Consumers' willingness to pay for electronically pasteurized fresh produce in Mexico and water quality perception [§]

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Disposición a pagar de los consumidores mexicanos por productos frescos pasteurizados por irradiación y estimación de su percepción hacia la calidad del agua

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Síntesis

Una baja calidad del agua de riego es causa de enfermedades gastrointestinales para los consumidores urbanos de hortalizas en muchas naciones en desarrollo. La irradiación de alimentos es un enfoque alternativo para pasteurizarlos, pero su aplicación depende en gran medida la aceptación del consumidor.

En México no se aplica la técnica de irradiación para los alimentos, por lo que este proyecto tuvo como objetivo llevar a cabo un estudio piloto para conocer por vez primera la aceptación de consumidores mexicanos a esta técnica, así como para estimar su percepción hacia aspectos ambientales (calidad del agua). Para ello se llevó a cabo un experimento de campo en supermercados de la Ciudad de México elegidos al azar. Se aplicaron cuatro tratamientos en encuestas a consumidores elegidos aleatoriamente a la entrada de la tienda. En el primer tratamiento se proporcionó información sobre calidad del agua de riego y sobre el procesos de la irradiación de alimentos, previo a las preguntas de disposición a pagar y de percepción. En el segundo tratamiento sólo se dio información sobre irradiación, en el tercero sólo sobre calidad del agua y en el tratamiento control no se dio información previa alguna.

Se muestra que la mayoría de los encuestados considera la calidad del agua de la Ciudad de México es baja y representa problemas potenciales de salud. También consideran que la información sobre los alimentos y sobre los aspectos ambientales es muy importante y tienen más confianza en los empaques que portan etiquetas que informan sobre estos aspectos. La información que reciben los consumidores sobre la calidad del agua fue determinante para aceptar a la irradiación como una forma de pasteurizar lechugas romanas frescas. Específicamente, el 73% de los sujetos considera que el agua del grifo no es potable y el 51% reconoció que la calidad del agua representaría un peligro para la salud. Los consumidores demostraron que su disposición a pagar por una lechuga romana fresca pasteurizada por irradiación sería diferenciada según la información dada al principio del cuestionario. Así, el 80% de los consumidores que recibieron información completa, pagarían por la lechuga irradiada, el 50% de quienes recibieron sólo información sobre la calidad del agua para riego pagarían, el 44% de quienes recibieron la información sobre irradiación pagaría y finalmente, sólo el 30% de quienes no recibieron información alguna pagaría por ello.

En general, los alimentos irradiados son potencialmente aceptados en los países en desarrollo con problemas de calidad del agua posiblemente debido a una

percepción de que esa nueva tecnología puede disminuir riesgos por la baja calidad del agua y, debido a que se percibiría como una forma de mejora económica. Por lo tanto, la calidad del agua es una preocupación más apremiante para los consumidores que los efectos secundarios potenciales de la irradiación de alimentos. Además, la concientización y la información que posean los consumidores serán fundamentales para sus decisiones de compra.

Es importante señalar que el tamaño de muestra de este estudio piloto (39 respuestas útiles) no permite la generalización para los consumidores mexicanos, por lo que nuestros resultados deben ser tomados con reserva; sin embargo es la primera aproximación al tema en México.

Palabras clave: percepción de la calidad del agua; aceptación de los alimentos irradiados, consumidores mexicanos; estudio piloto.

Consumers' willingness to pay for electronically pasteurized fresh produce in Mexico and water quality perception

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Summary
Poor quality irrigation water is a major cause of disease transmission for urban inhabitants consuming fresh produce in many developing countries. Irradiation of food is an alternative approach to reducing health risks on consumers, but its implementation heavily depends on consumers' acceptance. This paper assesses how water quality perception and food irradiation information can influence consumers' acceptance and willingness to pay (WTP) for irradiated food in Mexico. Using a field experiment in randomly selected supermarkets, we assessed consumers' WTP for an irradiated iceberg lettuce. Our results show that concerns on water quality in Mexico constitute a big public policy issue and that this perception has a significant influence on the acceptance of food irradiation as a way of preventing water-borne diseases. Specifically, 73% of our subjects considered that tap water is not suitable for drinking and 51% reckoned that water quality represents a health hazard. Furthermore, 51% declared to accept paying the random price presented for an irradiated iceberg lettuce. However, consumers demonstrated a differentiated willingness to pay for irradiated lettuce, according to the information given at the beginning of the questionnaire. Specifically, 80% of consumers who were given full information would pay for it; 50% of those given only water quality information would pay; 44% of those given only irradiation information would pay; and only 30% of those given no information at all would pay for it. Finally, most of our respondents indicated that information on both environmental and food safety issues is always important. Therefore, consumer awareness and information are critical for their buying decisions. In our study, although the influence of water quality perception on willingness to pay for irradiated iceberg lettuce is not conclusive, we did find that it is a significant factor in the acceptance of irradiation as a pasteurizing method for fresh produce.

Introduction

Wastewater irrigation is a very common activity in developing countries. Water scarcity, low-cost production input to farmers, and a pressing need for food production frequently lead to a high dependence on reclaimed water coming from urban areas. This dependence has important health risk implications to potential consumers of fresh produce. Food- and water-borne illnesses are a major concern as they affect the health and productivity of people, having presumably much higher economic impacts in developing countries than in industrialized nations (Potishiri et al., 1991).

According to Jimenez (2006), about three quarters of the total irrigated area in the world are located in developing countries and from this total, about ten percent is

irrigated using wastewater. For example, the largest irrigated surface in the world which employs untreated wastewater (85,000 Ha) is located in the Mezquital and Mexico City valleys (Jimenez, 2001). This poor quality irrigation water is a major cause of disease transmission for inhabitants of Mexico City, as demonstrated by Jimenez and Garduno (2001) and Mazari et al. (2005). Although this is a major public health issue, and despite the fact that wastewater facilities could bring economic benefits to stakeholders (Silva-Ochoa and Scott, 2004), wastewater treatment is not a widespread practice in Mexico. Hence, alternative or complementary ways to cope with this issue in large urban populations that consume crops irrigated with wastewater have to be sought.

One approach is the use of alternative pasteurizing methods to reduce health risks on consumers; and one of these technologies is food irradiation. Food irradiation is used to extend the shelf-life of fruits and vegetables and is used as a method of food sterilization (Olson, 1998; Diehl, 2002). It consists of applying either Gamma rays or accelerated high-energy electron beams to the irradiation unit. The dose and therefore the cost depend on the type of food and the objective of the irradiation (i.e. inhibition of sprouting, reduction of microbial load, or ripening delays for fruits). The Codex Alimentarius Commission has adopted a standard for irradiated foods as an acceptable way of eliminating bacterial spores and reducing, at the same time, the use of environmental-harmful methods for preventing bacteria infestations[1] (e.g., chemical or toxic substances on crops).

As with any new technology, especially when food safety and/or quality are involved, food irradiation implementation heavily depends on consumer's acceptance (Nayga et al., 2005). Extensive reviews on consumer attitudes towards food irradiation can be found in Bord (1991) and Feenstra and Scholten (1991) for the 1980s. Nayga et al. (2006) and Rousu and Shogren (2006) give a comprehensive review on studies on irradiated food from the 1990s to the mid-2000s. In general, studies have shown the importance of information in influencing consumers' buying decisions. In these studies, it was evident that consumers are not well informed about food irradiation and are risk-averse towards the technology. However, these studies have also demonstrated that once consumers are informed about the nature and benefits of food irradiation, their acceptance and WTP for irradiated foods increase. For example, Nayga et al. (2006) found that consumers in Texas were willing to pay for irradiated ground beef once they had information on irradiation technology and food-borne illnesses. In contrast, reference risk effects, loss aversion, status quo bias, ambiguity aversion and alarmist reactions seem correlated to negative information on consumers acceptance of irradiated food (Fox et al., 2002).

Most studies on consumer acceptance of new technologies applied to food have been carried out in industrialized countries. For example, early studies have shown a much lesser acceptance in the European Union, compared to the USA

[1] General Standard for Irradiated Foods: CODEX STAN 106-1983, REV.1-2003. Available at: http://www.codexalimentarius.net/ (Accessed on March 10, 2009).

(Ehlermann, 1991). This is similar to the case of genetically-modified food as observed by Curtis et al. (2004) and Lusk et al. (2005). In contrast, studies on this topic in developing countries are very limited. This is an important knowledge gap as behavior of consumers in developing countries has dramatically evolved in the past few years, and is not necessarily the same as in industrialized countries (Vega Jimenez, 2004). In fact, concerns on food availability and nutritional intake are more highly regarded by consumers in developing nations than new food technologies, as in the case of genetically modified food (Curtis et al., 2004). Acceptance of food irradiation in developing countries might, therefore, be similar to that of genetically modified food. However, the evidence is scarce. As far as we know, only three studies have been conducted in developing countries on acceptance of irradiated food: one in Turkey (Gunes and Tekin, 2006) and two in Brazil (Ornellas et al., 2006; Behrens et al., in press).

In a survey conducted in Istanbul, Turkey, respondents were more concerned towards bacteria, pesticides, hormones, additives and toxins than on food irradiation. But before having information on irradiation during the survey, 80% of respondents were uncertain about it. After having information on irradiation during the survey, 62% of respondents declared they would buy irradiated food, 25% were undecided and 13% would not buy it. With respect to their willingness to pay, 44% of the respondents would buy irradiated food at the same price as non-irradiated, 19% would buy if price were 5% cheaper, 23% would buy if it were 5% more expensive; 8% were undecided and 18% would never buy (Gunes and Tekin, 2006).

In Brazil, 81% of respondents in Belo Horizonte City regarded irradiation labels and additional information as important and 89% of them declared that they would be willing to buy irradiated after having information on benefits to human health from irradiation (Ornellas et al., 2006).

Behrens et al. (in press) carried out a focus group survey with consumers in Sao Paulo, Brazil, to assess consumer concerns as well as their willingness to buy irradiated food. Their results suggest that Brazilian consumers are reluctant to accept irradiated food. The authors interpret this observation as an ambiguous association between nuclear power and non-defense use. However, acceptance of irradiated food increased in the focus group: (i) after consumers learned about the government approval and regulation of irradiated food, (ii) after having information, and (iii) after actually tasting irradiated food.

As mentioned above, identifying consumer concerns about water quality and water-borne diseases and their relation to potential acceptance of irradiated food in developing countries is important but still generally unknown. Hence, there is a gap in our understanding of the relationship between environmental and health hazards and society's behavior. This paper attempts to estimate how water quality perception and irradiation information influences consumer acceptance and WTP for irradiated food in a developing country. It also empirically assesses the effect of

information on irrigation water quality, irradiation procedures, and food irradiation on consumers' acceptance and WTP for irradiated food.

Methods

Description of surveys

We carried out a framed field experiment (sensu Harrison and List, 2004) in randomly selected supermarkets. Supermarkets are a more familiar setting for consumers when performing economic experiments on consumer attitudes (Nayga et al. 2006). Specifically, we conducted our field experiment using face-to-face hypothetical willingness-to-pay (WTP) dichotomous choice questions (see Nayga et al., 2006 for a detailed description of this method) in randomly selected supermarkets. We used iceberg lettuce as product of interest since this is frequently consumed in Mexican homes.

Experiments were carried out in seven supermarkets randomly chosen in Mexico City. Respondents were randomly selected at the entrance of the store with systematic sampling. A consumer was approached in three-minute intervals. That is, after we finish interviewing a respondent, we let three minutes pass before we approached another consumer. If the consumer we approach refuses, we let three minutes pass again before approaching another potential respondent.

A total of 44 consumers accepted to participate in our survey. The first four were used as pre-test subjects in one supermarket and were set aside from the analysis. One respondent abandoned the survey while being interviewed, so statistical analyses were performed with a sample size of 39 observations. While our sample size is small relative to other market surveys, this would not be considered unusually small for economic experiments. Respondents fatigue was avoided by applying questionnaires lasting no longer than ten minutes as recommended by Silva et al. (2007a). No participation fees were offered after all subjects rejected the amount in the pre-test questionnaires.

Description of questionnaire[2]

The questionnaire was divided in five parts (Figure 1). The first part pertained to the screening of respondents. We excluded (i) persons not purchasing for themselves or their own family (i.e., maids or employees), and (ii) people under 18 years old.

The second part presented information on water quality, irradiation as a pasteurizing method, and a 'cheap talk' script (see Appendix). 'Cheap talk' scripts have been used for diminishing the bias implied in hypothetical experiments (Cummings and Taylor, 1999; Brummett et al., 2007). In our study, we applied a short and neutral cheap talk script in order to diminish hypothetical bias as recommended by Silva et al. (2007a,b). The premise behind this technique is that one might be able to reduce or eliminate hypothetical bias by simply making respondents aware of it regardless of its underlying causes. Lusk (2003) argued

[2] Both the questionnaire and database are available (in Spanish) upon request from the authors.

that the use of cheap talk is more general than calibration because it provides an ex ante bias correction.

Four different questionnaires were applied. The main difference among these was the quantity of information given to consumers before asking their willingness to pay:

- Type I questionnaire: information on both water quality and food irradiation.
- Type II questionnaire: information on water quality but none on food irradiation.
- Type III questionnaire: information on food irradiation but none on water quality.
- Type IV questionnaire: no information.

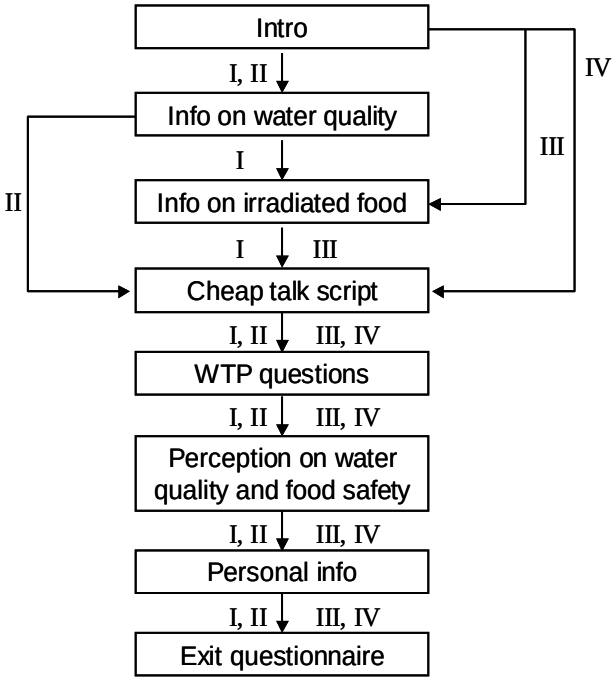

Figure 1. Survey design. Roman numerals correspond to the four questionnaires applied. See text for an explanation.

The third part comprised the WTP questions. Firstly, a reference price (i.e., market price) was given to subjects. Such price was the average price for iceberg lettuce in Mexico City during the previous week. This information was obtained from the Mexican Consumers Attorney official program 'Who's who in prices', available at its internet site[3]. Secondly, we presented a bid value to the interviewee and asked him/her whether or not he/she would pay such price for an irradiated lettuce. Bid values were randomly chosen in the range 3.00 – 15.00 Mexican pesos (about 0.3-1.5 USD in May 2008) per piece of iceberg lettuce. This price range was chosen based on current supermarket prices and results from our pre-test. Thirdly, questions were asked depending on the former answer. If 'yes': would you pay twice the price [just presented] for an irradiated lettuce? If 'no': would you pay half the price [just presented] for an irradiated lettuce? If the answer was again 'no': would you then accept bringing home an irradiated lettuce if you were given some amount of money? If 'yes': how much money? If 'no': would you please tell me why?

The fourth part was designed to assess the perception on water quality and food information from consumers. A 'Likert scale' was used for three different topics (See Table 3). For each topic a series of five statements were presented and

[3] www.profeco.gob.mx (In Spanish).

subjects responded using a one to five scale. The first topic was related to water quality perception (1= completely disagree; 5=completely agree). The second assessed their confidence towards food labels (1= not confident at all; 5=completely confident) and the third one elicited how important was information about food and water quality issues (1= not important; 5=very important).

Finally, in the fifth part, demographic data on educational level, income and age were obtained.

Construction of perception scores

Perception scores were constructed according to the procedure described by Bryman and Cramer (2004). These authors recommend the use of several scale indicators in order to construct an aggregated score. Such a score is constructed by summing scales up using several items or questions for a given topic. This approach helps to offset problems when respondents misunderstand a question, thus obtaining a much finer semi-quantitative measurement of people's perceptions.

The three different topics presented to respondents had five statements each, and had to be scored from one to five. Each answer was weighted according to the score given by the respondent. Thus, a minimum score of five and a maximum of 25 was possible for each of the three topics as the five scores are summed up. According to Bryman and Cramer (2004), such scores can be treated as interval/ratio variables for reporting research results. Hence, three perception scores were obtained for each respondent: water quality perception, confidence towards food labels, and importance on food and water quality information.

Statistical analysis

As stated above, the main objective of this paper was to estimate the effect of information on consumers' WTP for an irradiated good. That is, we wanted to determine the effect of a treatment on a response variable of interest. Here the treatment is the information and the response variable is consumers´ WTP for the good. The estimation of such effect is relevant since, once we know the aforementioned effect, it is possible to intervene to adjust the treatment and attain a desired level of the response variable. The most basic way to measure the treatment effect is to compare the means of two groups, one of which received treatment and the other did not. If the two groups are homogeneous in all aspects (i.e., random assignment), other than their treatment status, then the difference between response outcomes is the desired treatment effect.

Specifically, the interest is to compare outcomes of the information recipients to the counterfactual, that is, their outcomes when information is not available. If information is randomly distributed, its effect can be measured by comparing outcomes of recipient and non-recipients.

Let Y_{io} be individual *i´*s willingness to pay without information and Y_{i1} the counterfactual, that is the same outcome variable, for a comparable individual, but

in the presence of information. Then, the average treatment effect (ATE) will be given by:

(1) $ATE = E [Y_{io} - Y_{i1}]$

If (1) is positive and significant for the data at hand we can conclude that the information provided to the consumers had an effect on consumers´ WTP. If this is not the case, then we can conclude that the treatment does not change consumers´ intentions.

We employed a Student's t-test assuming equal variances. This test reports a probability level, in order to verify our Null Hypothesis: whether the treatments means being compared are equal or not.

We defined treatments as:

- Treatment 1 is equal to 1 if subject received complete information (i.e., both on water quality and on irradiation) and equal to 0 if no information at all was provided. (i.e., questionnaire I vs questionnaire IV).
- Treatment 2 is equal to 1 if subject received partial information (i.e., only on irradiation) and equal to 0 if no information at all was provided. (i.e., questionnaire III vs questionnaire IV).
- Treatment 3 is equal to 1 if subject received partial information (i.e., only on water quality) and equal to 0 if no information at all was provided. (i.e., questionnaire II vs questionnaire IV).
- Treatment 4 is equal to 1 if subject received complete information (i.e., both on water quality and on irradiation) and equal to 0 if partial information (i.e., only on irradiation) was provided. (i.e., questionnaire I vs questionnaire III).
- Treatment 5 is equal to 1 if subject received complete information (i.e., both on water quality and on irradiation) and equal to 0 if partial information (i.e., only on water quality) was provided. (i.e., questionnaire I vs questionnaire II).
- Treatment 6 is equal to 1 if subject received partial information (i.e., only on irradiation) and equal to 0 if partial information (i.e., only on water quality) was provided. (i.e., questionnaire III vs questionnaire II).

These estimates can also be obtained by considering the treatment effect conditioned on a set of individuals´ characteristics **x** (age, sex, income category, and Likert scale scores). Then, the conditioned average treatment effect (CATE) is:

(2) $CATE = E [Y_{io} - Y_{i1} \mid \mathbf{x}]$

Hence, for this analysis we specified three models in order to compare the WTP when respondents were confronted with no information at all - in comparison with full information and partial information (both on water quality only and irradiation info only):

- Model 1: WTP = f (Treatment 1, **x**)
- Model 2: WTP = f (Treatment 2, **x**)
- Model 3: WTP = f (Treatment 3, **x**)

Where WTP = 1 if subject accepts random price; and WTP = 0 if subject rejects random price.

Results

WTP for an irradiated iceberg lettuce

Consumers demonstrated a differentiated WTP for irradiated lettuce, according to the information given at the beginning of the questionnaire. Out of the 39 subjects, 20 (51%) declared to accept paying the random price presented for an irradiated iceberg lettuce. With respect to the expected WTP (E[WTP]), for questionnaire I (full info), eight out of ten consumers (80%) would pay, for questionnaire II (only water quality info), five out of ten (50%) would pay, for questionnaire III (only irradiation info), four out of nine (44%) and for questionnaire IV (no info at all) the figure dropped to three out of ten (30%).

Table 1 shows that average treatment effects for E[WTP] was statistically significant ($p<0.05$) only for Treatment 1 (i.e., comparison between questionnaires I and II).

Table 1. Results of the average treatment effect for the expected WTP treatments.

Treatment number	Average Treatment Effect (grouped variance)	Student's t-test p-value
1	0.500 (0.206)	0.0239
2	0.200 (0.254)	0.5413
3	0.200 (0.256)	0.3880
4	0.300 (0.225)	0.1211
5	0.300 (0.228)	0.1769
6	0.000 (0.278)	0.8213

These results were corroborated by the CATE model. The significant variables ($p<0.05$) on WTP of respondents were, in Model 1: the treatment variable, Educational level, Perception on dams water quality, Label on pasteurization by irradiation, and Income. For model 2: the treatment variable, Water quality in Mexico City, Label on pasteurization by irradiation, and Income category. And for

Model 3: the treatment variable, Importance of having info on water quality, and Label on pasteurization by irradiation (Table 2).

Table 2. Coefficients and standard errors (in parentheses) of the conditioned average treatment effect for the expected WTP models.

Variable	Model 1	Model 2	Model 3
Treatment variable	0.687 (0.205)	0.256 (0.183)	0.295 (0.181)
Educational level	0.159 (0.090)		
Water quality of dams	0.126 (0.084)		
Water quality in México City		-0.133 (0.056)	
Importance of having info on water quality			0.327 (0.140)
Pasteurizaction by irradiation	0.108 (0.076)	0.148 (0.058)	0.244 (0.070)
Income category	-0.124 (0.064)	0.071 (0.052)	
Constant	-0.570 (0.461)	--	-2.096 (0.757)
Number of observations	20	19	19
R-Squared	0.5139	0.6766	0.5086
Adjusted R-Squared	0.3402	0.5903	0.4103

Perception scores

Table 3 summarizes the results in percentage of respondents perception towards water quality, confidence on food labels, and importance of having information about food and water quality issues.

Water quality in Mexico City represented a high concern for most respondents as 73% of them considered that tap water is not suitable for drinking, and 51% reckoned that water quality represents a health hazard. In contrast, the perception towards water quality for irrigation purposes was not as clear since 22-38% of respondents scored a 3 in the Likert scale which means that they either do not know, or feel indifferent, towards the subject. They presumably reflected the fact of being a urban population without much knowledge on irrigation water issues.

Table 3. Likert scale statements and percent of total respondents for assessing water quality perception (1= completely disagree; 5=completely agree), confidence towards food labels (1= not confident at all; 5=completely confident), and importance on food and water quality information (1= nothing important; 5=very important).

Water quality perception					
How much do you agree with the following statements?	**1**	**2**	**3**	**4**	**5**
Water quality coming from wells is suitable for agricultural irrigation.	11	11	38	19	22
Water quality coming from rivers is suitable for agricultural irrigation.	24	24	22	16	14
Water quality coming from dams is suitable for agricultural irrigation.	11	22	24	32	11
Tap water quality at home is suitable for drinking.	57	16	16	5	5
Water quality in Mexico City implies health hazards.	16	8	24	8	43
Confidence towards food labels					
How confident do you feel when reading any of the following labels in an iceberg lettuce package?	**1**	**2**	**3**	**4**	**5**
“Irrigated with water from deep well”	8	16	32	24	19
“Disinfect and wash”	14	22	19	14	32
“Pasteurized by irradiation”	19	3	27	35	16
“Ready to eat”	19	16	11	22	32
No labels	70	14	11	3	3
Importance on food and water quality information					
How important do you consider having:	**1**	**2**	**3**	**4**	**5**
Information on food pasteurization procedures?	0	5	8	19	68
Information on food safety labeling?	3	5	14	22	57
Information on water quality for drinking?	3	3	5	14	76
Information on water quality for irrigation?	3	3	5	30	59
Information on water-borne health risks?	3	8	0	3	86

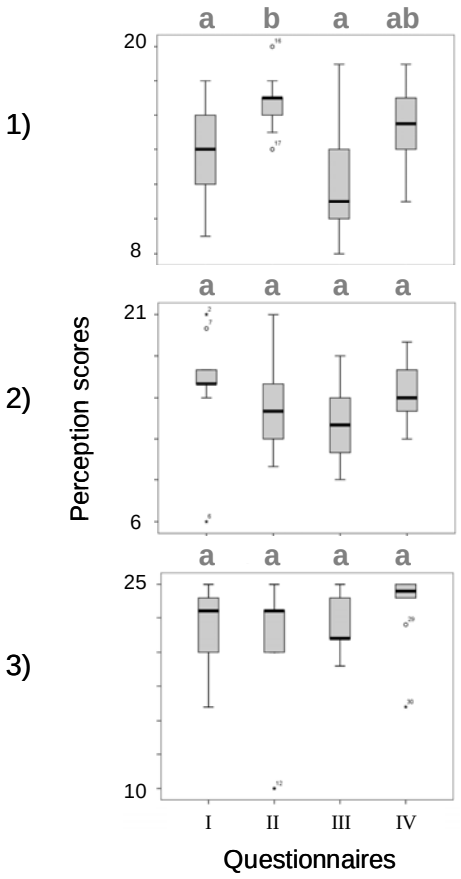

Figure 2. Boxplots showing the resulting perception scores for each questionnaire (represented in roman numerals). 1) Water quality perception, 2) Confidence towards food labels, and 3) Importance on food **and** water quality information. Boxplots with the same letter represent no statistical difference ($p<0.05$) between questionnaires.

Surveyed consumers had a high regard on having information concerning their purchases, mostly with the use of labels. Specifically, 86% of the respondents considered information on food pasteurization procedures as very important. And for 78% of them, information on food safety labeling was very important as well. In the same vein, 84% of subjects felt little or no confidence at all towards food products without labeling. Moreover, water-borne diseases represented a high concern for 89% of consumers. As expected, our results show the important role information plays in consumer buying decisions.

When asked how confident they felt towards irradiation as a means for pasteurizing lettuce: 22% of them had little or no confidence in buying irradiated lettuce, 27% were indifferent and 51% were rather or very confident about it.

Differences among treatments after performing the Student's t-Tests on perception scores were found only for the water quality perception score. Confidence on labels and importance of information about food and water quality issues showed no significant differences. The water quality score was statistically different ($p<0.05$) between questionnaires I and II, and between questionnaires II and III (Figure 2). In other words, when information on irradiation was presented, the water quality score was lower than when water quality information was provided to respondents.

Discussion

Concerns on water quality in Mexico constitute a big public policy issue. For example, Soto and Bateman (2006) show that Mexico City inhabitants are willing to pay a higher water bill for having better water services. This concern was reflected in our survey as Table 3 shows that most respondents considered that Mexico City's water quality is rather poor and represents health risks. This perception might have had a role in accepting food irradiation as a way of preventing water-borne diseases. The fact that questionnaires I and II, and questionnaires II and III were statistically different in our study is, as stated above, a signal showing that when information on irradiation was presented, the water quality score was lower than when water quality information was provided to respondents.

It seems then, that consumers reckon that if a new technology for pasteurizing fresh produce is needed, then water quality problems might be worse than what they expected. It is then possible that water quality could be more of a pressing concern to them than any potential side effects that food irradiation may bring. A similar result was found by Resurrection et al. (1995) as irradiation was a lesser concern in comparison to pesticide residues, animal drug residues, growth hormones, food additives and bacteria for consumers in their study.

Acceptance of irradiation as a means for pasteurizing food is, nevertheless, not only subject to environmental problems or health hazard perceptions. As Feenstra and Scholten (1991) point out, attitudes of consumers are either positive (novel products and technologies) and negative (potential side effects). Indeed, new technologies are seen as necessary improvements for economic development in many developing countries; and concerns on food availability and nutritional intake are more pressing than in industrialized nations such as Europe and Japan. For Curtis et al. (2004) both considerations would explain an easier acceptance of new food technologies in developing nations, such as genetically modified food and, in our case, food irradiation. Thus, the outcome of accepting irradiated food in developing countries such as Mexico might be similar as in the USA, although the reasons might be somewhat different.

Other factors, apart from perception on water quality and information on irradiation, that influenced consumers in our study, as shown by the conditioned expected WTP for Treatment 1, included educational level and income. Both variables have been found to be important in former studies. For example, willingness to buy irradiated food was directly proportional to education level amongst Turkish (Gunes and Tekin, 2006) and US consumers (Rousu and Shogren, 2006). Although the negative sign of income level for explaining the conditioned expected WTP in Treatment 1 seems rather counterintuitive, Fox (2002) also concluded that effects of both age and income give no conclusive results for accepting irradiated food. This is confirmed in our study as income level presented a positive sign in Treatment 2 and was not significant for Treatment 3.

Acceptance of irradiation will also depend on the type of food. When consumers perceive a produce as naturally fresh, their acceptance of irradiation as a means for pasteurizing is probably lesser than other products which are regarded not as fresher, such as shrimps or poultry (Feenstra and Scholten, 1991). Indeed, Resurrection et al. (1995) report that about half of respondents considered irradiation of produce (54% for fruits and 52% for vegetables) as unnecessary, whereas other food was regarded as very necessary by consumers: seafood (44% of respondents), poultry (41%), pork (40%), and beef (32%). For example, iceberg lettuce can be disinfected or rinsed without an extra cost for the consumer. In fact, a potential higher price of irradiated food seems to be a big concern among consumers in developing countries (Behrens et al. in press).

Whether information on food irradiation is positive or negative has been demonstrated as a factor that can influence consumer's acceptance. For example,

Nayga et al. (2005) found that information about the benefits of food irradiation might lead to positive perception. Fox et al. (2002) found that negative information on food irradiation as opposed to positive information, dominated the decision of buying irradiated pork among consumers. In contrast, when the two kinds of information were presented in isolation, both positive and negative information influenced consumers, resulting in favorable/unfavorable assessments, respectively. Moreover, the value of information on irradiated food depends on whether there is conflicting information or not (Rousu and Shogren, 2006).

Consumers in general demand more information. This fact was corroborated in our study as most of our consumers indicated that information on both environmental and food safety issues are always important. Besides, in all three conditioned WTP models, labels on pasteurization by irradiation were significant variables for explaining the average treatment effect, independent on whether respondents had prior information on water quality/ irradiation, or not. This is a standard result as other surveys carried out elsewhere have shown. For example, irradiation labels were considered as important by 80% of consumers in the Resurrection et al. (1995) study. A survey by the Brand Group quoted in Bord (1991) found that 64% of respondents conditioned their acceptance of irradiated food to labeling and further safety tests. Feenstra and Scholten (1991) found that most respondents in surveys considered labeling as a necessary, although not always sufficient, desirable feature of irradiated food. In fact, the way the information is presented and whether it is understandable, is of relevance to consumers. However, doubts about risks even after having information frequently persist among consumers either from industrialized (Bord, 1991) or emerging economies (Behrens et al., in press). Therefore, consumer awareness and their need of information are critical for their buying decisions. In our study, although the influence of water quality perception on WTP for irradiated iceberg lettuce is not conclusive, we did find that it is a factor in the acceptance of irradiation as a pasteurizing method for fresh produce.

A final word must be given with respect to methodological issues. We are aware that the hypothetical setting leads consumers to overstate their WTP (Voelckner, 2006; Silva et al. 2007a). However, we think that both the cheap talk script and randomized prices helped to diminish this bias in our study. We also think that iceberg lettuce is a very common produce in Mexican cuisine and therefore consumers are familiar with its features and prices.

Perception scores are a lower measure for predicting behavior of consumers when actual purchases take place in comparison to willingness to pay or actual purchases. They, however, provided useful information on perception about environmental and food safety issues.

Finally, the size of the sample employed in our analyses does not allow us to generalize on the behavior of Mexican consumers toward irradiated food. Therefore, our results should be taken with caution and considered only as a pioneer study to empirically explore a relationship between water quality concerns

and the acceptance of the use of irradiated-food technology among Mexican consumers.

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Appendix I. Information given to consumers[*].

WATER QUALITY INFORMATION

The use of waste water for agricultural irrigation in Mexico stems from the construction of an outlet for sewage in the valley of Mexico. This practice started in 1890 in both the Mezquital and Mexico valley. The present irrigation surface in these areas is about 85,000 Ha, corresponding to the largest irrigation district in the world that employs untreated waste water. Some other districts with similar practices are: Valsequillo, Puebla; Tulancingo, Hidalgo and Ciudad Juarez, Chihuahua.

It has been demonstrated that using untreated wastewater for irrigation purposes is the main cause of disease transmission concerning helminths (worms). (Source: Mazari et al., 2005).

IRRADIATED FOOD INFORMATION

Food irradiation consists basically in food exposure to ionizing radiation from a source of radiation allowed for this purpose; it is an alternative for reducing or eliminating bacterial and pathogenic microorganisms loads, which threaten or lead to damaging human health.

Food irradiation is proposed by the World Health Organization as a measure for reducing the incidence of food-borne diseases, which affect the health and productivity of most countries. These constitute one of the more widespread public health problems in the contemporary world. (Source: Mexican Official Standard Draft No. NOM-033-SSA1-1993).

CHEAP TALK SCRIPT[**]

Studies show that people tend to act differently when they face hypothetical decisions. In other words, they say one thing and do something different. For example, some people state a price they would pay for an item, but they will not pay the price for the item even when they see this product in a grocery store.

There can be several reasons for this different behavior. It might be that it is too difficult to measure the impact of a purchase in the household budget. Another possibility is that it might be difficult to visualize themselves getting the product from a grocery store shelf and paying for it. Do you understand what I am talking about?

We want you to behave in the same way that you would if you really had to pay for the product and take it home. Please take into account how much you really want the product, as opposed to other alternatives of vegetable products that you like or any other constraints that might make you change your behavior, such as taste or your grocery budget.

Now could you please tell me what price are you willing to pay for the following product? Please try to really put yourself in a realistic situation.

[*] Free translation from Spanish by the authors.

[**] Source: Silva et al. (2007b).

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Short Communication

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Water quality concerns and acceptance of irradiated food: a pilot study on Mexican consumers

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Abstract

BACKGROUND: Poor quality irrigation water is a major cause of disease transmission for urban inhabitants consuming fresh produce in many developing countries. Irradiation of food is an alternative approach to reducing health risks for consumers, but its implementation depends heavily on consumer acceptance.

RESULTS: In this pilot study, we show that most respondents consider the water quality of Mexico City to be poor and a health risk, and would be willing to pay for irradiated food as a means of pasteurizing fresh iceberg lettuce.

CONCLUSION: Irradiated food could, potentially, be accepted in developing countries that have problems with water quality. Such acceptance would presumably be due to the perception that such a novel technology would (1) alleviate water impairment, and (2) lead to economic improvement. It is then possible that the public considers that water quality is a more pressing concern than any potential side effects of food irradiation.

Keywords: water quality perception; irradiated food acceptance; Mexican consumers; pilot study

INTRODUCTION

Wastewater irrigation is a very common activity in developing countries. In fact, about three-quarters of the total irrigated areas in the world are located in developing countries and from this total, about 10% uses wastewater.[1] This poor-quality water is a major cause of disease transmission and, although this is a major public health issue, wastewater treatment is not a widespread practice in many developing countries. Hence, alternative or complementary methods to cope with this issue in large urban populations that consume crops irrigated with wastewater are needed. One approach is the use of alternative pasteurizing methods to reduce health risks on consumers; and one of these technologies is food irradiation.

Food irradiation is a pasteurization method used to extend the shelf life of fruit and vegetables, and can also be used for food sterilization. Such methods are not as widespread among developing countries as it is in industrialized countries. As with any new technology, especially when food safety or quality is involved, the implementation of food irradiation depends heavily on consumer acceptance. Hence, this paper attempts to approach for the first time a common problem in developing countries: agricultural water quality and acceptance of a new technology for pasteurizing food.

EXPERIMENTAL

We carried out a framed field experiment[2] pilot study in Mexico City which comprised a sample of 44 consumers who voluntarily agreed to participate in our survey but statistical analyses were performed with 39 observations. (A more detailed description of the methods is given in unpublished data by Ibarra *et al*. and is available upon request from the authors.) We used face-to-face willingness-to-pay (WTP) dichotomous choice questions in randomly selected supermarkets.[3] Fresh iceberg lettuce was employed as the product of interest since this is frequently consumed in Mexican homes.

Four different questionnaires were randomly applied to respondents. The main difference among these was the quantity of information given to consumers before asking their willingness to pay:

- *Questionnaire I*: information on both water quality and food irradiation
- *Questionnaire II*: information on water quality but none on food irradiation
- *Questionnaire III*: information on food irradiation but none on water quality
- *Questionnaire IV*: no information

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Data obtained from these four questionnaires were arranged in six statistical treatments for analysis. We defined treatments as:

- *Treatment 1* is equal to 1 if the subject received complete information (i.e. both on water quality and on irradiation) and equal to 0 if no information at all was provided (i.e. questionnaire I vs. questionnaire IV).
- *Treatment 2* is equal to 1 if the subject received partial information (i.e. only on irradiation) and equal to 0 if no information at all was provided (i.e. questionnaire III vs. questionnaire IV).
- *Treatment 3* is equal to 1 if the subject received partial information (i.e. only on water quality) and equal to 0 if no information at all was provided (i.e. questionnaire II vs. questionnaire IV).
- *Treatment 4* is equal to 1 if the subject received complete information (i.e. both on water quality and on irradiation) and equal to 0 if partial information (i.e. only on irradiation) was provided (i.e. questionnaire I vs. questionnaire III).
- *Treatment 5* is equal to 1 if the subject received complete information (i.e. both on water quality and on irradiation) and equal to 0 if partial information (i.e. only on water quality) was provided (i.e. questionnaire I vs. questionnaire II).
- *Treatment 6* is equal to 1 if the subject received partial information (i.e. only on irradiation) and equal to 0 if partial information (i.e. only on water quality) was provided (i.e. questionnaire III vs. questionnaire II).

We assessed consumers' perception of water quality and food information through a five-point Likert scale for three main topics: water quality perception, confidence towards food labels, and importance of food and water quality information. Demographic data on educational level, income and age were obtained as well.

A Student's *t*-test that assumed equal variances was applied. This test reports a probability level, in order to verify our null hypothesis: whether the treatment means being compared are equal or not.

RESULTS AND DISCUSSION

Consumers demonstrated differences in WTP for irradiated lettuce, depending on the information given at the beginning of the questionnaire. Fifty-one % of subjects declared they would accept paying the random price presented for an irradiated iceberg lettuce. With respect to the expected WTP (E[WTP]), 80% of consumers who were provided with full information would pay, 50% of consumers given only water quality information would pay, 44% of consumers given only irradiation information would pay, and 30% of consumers with no information at all would pay. Table 1 shows that average treatment effects for E[WTP] was statistically significant ($P < 0.05$) only for Treatment 1.

Differences among treatments after performing the Student's *t*-tests on perception scores were found only for the water quality perception score. Confidence on labels and the importance of information about food and water quality issues showed no significant differences. The water quality score was statistically different ($P < 0.05$) between questionnaires I and II, and between questionnaires II and III (Fig. 1). In other words, when information on irradiation was presented, the water quality score was lower than when water quality information was provided to respondents. It seems then, that consumers might think that if a new technology for pasteurizing fresh produce is needed, then water quality problems are worse than what they expected. It is then possible that consumers are more preoccupied by environmental problems, especially water impairments, than the perception of food irradiation effects. A similar result was found by a study[4] with US consumers, where irradiation was of less concern in comparison to pesticide residues, animal drug residues, growth hormones, food additives and bacteria. Besides, novel technologies are often

Table 1. Results of the average treatment effect for the expected WTP treatments

Treatment number	Average treatment effect (grouped variance)	Student's *t*-test *P* value
1	0.500 (0.206)	0.0239
2	0.200 (0.254)	0.5413
3	0.200 (0.256)	0.3880
4	0.300 (0.225)	0.1211
5	0.300 (0.228)	0.1769
6	0.000 (0.278)	0.8213

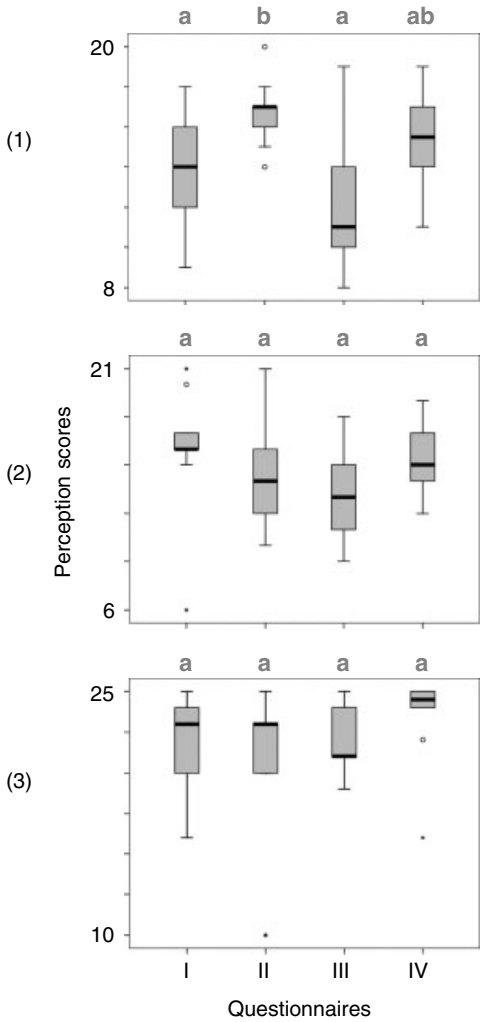

Figure 1. Boxplots showing the resulting perception scores for each questionnaire (represented in roman numerals): (1) water quality perception, (2) confidence towards food labels, and (3) importance of food and water quality information. Boxplots with the same letter represent no statistical difference ($P < 0.05$) between questionnaires.

seen as necessary improvements for economic development in many developing countries.[5] Both considerations would explain an easier acceptance of new food technologies in developing nations, such as genetically modified food[6] and, in our case, food irradiation.

It has been shown that inhabitants of Mexico City are willing to pay a higher water bill for having better water services.[7] This concern was reflected in our survey as 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.

Other factors, apart from perception on water quality and information on irradiation, that influenced consumers in our study, included educational level and income, which is a standard result in both developed[8] and developing countries.[9,10]

Finally, the size of the sample employed in our analyses does not allow us to generalize on the behavior of Mexican consumers towards irradiated food. Therefore, our results should be taken with caution and considered only as a pioneer study to empirically explore a relationship between water quality concerns and the acceptance of the use of irradiated-food technology among Mexican consumers.

CONCLUSIONS

Our findings suggest that irradiated food, as a novel technology, will likely be accepted in developing countries with similar water quality issues as Mexico City. It could be a consequence of the perception that consumers might have of a new technology for pasteurizing fresh produce needed for avoiding problems with water quality. It is then possible that water quality could be more a pressing concern to them than any potential concerns on the possible side effects of food irradiation. Furthermore, accepting a new technology such as irradiated food in developing countries might also be related to a perception of economic improvement.

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