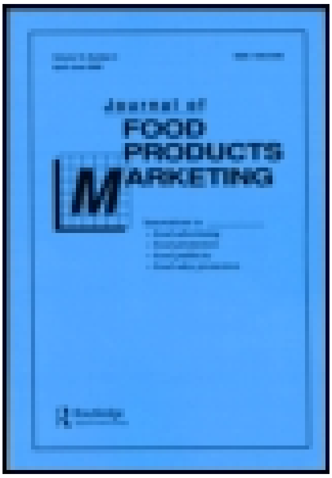

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Influence of Information on the Acceptance and Purchase Intention of an Irradiated Food: A Study With Brazilian Consumers

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Influence of Information on the Acceptance and Purchase Intention of an Irradiated Food: A Study With Brazilian Consumers

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*This study investigated the effect of information on the acceptability and purchase intention of an irradiated watercress salad and its non-irradiated counterpart among Brazilian consumers (*N = 236*). Both the irradiated and the non-irradiated products were fairly accepted (ratings about 6.0–7.0 in the hedonic scale). Significant effects (*$p \leq 0.05$*) of gender, education, and age were also observed: acceptance and purchase intention was lower among male participants who received both information and an identified irradiated product, and higher among female participants who received only information about the process. Adults (30–39 years old) were more critical, and the higher the educational level, the lower the acceptability and purchase intention ratings. Brazil is one of the major irradiators in the world, but there is still a lack of consumer studies focusing the acceptability*

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of irradiated foods. So the findings presented herein would favor Brazilian producers and regulators to develop effective communication strategies and to promote the irradiation technology.

KEYWORDS *consumer behavior, food irradiation, sensory evaluation, purchase intention, watercress*

INTRODUCTION

The use of ionizing radiation in food processing has been extensively utilized in several countries for the purpose of assuring food safety and extension of shelf life of food products (Sommers, 2004).

Food irradiation is still an emerging technology, and accurate data about the annual world production of irradiated foods is hardly found in the literature. The article by Kume and colleagues (2009) is unique to present information about the amount of irradiated foods produced in several countries, including Brazil. Data from 2005 indicate that Brazil irradiated about 23,000 ton of foods that year, making the country one of the major irradiators in the world, following China (146,000 tons), the United States (92,000 tons), and Israel (70,000 tons). Spices and dried vegetables (87%) as well as fruits (13%) have been the most irradiated foodstuffs in Brazil (Kume et al., 2009; Farkas & Mohácsi-Farkas, 2011), and most of them are used as ingredients for food industries or are exported. For more complex and processed products (e.g., frozen foods, meat cuts, seafood) the technology remains underutilized, despite the approval by the Brazilian Health Authority since 1973 (Brasil, 2001).

Public perception of food irradiation is a relatively recent research topic in Brazil. Surveys conducted with local consumers have pointed out fear and suspicion as the main barriers to consumption, and purchase of whole irradiated foods if they were launched in the local market (Oliveira & Sabato, 2004; Ornellas, Gonçalves, Silva, & Martins, 2006). Indeed, the use of radiation to process food is still considered risky even in markets where irradiated foods have already been launched, although the conclusions of several consumer studies state that consumers tend to develop a positive attitude to irradiation when they perceive the benefits of this technology (Bruhn & Noell, 1987; Resurréccion et al., 1995; Frewer et al., 1998; Gunes & Tekin, 2006).

According to the International Atomic Energy Agency (IAEA), early research has indicated that food irradiation is unfamiliar to most consumers, and a firsthand conclusion is, without previous information, fear of the effects of radioactivity is by far the most frequent concern among consumers (Gunes & Tekin, 2006; Behrens et al., 2009).

Food irradiation is usually viewed as a high-risk technology, and consumers' initial concerns are usually expressed through metaphors related to nuclear power's lethal effects, especially with view to nuclear disasters and weapons (Bruhn & Noell, 1987; Oliveira & Sabato, 2004; Behrens et al., 2009). Indeed, nonconventional technologies, despite differences in nature and concepts, may provoke fear and feelings of uncertainty, besides increased suspicion among consumers. Some authors argue that such effects may be caused by the lay public's inability to understand the scientific knowledge and its implications in everyday life (Turney, 1996; Bäckström et al., 2003; Deliza et al., 2003; Barcellos et al., 2009; Barcellos et al., 2010).

Although the sensory experience is by far the most important dimension driving consumers' food choices, other non-sensory factors can affect consumer perception, attitude, and behavior to food (Prescott, 2012). In this sense, information (e.g., nutrition, health claims, technological benefits) have an undoubted impact on food decisions because it may create a positive expectation that modifies consumer perception and that can enhance purchase intent. During the decision-making process, previous experience and all the information available are processed in the consumer's mind, and the higher the expectation level, the more likely is the purchase. Conversely, low expectation leads to lower chances of purchase (Deliza & MacFie, 1996; Behrens et al., 2007).

For policy makers and marketers, it is important to know the public perception of a technology used in food processing, as well as factors that can potentially enhance attitude and purchase intent, such as the level of public trust in the actors directly involved in the food chain—that is, food industries, retailers, regulators, and scientists (Frewer et al., 1998; Poortinga & Pidgeon, 2005). Trust is the minimum requirement for the development of consumer confidence than can decrease the perception of risk (e.g., financial, physical, social) or the individual's expectation that a food product will not cause any harm to his or her health or to the environment.

According to Siegrist and colleagues (2000), science and technology are areas where many consumers lack sufficient scientific literacy to make personal decisions, and, in such context, they tend to rely on organizations or public authorities they judge trustworthy to give them information they need to make choices. This leads to the concept of social trust or the people's willingness to rely on those who are in charge of making decisions and taking actions related to science and technology, such as the public health authorities and academics. So when sound, reliable, and relevant information (either in written form or as audiovisuals) endorsed by health and science authorities is given, it may be positively assimilated by the audience increasing the acceptance and purchase intention of a product (Bruhn & Noell, 1987; Pohlman et al., 1994; Turney, 1996; Cardello, 2003).

Based on the exposed assumptions, the objective of this study was to investigate the effect of information on the acceptance and purchase intention of minimally processed and irradiated watercress salad, a vegetable widely consumed in fresh salads in Brazil. Minimally processed (MP) fruits and vegetables is a growing food market segment in Brazil reflecting the consumer search for convenience (e.g., ready-to-eat foods) and healthier food habits. A recent report indicates that fruits represent, on average, 7.4%, while vegetables (e.g., legumes and greens) represent 8.8% of the food expenditures in Brazilian households (Federação das Indústrias do Estado de São Paulo, 2010). Moreover, MP fruits and vegetables are particularly suitable for irradiation for both quality and safety purposes (International Atomic Energy Agency, 1999; Martins et al., 2007).

METHODS

Participants

This research was conducted in the city of São Paulo, the most important Brazilian market, which reflects urban consumption patterns within Brazil, quite similar to other large metropolitan areas in the world.

Consumers were approached and recruited in the São Paulo's downtown area, where people of diverse social classes and backgrounds are easily found. The participants were selected taking into account their willingness to participate, health conditions, and liking and regular consumption for watercress. Altogether, 236 subjects participated in the study; Table 1 shows their profiles according to the socioeconomic classification criteria of the Brazilian Association of the Research Companies (Associação Brasileira das Empresas de Pesquisa, 2011).

Samples

Minimally processed watercress (*Nasturtium officinale*) samples were acquired in a processing plant located in São Roque, Brazil, on the day of processing. The vegetables were submitted to minimal processing—within 24 hours of harvesting—that consisted of selection, cutting, washing, and sanitization with 0.08 ppm of ozone and portioning in 1-kg polyethylene

TABLE 1 Profile of the Participants in the Study ($n = 236$)

Gender (%)		Age		Socioeconomic status[a]		Educational level[b]	
Male	48.7%	18–29	37.3%	class A	11.0%	low	17.4%
Female		30–39	26.7%	class B	35.6%	intermediate	61.4%
	51.3%	40–49	21.6%	class C	53.4%	high	21.2%
		50–60	14.4%				

[a]Class A: > 15 minimum wage; class B: 5–16 minimum wage; class C: < 6 minimum wage, according to demographic criteria of the Brazilian Association of Research Companies.

[b]Low: elementary school or equivalent; intermediate: high school or equivalent; high: academic or equivalent.

bags. These samples were kept at (7 ± 1)°C in a refrigerator before and after irradiation.

Irradiation Process

Samples were irradiated using a gamma radiation ^{60}Co source with 92 kCi (dose rate: 2.0 kGy/h) located at Instituto de Pesquisas Energéticas e Nucleares (IPEN), in Sao Paulo, SP. The irradiation dose was set in 2.0 kGy and determined in a previous work (Martins et al., 2007.) The dosimetric system used was the Harwell Amber (United Kingdom), with accuracy of ±5 % and precision of ±2 %.

Information About Food Irradiation

Information about food irradiation was framed in the form of a leaflet similar to those distributed to consumers in supermarkets and food outlets. Most of the pieces of information were extracted from a brochure edited by the International Atomic Energy Agency (1999). Information about the price (a plus of R$0.50/kg of vegetables and R$1.00/kg of meats) was estimated with the help of a Brazilian irradiation factory (Embrarad, São Paulo, Brazil).

Only positive information composed the leaflet, and the major interest in this communication strategy was to observe how consumers would react to an advertisement presenting irradiation as an innovative and beneficial food processing technology. A previous qualitative study with Brazilian consumers had already revealed that consumers recognize the high reputation of international organizations such as the IAEA, FAO, WHO, and especially the Brazilian National Agency of Sanitary Surveillance (Anvisa) as sources of information about food safety and related issues (Behrens et al., 2009). Similar conclusions about the positive effect of information on the benefits of irradiation were reported in consumer studies in the United States, Europe, and Turkey (Bruhm & Noell, 1987; Frewer et al., 1998; Fox et al., 2002; Gunes & Tekin, 2006).

Table 2 presents the information that composed the leaflet given to the participants in the affective test.

Research Design

Consumers performed the assessments in a room fully equipped for affective tests located in a building close to the recruiting point.

Four different experimental conditions were designed to assess the effect of information on the acceptance and purchase intention of irradiated watercress: (1) presence of information with sample's labeling (irradiated and non-irradiated), (2) presence of information without sample's labeling,

TABLE 2 Information About the Irradiation Technology Given to the Participants in the Affective Test

What is the irradiation process?

"The irradiation process consists of the exposition of food to controlled doses of ionizing radiation. Ionizing radiation is energy similar to that of radio and TV waves, microwaves and sun radiation. During the process, there is no direct contact between the food and the source of radiation: the energy waves pass through the food and reduce the number of microorganisms, such as bacteria and fungi, responsible for deteriorating food or causing illness in humans. Irradiation also delays the ripening of fruits and vegetables since it inhibits cell division and also the reproduction of insects."

How does the process of irradiation work?

"The food, already in package, is placed in the machine where it will be irradiated. The food is then exposed to a source of radiant energy such as cobalt or electron beam. The amount of energy applied depends on the type of food. The waves of energy or electrons pass through the food and finding microorganisms or larvae or eggs of insects, cause the death of the microorganisms or failure of reproduction in the insects. The food remains unchanged, but free of bacteria such as *Salmonella*, among others. Furthermore, shelf life can be improved with the decrease of the number of microorganisms."

Does irradiation process change the quality of nutrition?

"The nutritional changes caused by irradiation are similar to those that occur in other types of processing such as cooking, pasteurization, and canning. The appearance of irradiated food is the same as before being exposed to irradiation."

How do I know that food has been irradiated?

"The World Health Organization (WHO) recommends that irradiated foods must be labelled with the words "treated by irradiation" or that the packages bear the international symbol for irradiation known as 'radura.'"

Will the irradiated food cost more?

"Like any other food production process, irradiation implies an additional cost to the product. According to researches carried out at the University of Sao Paulo and Instituto de Pesquisas Energéticas e Nucleares, the estimated increase in the cost of vegetables will be around R$ 0.50/kg and of meat and fish, from R$ 0.60 to R$ 1.00/kg. This is not a large increase if we consider the improvement of food safety and shelf life."

Is irradiation safe?

"YES. In fact, the exposure of the food to the radiation is similar to the luggage going through the x-rays in an airport. Food will not become radioactive after being submitted to the irradiation process. As a consequence of the process the so-called radiolytic compounds are formed in small quantities, not harmful to the human health. Such compounds allow the identification of irradiated food when needed. Besides, foods may not be subjected to high radiation doses because they lose sensory acceptability. The commercialization of irradiated food is allowed in almost 40 countries and the technology is approved by FAO/Word Health Organization. In Brazil ANVISA regulates the use of radiation in food processing. For more than 40 years the safety of the irradiated food designed for human consumption has been investigated by scientists in many countries and the conclusion is that irradiation is a safe technology."

Are the irradiation plants safe for employees and neighboring communities?

"The radiators are projected with several levels of protection for human beings in order to detect any problem that occurs during the work process. For this reason, employees and neighbors are protected from accidental exposure to radiation. Irradiation plants in Brazil are checked periodically by the *Comissão Nacional de Energia Nuclear* (CNEN) that reports to IAEA, an organ directly related to the United Nations."

TABLE 3 Experimental Conditions Used to Assess the Effect of Information on the Acceptability on the Purchase Intention of Minimally Processed and Irradiated Watercress

	Experimental condition			
	I ($n = 59$)	II ($n = 58$)	III ($n = 59$)	IV ($n = 60$)
Information	yes	yes	no	no
Labeled samples	yes	no	yes	no

(n = Number of Consumers in Each Condition).

(3) absence of information with sample's labelling (irradiated and non-irradiated), and (4) absence of information and labeling (a completely blind condition). Table 3 summarizes the experimental design.

Subjects were randomly assigned to each of the four experimental conditions. They were first asked to read the leaflet, and then the watercress samples (10 g each) were monadically served for evaluation on disposable white plates coded with a 3-digit number. Forks, salt, and water were also available to the participants. In each group, a balanced complete block design was used to control the serving orders and to avoid bias on the responses.

Overall liking was measured on a 10-cm hybrid hedonic scale (0 = *dislike extremely*; 5 = *neither like, nor dislike*; 10 = *like extremely*; Villanueva et al., 2005), and the intention to purchase was measured on an 11-point scale (0 = *I certainly would not buy*; 5 = *maybe I would buy*, maybe not; 10 = *I certainly would buy*).

Statistical Analyses

Paired *t*-tests were used to analyze differences between sample means (irradiated versus non-irradiated), and medians and quartiles were calculated to explore data in each experimental condition. Additional analyses of variance (factors age, gender, and educational background) were calculated to find out significant effects on the irradiated sample liking and purchase intention. The statistical package Statistica was used in the calculations (Statistica, 2008).

RESULTS

Participants in the study (Table 1) fairly represented the majority of São Paulo's population—that is to say, young people (both male and female) from the middle class and with an intermediate educational level.

Table 4 presents the statistics (means, standard deviations, medians, p values for the t tests, and quartiles) related to the overall liking of the watercress samples evaluated in the four experimental conditions (Table 3). For each sample, in all conditions, the mean rating was about 6.0 and 7.0 ($p > 0.05$) in the hedonic scale, which evidences that, in general, should any sensory difference between the samples exist, it might have not been large enough to affect the irradiated sample's acceptance negatively.

On the other hand, medians did not coincide with the group means, suggesting some degree of asymmetry in data.

Group 1 comprised consumers who received information about irradiation and the identified irradiated sample. Examining the medians and the lower and upper quartiles in Table 4, the irradiated watercress presented slightly higher acceptance than its non-irradiated counterpart. This suggests that the information about the technology might have been assimilated by at least part of these consumers, resulting in increased acceptability of the irradiated product.

Consumers in group 2 also received the leaflet explaining irradiation, though the irradiated sample was not identified. In this context, the non-irradiated watercress showed higher medians than the irradiated sample. A similar trend can be observed with respect to group 3, which did not receive the leaflet but the identified irradiated sample. Perhaps these results were due to a negative assimilation of the claim "irradiated" in the absence of information.

Finally, results of group 4 can be interpreted as a baseline, since samples were evaluated in a completely blind condition and both were fairly accepted.

The results indicate that any minimal sensory change (e.g. flavor, texture) in the irradiated sample might have been minimized due to assimilation of the positive information. On the other hand, negative assimilation might have come up in conditions 2 and 3, where information was incomplete (no sample identification) or absent (only the identified sample.

Mean ratings for purchase intention are also presented in Table 4, and they were all above 5 (*maybe I would buy, maybe not*) in the purchase intention scale, evidencing that both samples would likely be purchased. However, no significant differences ($p > 0.05$) were found.

Noteworthy are the results of group 3, where the irradiated watercress showed lower likelihood of purchase (5.4) compared to the non-irradiated sample (6.3). Such a difference can be interpreted as tending to the significance, since $p = 0.1094$ (close to 10%). This finding reinforces the negative effect of the claim "irradiated" without proper information about the technology.

In order to gain a better understanding of the information effects, Table 5 presents the univariate tests of significance for acceptability and purchase intention considering gender, educational level, and age as additional factors in the ANOVA model. Income was not considered in the analyses since it was significantly correlated ($r = 0.229$, $p = 0.001$) to educational

TABLE 4 Overall Liking Mean Ratings* and Medians (Non-Irradiated/Irradiated 2kGy) Displayed by Information and Identification Conditions

Acceptability										
		Mean ratings (*SD*)			Medians		Lower quartile		Upper quartile	
Conditions	*N*	Nonirradiated	Irradiated 2kGy	*T* value (*p*)	Nonirradiated	Irradiated 2kGy	Nonirradiated	Irradiated 2kGy	Nonirradiated	Irradiated 2kGy
Group 1	59	6.1 (2.65)	6.2 (2.69)	−0.1533 (0.8787)	6.3	7.0	4.0	4.6	8.0	8.0
Group 2	58	6.9 (3.19)	6.4 (3.21)	1.7168 (0.0914)	8.0	7.0	5.9	4.0	9.7	9.0
Group 3	59	6.7 (2.86)	6.2 (2.84)	1.2721 (0.2084)	7.0	6.0	5.0	4.0	9.0	9.0
Group 4	60	6.7 (2.86)	6.7 (2.78)	0.1702 (0.8654)	8.0	7.0	5.0	5.0	9.0	9.0

Purchase Intention										
		Mean ratings (Std. deviation)			Medians		Lower quartile		Upper quartile	
Conditions	*N*	Nonirradiated	Irradiated 2kGy	*T* value (*p*)	Nonirradiated	Irradiated 2kGy	Nonirradiated	Irradiated 2kGy	Nonirradiated	Irradiated 2kGy
Group 1	59	6.1 (2.71)	6.4 (2.69)	−0.9054 (0.3690)	6.0	6.0	5.0	5.0	8.0	9.0
Group 2	58	6.4 (3.48)	6.0 (3.61)	1.0090 (0.3173)	7.0	7.0	5.0	3.0	10.0	9.0
Group 3	59	6.3 (3.30)	5.4 (3.57)	1.6259 (0.1094)	7.0	5.0	5.0	2.0	10.0	9.0
Group 4	60	6.5 (3.26)	6.6 (3.03)	−0.2832 (0.7780)	7.0	7.0	4.5	5.0	9.5	10.0

*Scores on a 11-point purchase intention scale (0 = *I certainly would not buy*; 5 = *maybe I would buy, maybe not*; 10 = *I certainly would buy*).

TABLE 5 Effects of Gender, Age, and Education in Acceptability and Purchase Intention Considering the Four Experimental Conditions

		Acceptability Analysis of Variance					Purchase Intention Analysis of Variance				
Experimental Conditions	Factors	Sum of Squares	Degrees of freedom	Mean Square	F	Significance level (P)	Sum of Squares	Degrees of freedom	Mean Square	F	Significance level (P)
1	Gender	25.041	1	25.041	3.6936	0.057186*	30.317	1	30.317	4.4569	0.037005*
	Age	51.312	2	25.656	3.7842	0.025712**	12.760	2	6.380	0.9378	0.394550
	Education level	3.855	2	1.928	0.2843	0.753081	40.798	2	20.399	2.9988	0.053902*
	Sample	0.098	1	0.098	0.0144	0.904536	3.059	1	3.059	0.4497	0.503848
	Error	752.546	111	6.780			755.02	111	6.802		
2	Gender	46.192	1	46.192	5.3015	0.023206**	48.507	1	48.507	4.4020	0.038207**
	Age	148.884	2	74.442	8.5437	0.000357**	150.49	2	75.425	6.8449	0.001584**
	Education level	29.774	2	14.887	1.7086	0.185938	38.280	2	19.140	1.7369	0.180895
	Sample	8.663	1	8.663	0.9942	0.320918	4.966	1	4.966	0.4506	0.503459
	Error	949.727	109	8.713			1201.1	109	11.019		
3	Gender	7.954	1	7.954	0.9508	0.331645	7.556	1	7.556	0.6295	0.429238
	Age	0.031	2	0.016	0.0019	0.998148	16.314	2	8.157	0.6795	0.508965
	Education level	2.141	2	1.070	0.1280	0.880026	21.242	2	10.621	0.8848	0.415708
	Sample	8.841	1	8.841	1.0568	0.306186	21.186	1	21.186	1.7649	0.186735
	Error	928.670	111	8.366			1332.4	111	12.004		
4	Gender	3.054	1	3.054	0.3719	0.543214	0.249	1	0.249	0.0244	0.876067
	Age	3.097	2	1.548	0.1885	0.828429	2.760	2	1.280	0.1256	0.882078
	Education level	5.736	2	2.868	0.3492	0.706016	11.816	2	5.908	0.5797	0.561723
	Sample	0.140	1	0.140	0.0171	0.896324	0.533	1	0.533	0.0523	0.819469
	Error	928.059	113	8.213			1151.7	113	10.192		

*Significant at $p < 0.10$ **Significant at $p < 0.05$.

TABLE 6 Descriptive Statistics for Acceptability and Purchase Intention of Irradiated Watercress in Groups 1 and 2 Separated by Gender, Age, and Educational Level

Experimental condition #1: information, identified simple			
Factor	Levels	Acceptance	Purchase intention
Gender	Female	6.4 ±3 .1	6.7 ± 2.7
	Male	5.9 ± 2.2	5.8 ± 2.6
Age	18–29	6.4 ± 2.5	6.6 ± 2.5
	30–39	5.2 ± 2.9	5.8 ± 2.9
	40–60	6.7 ± 2.5	6.2 ± 2.5
Educational level	Low	6.6 ± 2.5	7.3 ± 2.5
	Medium	6.2 ± 2.6	6.3 ± 2.6
	High	5.5 ± 2.9	5.3 ± 2.9
Experimental condition #2: information, no identified simple			
Factor	Levels	Acceptance	Purchase intention
Gender	Female	6.4 ± 3.5	5.9 ± 3.9
	Male	7.1 ± 2.6	6.6 ± 3.1
Age	18–29	7.0 ± 3.1	6.5 ± 3.1
	30–39	4.8 ± 3.4	4.3 ± 3.4
	40–60	7.8 ± 2.6	7.3 ± 3.1
Educational level	Low	7.5 ± 2.9	7.1 ± 3.5
	Medium	6.3 ± 3.4	5.8 ± 3.7
	High	6.3 ± 3.1	5.6 ± 3.2

level. Moreover, previous research has demonstrated that, regarding the acceptance of novel technologies, the education background, rather than income, plays a major role (Frewer et al., 1998; Fox et al., 2002; Nayga et al., 2005; Teisl et al., 2009).

Results indicated some significant effects ($p < 0.05$ or $p < 0.10$) on data from groups 1 and 2, while no significant effects ($p > 0.05$) were observed regarding groups 3 and 4.

Table 6 presents the acceptance and purchase intention means considering the three factors. It can be noticed that male subjects, as well as young (18–29 year old) and middle-aged (40–60 year old) adults, in general, reacted to the information differently than women and adults (30–39 year old). In group 1, men tended to be more critical than women with respect to the acceptance and likelihood to purchase the irradiated salad. Nonetheless, such an effect is not clear, because men under condition 2 accepted and showed intention to buy the irradiated product to a higher (and significant) extent. In spite of not being a significant effect, the lower the education level, the higher the acceptability and purchase intent.

DISCUSSION

Information presented to the participants in the present study focused only on the benefits of irradiation to the safety of food products and the approval and support of the Brazilian health authority (Anvisa), FAO, WHO, and IAEA to the technology. Therefore, it was essentially positive and seemed to affect consumers' attitude to the irradiated product in different ways.

There is substantial support in the literature about the effect of positive information about food irradiation. Positive information acts to reduce anxiety and minimize risk perception associated with the use of radioactivity in the process, making consumers see the technology more favorably (Resurrección et al., 1995; Fox et al., 2002; Lusk et al., 1999; Zienkewicz & Penner, 2004; Nayga et al., 2005).

Gender can play a significant role on the effect of expectation on food acceptance (Lappalainen et al., 1998; Verbeke, 2005). While women generally tend to be more reflective about food and health issues and more concerned about eating healthily, men demonstrate an uncritical and traditional view on eating, considering taste more important in their food choices (Verbeke, 2005). In another Brazilian study, when consumers talked about irradiation in focus group interviews, men's concerns were mostly about the collateral effects of the process on food quality and prolonged consumption, while women questioned nutrition losses and showed higher perception of risk regarding the use of radioactivity in food processing (Behrens et al., 2009). In this sense, information about irradiation technology may probably provoke different reactions among male and female consumers.

Young (18–29 years old) and middle-aged (40–60 years old) participants seemed to be more receptive to the irradiated food than adults between 30–39 years old. Morris and Venkatesh (2000) argued that young people tend to accept and adopt technology more easily as a consequence of openness to new experiences and learning, while adults over 30—especially those with a higher educational background—tend to be more critical, especially when they perceive a possible industry's vested interest in the use of the technology—for instance, to "make spoiled food sound food" (Behrens et al., 2009).

Barcellos and co-workers (2009) found that Brazilian consumers are more prone to innovation in technology and less open to trying new foods—possibly to neophobia (Prescott, 2012). The authors also argued that being less phobic toward technology could be attributed to personal traits common to youngsters—that is to say, peer pressure or the tendency to "follow the trend" and "keep abreast of their peers" (Mowen & Minor, 2001; Barcellos et al., 2009) This research did not consider other factors that may affect decisions and purchasing behavior, such as the level of involvement in the purchase and relevance of information for decision making (Mowen & Minor, 2001).

Consumer involvement in food purchase is usually low, unless there is some level of concern with health and safety issues or even the influence of others (e.g., family members; Turney, 1996; Frewer et al., 1998; Eiser et al., 2002). In this sense, health and nutrition claims may have little influence on consumer choice—particularly information conveyed by the label.

A recent survey ($N = 900$ consumers) in the largest Brazilian urban areas revealed consumers' inattention to label claims including food products. Female and elderly people (>55 years old) are more aware of health claims, but only 35% make their food choices based on health claims (Instituto Brasileiro de Defesa do Consumidor, 2013). This research also revealed that Brazilian consumers tend to be critical (35%) or suspicious (55%) of label claims, despite believing in certifications by international organizations (53%) and specialists (38%). For these reasons, even though labels are means of communication between companies and consumers (Eden, 2011), they are less effective (in the sense of persuasive) than advertising on the Internet, television, and so forth.

Another important issue in consumer food choices is how they make sense of novel technologies (Deliza et al., 2003) and if they are prepared to understand science and innovation (Barcellos et al., 2010). Concerning the use of radiation food processing, ambivalent feelings usually come up among consumers, but as long as they perceive the relevance of such an energy source, for instance, to improve sensory quality or safety and how it can be used in non-defense activities (e.g., agriculture, medicine), a positive attitude is developed (Noell & Bruhm, 1987; Nayga et al., 2005).

In Brazil, in spite of the existence of a national nuclear program and research centers working on the development of non-defense radiation technology, the public debate about the matter is still incipient. Indeed, non-defense uses of nuclear energy are practically unknown among Brazilians, and this may justify a lack of relevance of this issue by the general public (Brasil, 2001; Almeida, 2011).

To illustrate the incipiency of the nuclear energy debate in Brazil, a survey conducted with more than 2,000 respondents showed that the development of the national nuclear program for the coming years is relevant for only 11% of the public (Brasil, 2006). A more recent study in Rio de Janeiro revealed that most people recognize the benefits of the traditional uses of nuclear technology in medicine and energy production, although there is a great and generalized concern about nuclear waste and the safety of the nuclear plants (Almeida, 2011). These findings reinforce the need for an ample public debate about the potential usages of nuclear energy. Otherwise, food irradiation will remain unknown or irrelevant to the vast majority of Brazilians.

CONCLUSIONS

Despite its exploratory nature, this research showed that positive information about irradiation can be assimilated to increase the acceptability and purchase intention of an irradiated food product.

In general, the acceptability of the irradiated watercress salad did not differ significantly ($p > 0.05$) from its non-irradiated counterpart. In this sense, the radiation dose did not produce sensory differences to such a degree that it affected liking negatively.

A more accurate statistical analysis revealed that gender, age, and education had significant effects ($p < 0.05$) on the attitude and purchase intention, although such effects could not be generalized to the entire experiment. As a first conclusion, future research should be focused on consumer segments with different socioeconomic and demographic backgrounds searching for different opinions and behaviors. Moreover, the effect of negative disconfirmation—when there is a mismatch between high expectation and low sensory quality—should be investigated in order to understand how far information on irradiation can influence acceptability and purchase intention.

Further research should also focus on the effect of negative information about irradiation as well as the combined effect of positive and negative sources. Fox and colleagues (2002) pointed out that negative information prevails against positive facts about irradiation when consumers are provided with both types of information (e.g., detractors fighting against the technology). As the use of ionizing radiation involves great perception of risk, food irradiation causes suspicion and fear, and many studies have pointed out the positive effect of informing consumers about the benefits of the new technology—namely, safety and shelf life improvements. On the other hand, consumer advocacy and environmental activists advocate against irradiation using varied arguments, from risks to the environment and public health to vested interests of industries and retailers. The combined effects of the positive and negative information and how they affect consumer willingness to buy irradiated foods (and other emerging food technologies) remain under-researched, especially in emerging countries such as Brazil. Moreover, Brazilians' level of confidence in both national and international regulatory agencies such as Anvisa (the Brazilian health authority), CNEN (Brazilian Nuclear Energy Commission), WHO, and IAEA should also be investigated more in-depth.

In conclusion, Brazil is a transitional and unequal economy that requires timely knowledge about Brazilian consumers' food choices that have been changing over the last years. Moreover, the potential of the Brazilian market for emerging food production and processing technologies poses additional marketing questions such as understanding regional preferences and attitudes. Such knowledge will provide regulators, policy makers, producers, and consumer groups with more accurate information directed to educational and promoting campaigns about nonconventional technologies in food production.

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