as a research agenda, in order to evaluate the feasibility of educational campaigns and encourage the consumption of irradiated food. The impact of educational programs was seen as being of fundamental importance for the acceptance and breaking of paradigms on irradiated food. New trends in the field of education and distribution of irradiated food to consumers should be thought of as a way of encouraging a new view of consumer acceptance and empowerment in market relations.

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