Consumer Attitudes toward Freshness Indicators on Perishable Food Products

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This article analyzes the effect of freshness indicators on consumers' attitudes—specifically, their willingness to pay and preference for freshness indicators. The data come from a consumer survey conducted in a United States metropolitan area of approximately 400,000 people. A logit model was used to estimate the factors that influence willingness to pay. Marginal effects and price elasticities were calculated to determine further economic and marketing implications associated with the freshness indicators. Even though many consumers perceive their meat and salad products to be both safe and fresh, there are still people with reservations about the food they purchase. Respondents overwhelmingly attributed advantages to the indicators. Most respondents accepted the price offered them in the dichotomous choice question. The elasticity of demand over a price range of $0.05 to $0.25 per indicator was −0.14 in the context of fresh meat and −0.25 in the context of bagged salad.

Food quality is determined in large part by a food's environment from product packaging to consumer. Events that occur while food is in the distribution system can adversely impact quality. These events could be the result of random shocks, such as power outages, or negligence on the part of employees who improperly store, refrigerate, or handle food products in distribution. In short, there are numerous circumstances that can create a situation where a fresh product may go out of temperature compliance. Generally, color, odor, and texture are indicators of a product's environment, and consumers can use these indicators to infer overall product quality. However, sometimes a product's packaging prevents the consumer from fully employing conventional freshness identification (Lewis 2002). Consequently there is a need for a visual-based technology that would provide an additional way for consumers to assess quality of fresh food products.

This study measures consumer attitudes and analyzes consumer willingness to pay for time- or temperature-sensitive freshness indicators that can be applied to individual packages of fresh food products. This is done through the use of well-established contingent valuation methods. The indicators under study are roughly the size of a postage stamp and can be affixed to the outside packaging of temperature-sensitive pharmaceuticals and fresh food products (See Figure 1). The indicators have an active reagent contained inside a color reference circle. The reagent can be calibrated based on the specific storage-temperature range for any fresh food product. Bacterial and spoilage tests are done on individual products to determine thresholds for each product. Indicators are then calibrated based on these thresholds. When the active reagent circle is lighter than the color reference circle, the product has been stored within time and temperature thresholds and can be used. As the product is subjected to time or temperature abuse the active reagent becomes darker. If enough time or temperature abuse has occurred the active reagent will become the same color as the color reference circle, indicating the product should be consumed immediately. If the product has been subject to excessive time or temperature abuse the active reagent will become darker than the color reference portion, indicating the product should not be consumed (Stuppa 2007a). The color change is irreversible, continuous, and tamper-proof; it uses a chemical polymerization reaction (Stuppa 2007b). The indicator supplements information provided by the use-by/best-before date and thereby gives consumers more comprehensive information about their food products. Depending on volume, the indicators cost between $0.025 and $0.035 per package. With additional labor involved, each indicator's estimated cost would be $0.035 to $0.045 per package.

The indicators being studied have been shown to have commercial promise, although they are currently not widely used in retail packaging in the US. In Europe the indicators have been adopted by food retailers such as Monoprix, Wagon-Lits, and Ooshop. Indicators are also used in Milco, Barakat,

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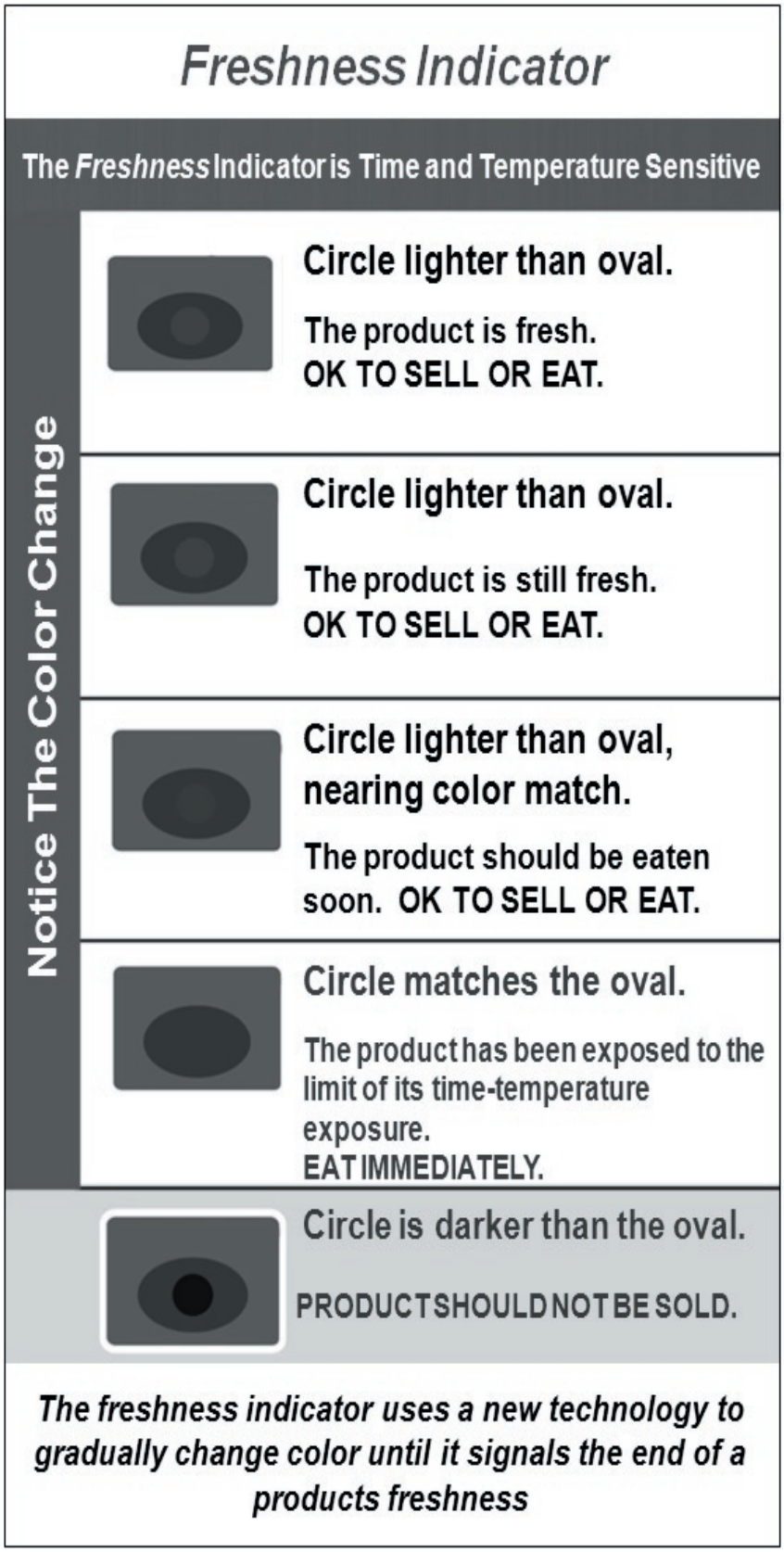

Figure 1. Description of the Freshness Indicator.

and Citychef in the Middle East. Some U.S. firms such as Marriott's food services, Texas American Beef, and Jennie O'Turkey use the indicators to aid in food freshness, food distribution, and inventory control activities (Stuppa 2007b). In terms of performance, a European Union commissioned study concluded that the color change of freshness indicators showed good correlation with the sensory and microbiological quality of the products being tested (Stuppa 2007a).

There are reasons why consumers would be expected to value the additional information provided by freshness indicators. First, consumers around the world are becoming acutely attentive to factors influencing food freshness and wholesomeness. This is due in part to highly publicized food recalls, especially those connected with *E. coli* 0157: H7 and other pathogens. Diseases such as Bovine Spongiform Encephalopathy, avian influenza, and foot-and-mouth disease raise additional food safety concerns in the minds of consumers, as does uncertainty about genetically modified organisms and foods being produced with antibiotics and other synthetics. The freshness indicators being studied here clearly do not address all of these concerns, but they do provide additional reassurance that the foods being purchased are fresh and that adequate protections were in place throughout the cold-chain. Moreover, earlier studies show that consumers do value additional information about the quality of fresh foods. Latvala and Kola (2004) show that 59 percent of Finnish beef consumers are willing to pay more to get additional information on their fresh beef packages. Verbeke and Ward (2003) show fresh beef consumers rank quality guarantees (a stamp or seal which implies quality) just after expiration date, showing the importance consumers place on quality.

Second, the indicators provide a possible safety benefit, especially to certain segments of the consuming population. People may become sick when they have eaten food that contains certain microorganisms above threshold levels. Freshness indicators may be used to combat some of the cold-chain abuses by detecting and revealing possible shocks that could be conducive to growth of microbial pathogens. Young children, pregnant women, and the elderly are especially at risk to these cases of abundant microbial growth stemming from microbes and their toxins (Stuppa 2007b). Additionally, consumers may find the indicators useful when trying to determine the usability of products already in their homes. Lewis (2002) makes the point that use-by dates should not necessarily be interpreted as safety dates; instead they should be seen as a "good-faith promise" of overall quality and freshness. Specifically, use-by dates cannot account for cold-chain abuses.

Finally, consumers may stand to receive direct or indirect benefits if the indicators reduce food waste. Brody (2008) reports that approximately 15 percent of perishable goods spoil before they can be sold. Retailers could reduce food waste and keep food prices low by using the freshness indicator to help control and monitor inventories. They could stock products that have been subject to a small amount of time or temperature abuse first, therefore reducing product loss. In addition, the indicators may help consumers make better decisions about storage of fresh food products in the home environment and thereby reduce food waste. As cited by Brody (2008), a 2004 USDA report concludes that households throw away 40–50 percent of edible food, valued at nearly $50 billion.

On the other hand, consumers are inundated with point-of-sale information on labels and displays, and the freshness indicators add to this volume. Most consumers evaluate thousands of food products in less than one hour per week (Caswell and Padberg 1992). However, even if consumers do not use labels they may derive a sense of trust and security from the fact that information is present on the label. The consumer knows the label is there should he or she need to use it. Labels may also give people a sense of security in food production and quality (Caswell and Padberg 1992). These arguments are supported by findings of Gellynck, Verbeke, and Vermeire (2006) who found that only ten percent of Belgian consumers would pay a price premium for added information on a fresh meat label. However, when the Belgian consumers were given the chance to look at the labels and then choose their preferred package, the most preferred label was the one containing the most information. The label with little or no information on it was rejected.

Ultimately, the value that consumers place on the freshness indicators within a retail setting is an empirical question and is addressed in the remaining portions of this paper. The methods used to elicit consumer willingness to pay and analyze consumer

responses to the survey are described in the next section of the paper. This is followed by a presentation of the results. The paper concludes with a general discussion of the findings and their implications for stakeholders in the food system.

Data and Methods

An in-person contingent valuation survey was designed for interviewing shoppers in seven retail grocery outlets. The store-intercept method was chosen over mail or telephone surveys despite the cost advantages of the latter. Using a relatively short but precise survey, in-person store-intercept interviews ensured the most accurate and complete responses. The store intercept method encouraged respondents to fully participate in the survey and allowed for a thorough explanation of visual aids. Since the technology was new and complex, it was important to be able to fully explain the technology to respondents. (Mitchell and Carson 1989).

The survey was developed in three sections following Dillman (2007). The first section included five questions about respondents' shopping habits and attitudes including the frequency with which they shop, their feelings on the safety and freshness of products they purchase, and their trust in the expiration dates used on products.

In the second section of the survey, respondents were shown an eight-inch by ten-inch graphic (Figure 1) explaining how the freshness indicators worked. Interviewers explained the graphic to each respondent and then asked if he or she understood the basic concept. Respondents were asked a series of questions which elicited preference and willingness to pay. Actual perishable products were used in the survey to simulate a real choice respondents would make in the grocery store. Two packages of chicken were presented to respondents; the packaging was identical except that one package had an indicator on it and one did not. The same was done for two bagged salad products. Respondents were asked, "If you had a choice between the two packages presented, which package would you choose?"

Next, respondents were asked a dichotomous choice question, "Would you be willing to pay 'X' more *per package* for a meat/salad product with a freshness indicator on its package?" Respondents were asked if they would pay one of the five offer amounts ($0.05, $0.10, $0.15, $0.20, or $0.25) more per package. These offer amounts were randomly distributed throughout all surveys. One would expect the decision to accept or refuse the offer amount presented to depend on the level of utility the respondent would gain from the freshness indicator.

The final section of the survey sought to elicit demographic characteristics and information about how the freshness indicator would affect respondents' decision making in the retail outlet and at home. Specifically, respondents were asked if they would switch from their usual brand to a brand that had the indicator and whether they thought the indicator would be useful at home. Demographic information was solicited to enable a comparison of sample demographics to the actual demographics (as reported by the U.S. Census Bureau) of the two counties in which the survey took place.

The offer amounts discussed previously exceeded the actual estimated costs of the indicators ($0.035 to $0.045 per package) but were still relatively conservative when compared to the overall cost of the chicken or bagged salad product. Arrow et al. (1993) encourage the use of conservative bid amounts in an attempt not to bias the bid amount upward. In addition, these amounts are consistent with the findings of other studies, such as that conducted by Ernst et al. (2006), which elicited willingness to pay for specialty labeling of fresh food products.

The surveys were enumerated in March 2008 at seven retail grocery outlets within a single metropolitan area. The choice of the seven stores reflected the willingness of store managers to participate in the study and also the need to account for geographic variations in demographics within the study region. The survey was conducted during two pre-assigned periods at each store to help ensure a representative sample of those consumers patronizing each store. Scripts were developed and teams were trained on how to interview and answer respondent's questions to minimize bias. The survey was pre-tested on students and professionals at a major land-grant university.

As many shoppers as possible were randomly approached as they entered the store during the two-hour time blocks. Each respondent was at least 18 years old. The survey took three to five minutes to complete. In total, 845 people were approached and

320 responded to the survey. The survey response rate was 37.87 percent. The incentive given to complete the survey was the opportunity to enter a drawing in which respondents could win one of five $50 gift certificates to a grocery store of their choice, or a 4GB iPod with an approximate value of $150. Respondents were informed that participation was voluntary, their responses would remain anonymous, and that they could still be considered in the prize drawings even if they chose not complete the entire survey. Care was taken to ensure the confidentiality of each respondent's information. Respondents were provided with contact information and a web address providing more information about the freshness indicators.

In dichotomous-choice models, the dependent variable takes on only two values, either "yes" or "no." The objective is to model the probability of a "yes" response conditional on the amount (price) of the offer presented to the respondent and information that the respondent provided about his or her perceptions, preferences, and demographic characteristics. A logit model was chosen for this purpose. There were 33 variables that were hypothesized to affect willingness to pay for the freshness indicator. Names and definitions of these variables are provided in Table 1.[1]

Two interesting measures can be derived from the estimates of the logit model. The first is the marginal effect of a given explanatory variable on the probability of a "yes" response. These effects were calculated for each explanatory variable as prescribed by Greene (1997). When the explanatory variables are binary, the appropriate marginal effect is

$$(1)\quad Prob[\mathrm{Y}=1|\bar{x}, d=1] - Prob[\mathrm{Y}=1|\bar{x}, d=0],$$

where Y is the response and takes a value of 1 if "yes" and 0, otherwise; d is the binary explanatory variable in question; and $\bar{x}$ is a vector of mean values for all explanatory variables except for variable d. A second interesting measure is the own-price elasticity of demand. Specifically, Rappoport et al. (2006) use an arc formula to derive elasticities of demand from willingness-to-pay data. Following this, own price elasticities for the freshness indicators are given by

$$(2)\quad \frac{F(b=1)-F(a=1)}{b-a}\,\frac{b+a}{F(b=1)+F(a=1)},$$

where a and b are binary variables taking a value of 1 for offer values corresponding to $a and $b, respectively, and F represents the cumulative density function of the logistic distribution.

Results

Characteristics of the sample along with corresponding census information from the reference counties are presented in Table 2. Chi-square or Cochran-Mantel-Haenszel tests were conducted on all demographic statistics to determine if the sample differed from the census data. There were no statistical differences between the sample and the reference counties in terms of age, marital status, age, or number of children. However, the sample significantly over-represents females, people of higher education, and individuals who classified their ethnicity as white and not Hispanic. The over-representation of females is to be expected because the surveys were carried out in grocery stores, and it is likely that more women than men shop for groceries. Indeed, Table 2 shows that 88 percent of the respondents were the primary food shopper for their households. There are three reasons for the differences in education. First, people with higher education may have been more willing to participate in the survey. Second, the survey was carried out in relatively urban areas. Finally, some survey locations were near a large land-grant university, which may have led to higher numbers of degree holders at those locations. The difference in ethnicity between the sample and the reference counties is likely due to the fact that English was the only language used for the survey. Asian and Latino team members helped in recruiting respondents, but hiring a translator was not economically feasible in this study.

Figures 2 and 3 summarize respondents' degree of trust in the safety, freshness, and product expiration dates. Specifically, respondents were asked if

[1] Because there were very few responses of "uncertain," the "no" and "uncertain" responses were combined when estimating the empirical model. In other words, "Yes" responses were modeled versus the "non-yes" responses. Respondents who indicated they did not buy fresh chicken or bagged salad were counted as missing for the variables Mchoice and Schoice in Table 1. Very few respondents (3.4%) do not buy bagged salad and (3.8%) do not buy fresh chicken.

Table 1. Definition of Variables Used in Statistical Analysis.

Variable Name	Definition
WTPmeat (WTPsalad)	Binary variable assigned a value of 1 if respondent accepted the meat (salad) offer amount. .
Shop	Binary variable assigned a value of 1 if respondent shops more than one time per week.
Msafe (Ssafe)	Binary variable assigned a value of 1 if respondent thinks meat (salad) he/she purchases is safe.
Mfresh (Sfresh)	Binary variable assigned a value of 1 if respondent thinks meat (salad) he/she purchases is fresh.
Mdate (Sdate)	Binary variable assigned a value of 1 if respondent trusts meat (salad) expiration dates.
Safety	Binary variable assigned a value of 1 if respondent sees a safety advantage with the indicator.
Freshness	Binary variable assigned a value of 1 if respondent sees a freshness advantage with the indicator.
Mchoice (Schoice)	Binary variable assigned a value of 1 if respondent preferred the meat (salad) package with the indicator.
Offer5*–Offer25	Series of binary variables corresponding to offer amounts \$0.05, \$0.10, \$0.15, \$0.20, and \$0.25; respectively.
Brand	Binary variable assigned a value of 1 if respondent would switch from his/her usual brand to a brand with an indicator.
Stores	Binary variable assigned a value of 1 if respondent indicated a shopping preference for stores using indicators.
Home	Binary variable assigned a value of 1 if respondent feels the indicator would be useful at home.
Gender	Binary variable assigned a value of 1 for female respondents.
Primary	Binary variable assigned a value of 1 if respondents was the primary shopper in his/her household.
Married	Binary variable assigned a value of 1 for respondents who were married.
Children	Binary variable assigned a value of 1 for respondents who have children under the age of 18 in their households.
Age1*–Age4	Series of binary variables corresponding to age groups of 18–24, 25–44, 45–64, and 65+; respectively.
Educ1*–Educ3	Series of binary variables that correspond to education levels of: (1) high school or less, (2) some college, and (3) a baccalaureate degree or higher; respectively.
Income1*–Income6	Series of binary variables corresponding to annual income levels of: less than \$15,000; \$15,000–34,999; \$35,000–49,999; \$50,000–74,999; \$75,000–99,999; 100,000+; respectively.
Nonwhite	Binary variable assigned a value of 1 for respondents that identified themselves as something other than "White-non Hispanic."

*Denotes variables included in the intercept of the regression model.

Table 2. Sample's Demographic Statistics and County Census Data.*

Characteristics of Sample	Sample (%)	Counties (%)	n	CMH or Chi-Square p-value
Females	60.94	49.67	320	<0.0001
Primary shopper	87.81	n/a	320	—
Married	60.63	58.20	320	0.3929
Children	38.75	37.32	320	0.2218
Ages (18–24)	13.44	7.59		
Ages (25–44)	35.63	29.85		
Ages (46–64)	38.75	22.07		
Ages (65–84)	11.25	9.43		
Ages (85 +)	0.94	1.39	320	0.5787
Did not complete high school	4.39	18.76		
Completed high school or equivalent	23.51	30.50		
Completed some college, no degree	27.27	21.91		
Completed associate's degree	8.46	4.95		
Completed bachelor's degree	22.88	16.27		
Completed graduate or professional degree	13.48	7.60	319	<0.0001
Earned <$15,000	14.71	13.07		
Earned $15,000–$34,999	24.84	26.64		
Earned $35,000–$49,999	17.32	16.98		
Earned $50,000–$74,999	14.71	20.13		
Earned $75,000–$99,999	14.38	11.98		
Earned $100,000 or more	14.05	11.20	306	0.4715
White, Non Hispanic	87.77	84.18		
Spanish, Hispanic, Latino	5.33	13.32		
Black or African American	2.19	2.06		
Asian	0.94	1.43		
American Indian or Alaskan Native	0.63	2.06		
Native Hawaiian or Pacific Islander	0.31	0.44		
Other	2.82	8.22	319	<0.0001

*Due to a small number of responses in certain age, education, and ethnicity categories some aggregation was required to implement the logit models. Consequently the variable definitions reported earlier in Table 1 and later in Table 3 do not correspond exactly to the categories as reported here.

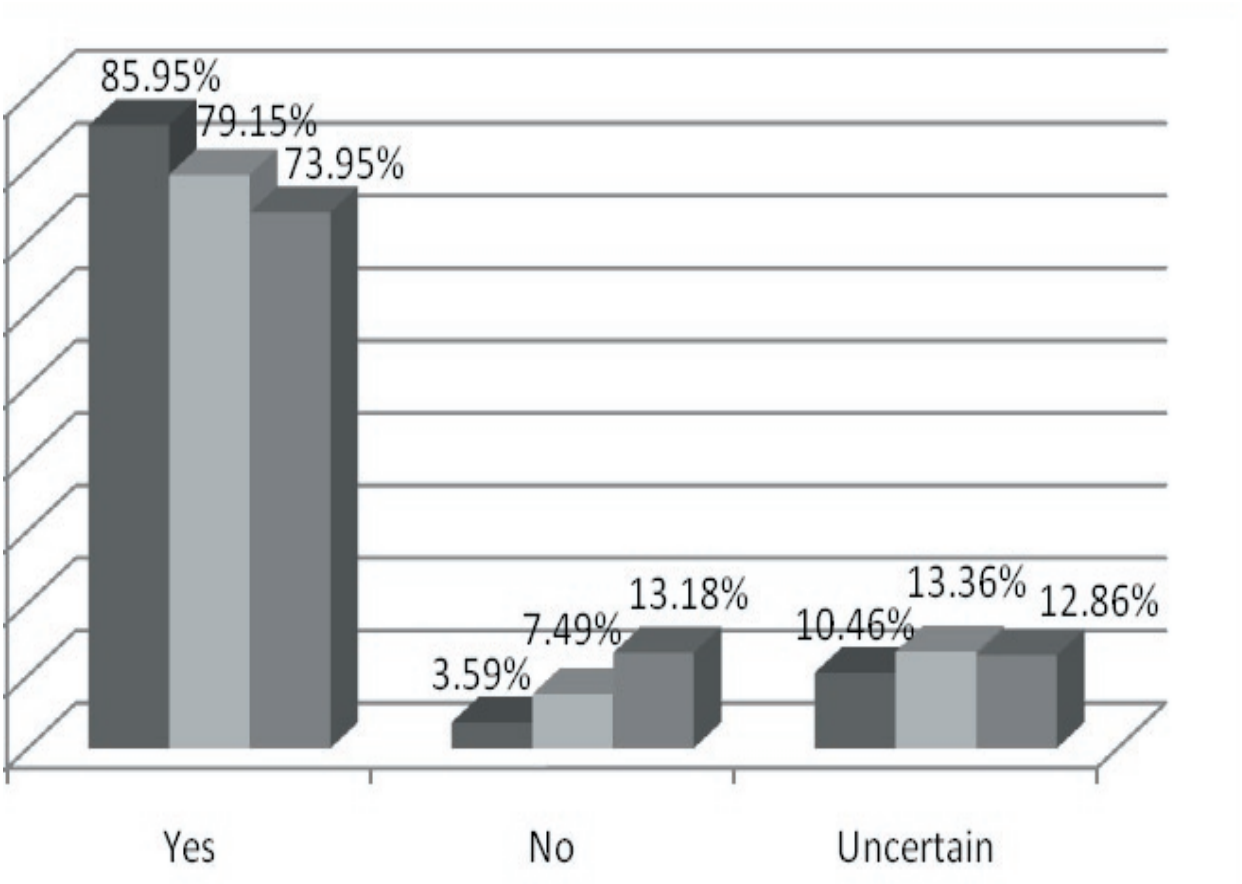

Figure 2. Trust in Fresh Meat Safety, Freshness, and Expiration Date.

they felt the fresh meat or salad they purchased at the store in question was safe and if it was fresh. They were also asked if they thought the expiration dates on fresh meat and salad were reliable. Figure 2 shows an overwhelming majority of respondents think the meat they purchase is both safe (85.95 percent) and fresh (79.15 percent). However, 14.05 percent of respondents do not think meat is safe or are uncertain of the safety of fresh meat, and 20.85 percent do not think meat is fresh or are uncertain of the freshness of meat. An even larger 23.05 percent think the expiration date on meat is unreliable or are uncertain about its reliability. Nearly 25 percent of respondents answered with "no" or "uncertain" when asked if they thought the bagged salad at the store was safe, and nearly 31 percent had reservations with the freshness of bagged salad. When asked about reliability of the expiration date, approximately 35 percent of respondents had reservations about the reliability of the expiration date for bagged salad.

Figures 2 and 3 indicate that while there is a general sense of safety, freshness, and reliability with the products in question, a considerable minority did have reservations. An interesting finding is that even when consumers were generally satisfied, most still saw some advantages from the indicators. In fact, 95 percent of respondents felt the indicator provided a safety advantage, and 88 percent felt it provided a freshness advantage. However, a slightly lower percentage actually indicated a preference for the packages with indicators. When asked to choose

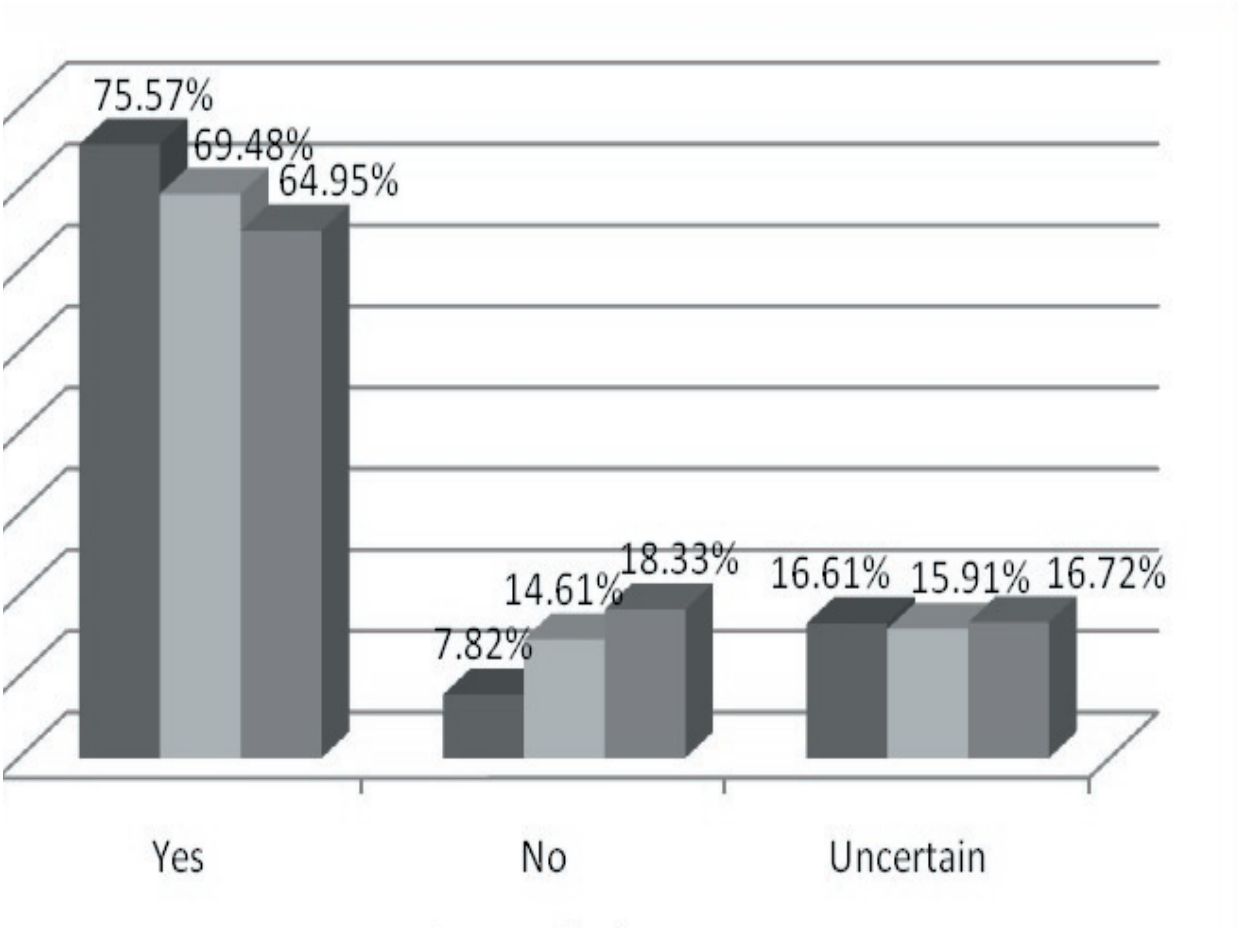

Figure 3. Trust in Bagged Salad Safety, Freshness, and Expiration Date.

between packages, 80 percent of respondents chose the meat package with the indicator and 78 percent chose the salad package with the indicator. This finding can be attributed to two things. First, in some cases it was clear that the respondent failed to notice the indicator on the package. Second, although every effort was made to have product examples that were identical when showcasing the indicator, there were minor variations in appearance of the actual products and these differences were reflected in the stated preferences.

Table 3 shows the percentage of respondents who indicated they were willing to pay the presented offer amount for freshness indicator on packages of fresh meat and salad. Respondents are more willing to pay for the indicator on fresh meat than on bagged salad. As would be expected, the percentage of respondents willing to pay the offer amount declines as the amount increases from $0.05 through $0.15. However, the percentage of respondents willing to pay for the indicator goes back up at offers of $0.20 and $0.25 per indicator. This was not expected. A possible explanation is that respondents used offer prices to come up with an initial assessment of the magnitude of the benefits provided by the freshness indicators and this may have led to more "yes" responses at the $0.20 and $0.25 amounts. In general results suggest that people may be less willing to pay for the indicator on a bagged salad product than they are for the indicator on a fresh meat product.

In addition to the willingness-to-pay questions,

Table 3. Willingness to Pay.

Offer Amount	WTP Meat (% Yes)	n	WTP Salad (% Yes)	n
$0.05	84.50	68	72.73	68
$0.10	74.14	59	63.16	59
$0.15	65.63	66	53.97	66
$0.20	71.19	62	57.38	62
$0.25	74.58	65	55.56	65

respondents were asked if they would switch from their usual brand to a brand with a freshness indicator if there was no price difference. Nearly 76 percent of the total sample would switch from their usual brand to a brand with a freshness indicator. Switching behavior is 14 percent greater for females than for males. Respondents were also asked if the indicator would be useful at home. Eighty-nine percent of the total sample felt the indicator would be useful at home. Respondents with children said the indicator would be useful at home six percent more often than did respondents without children.

Table 4 presents estimated coefficients from the logit models, and Table 5 presents corresponding marginal effects implied by these estimates. In the fresh meat model, several variables are negatively related to the likelihood of a "yes" response. Offer15, Offer20, and Offer25 are negative and statistically significant; that is, as the amount offered (the price) increases, the probability of a "yes" response goes down. Also, as would be expected, the respondents who expressed confidence in the safety of meat (Msafe) are less willing to pay for the freshness indicator. Respondents with some college or college degree holders were also less likely to be willing to pay a higher amount for the indicator than were respondents with the base education level of a high school degree or less.

Several respondent characteristics were statistically significant and positively related to the likelihood of a "yes" response in the fresh meat model. First, when the respondent reported being satisfied with current freshness levels of meat (Mfresh) he or she was more likely to provide a "yes" response. This relationship was not expected; however, respondents may feel that the freshness indicators can provide them with the additional measure of freshness they seek. Therefore respondents are willing to pay for it even though they perceive meat as generally being fresh. Respondents who showed a preferences for the packages with indicators (Mchoice), those who indicated a preference for stores that used the indicators(Stores), those who associated a freshness advantage with the indicator (Freshness), and those who felt the indicator would be useful in the home environment (Home) were also more likely to provide a "yes" response. Age, income, and ethnicity variables were not statistically significant in influencing the willingness to pay for fresh meat.

Turning now to results for bagged salad, again the amount offered is negatively related to the probability of a "yes" response. Specifically, Offer20 and Offer25 have negative and statistically significant coefficients. In addition, several respondent characteristics including age, education, and ethnicity were shown to reduce the likelihood of a "yes" response. This was true for the more educated respondents, those with at least some college (Educ2 and Educ3), those who were older, and respondents with ethnicity other than "White Non-Hispanic." As in the fresh meat model, the variables Schoice, Stores, and Home had positive effects on willingness to pay for the freshness indicator, again showing an expected correlation between perceptions of indicator benefits and willingness to pay. In particular, Schoice had the largest positive impact on respondent's willingness to pay. Income level did not have a significant impact on willingness to pay for indicators on bagged salad products.

Table 4. Willingness to Pay Models for Meat and Salad.

	Meat Model (n = 296)		Salad Model (n = 299)	
Parameters	Estimate	p-value	Estimate	p-value
Intercept	0.1077	0.9230	–0.1602	0.8790
Offer10	–0.8160	0.1457	–0.5590	0.2572
Offer15	–1.4449	0.0074***	–0.7055	0.1282
Offer20	–1.1151	0.044**	–1.0397	0.0274**
Offer25	–1.0789	0.047**	–0.9435	0.0399**
Shop	0.2483	0.4847	0.5269	0.1023
Msafe	–1.3570	0.0239**	—	—
Ssafe	—	—	–0.1848	0.6589
Mfresh	0.8209	0.0647*	—	—
Sfresh	—	—	–0.0907	0.8140
Mdate	–0.3802	0.3659	—	—
Sdate	—	—	0.4256	0.1942
Safety	0.0157	0.9839	–0.5227	0.5174
Freshness	1.2975	0.0114**	0.6030	0.2615
Mchoice	1.2216	0.0030***	—	—
Schoice	—	—	1.8131	<0.0001***
Brand	0.0603	0.8886	0.3927	0.2999
Stores	0.8239	0.0220**	0.7397	0.0204**
Home	1.2007	0.0174**	1.1428	0.0340**
Gender (female)	0.3277	0.3563	–0.2598	0.4155
Primary (primary shopper)	–0.0169	0.9748	–0.1884	0.7055
Married	–0.2539	0.5092	–0.0391	0.9105
Children (has children)	–0.1034	0.8075	0.2452	0.4942
Age2 (25–44)	–0.2702	0.6639	–0.7919	0.1673
Age3 (45–64)	–0.7263	0.2358	–1.1930	0.0379**
Age4 (65+)	–1.0129	0.1483	–1.8247	0.0060***
Educ2 (Some College or 1–2 year degree)	–0.8618	0.0743*	–1.0798	0.0113**
Educ3 (4 year degree or graduate degree)	–1.1016	0.0228**	–1.2823	0.0040***
Income2	0.0523	0.9185	–0.0534	0.9131
Income3	0.8648	0.1700	0.2193	0.6821
Income4	0.7494	0.2263	–0.3608	0.5089
Income5	0.7121	0.2633	0.3341	0.5729
Income6	0.3133	0.6360	–0.1085	0.8682
Nonwhite (other than White Non-Hispanic)	–0.4958	0.2319	–0.7181	0.0706*
LR Test	74.18	<0.0001***	93.15	<0.0001***
Score Test	70.45	<0.0001***	80.93	<0.0001***
Wald Test	47.76	0.0155**	56.78	0.0015***

*, **, and *** indicate statistical significance at the 0.10, 0.05, and 0.01 levels, respectively.

Table 5. Marginal Effects for Each Variable.*

Variables	Variables Compared To	Meat Model	Salad Model
Offer10	Offer5	–14.68	–13.14
Offer15	Offer5	–27.73	–16.67
Offer20	Offer5	–20.84	–24.79
Offer25	Offer5	–20.03	–22.42
Shop (Shop > 1 time per week)	Shop < 1 time per week	3.95	12.09
Msafe/Ssafe (Product is safe)	Product is not safe	–15.75	–4.10
Mfresh/Sfresh (Product is fresh)	Product is not fresh	14.50	–2.03
Mdate/Sdate (Trust expiration date)	Do not trust the expiration date	–5.57	9.76
Safety (Safety adv. with indictor)	Do not see safety adv. with indicator	0.25	–10.79
Freshness (Freshness adv. with indicator)	Do not see freshness adv. with indicator	25.78	14.34
Mchoice/Schoice (Chose indicator)	Did not choose indicator	23.10	42.28
Brand (Switch to a brand with indicator)	Would not switch to a brand with indicator	0.95	9.09
Stores (Switch to a store with indicators)	Would not switch to a store with indicators	13.30	16.76
Home (Indicator would be useful at home)	Indicator not useful at home	23.71	27.58
Gender (Female)	Male	5.21	–5.79
Primary (primary shopper)	Not primary shopper	–0.26	–4.15
Married (yes)	Not married	–3.87	–0.88
Children (yes)	No children	–1.62	5.47
Age2 (25–44)	18–24	–4.30	–18.23
Age3 (45–64)	18–24	–11.89	–27.32
Age4 (65+)	18–24	–19.31	–42.68
Educ2 (Some College or Assoc. Degree)	High School degree or less	–14.45	–24.90
Educ3 (Bachelors Degree or More)	High School degree or less	–18.78	–29.57
Income2 (15,000–34,999)	<15,000	0.81	–1.21
Income3 (35,000–49,999)	<15,000	11.21	4.82
Income4 (50,000–74,999)	<15,000	9.84	–8.41
Income5 (75,000–99,999)	<15,000	9.41	7.22
Income6 (100,000+)	<15,000	4.53	–2.48
Nonwhite (other than White Non-Hispanic)	White Non-Hispanic	–8.44	–17.02

*Marginal effects are reported in bold-face type when the corresponding coefficient estimate (Table 3) is statistically significant.

For both the fresh meat and salad products, respondents with higher education levels showed a lower willingness to pay. It is difficult to articulate good reasons for this finding. However, similar findings on education were revealed in Thompson (1998) and Misra et al. (1991) when examining willingness to pay for organic and pesticide-free produce, respectively. Incidentally, Thompson (1998) reveals that age may be a factor leading to a lower willingness to pay for organic produce. This finding is consistent with the lower willingness to pay for freshness indicators shown by older respondents in our study.

Although consumers with a preference for stores that featured the indicators (Stores) had a higher willingness to pay, consumers who indicated a preference for brands with the indicators (Brand) did not. This, along with the finding that most respondents felt that meat and salad products were generally safe and fresh, may indicate that the presence of indicators demonstrates an overall commitment to ensuring freshness and quality at the retail outlet and may not be as important on individual products. Of course this could also indicate that brand loyalty was relatively high or consumers perceive brands as conveying other product attributes beyond safety and freshness.

In both models, the frequency of shopping (Shop) was not statistically significant; neither was the level of trust consumers placed in product date stamps (Mdate, Sdate). These results are somewhat surprising because one would think that less-frequent shoppers or those who mistrust date stamps would stand to gain more from the benefit of having access to information from the indicator. Again, this finding may reinforce the idea that indicators convey a broad commitment to safety and freshness that is valued regardless of shopping frequency.

Price elasticity over the \$0.05 to \$0.25 range was −0.14 for the indicator on fresh meat and −0.25 for the indicator on bagged salad. Hence demand for freshness indicators is inelastic; a change in price over the range analyzed will have little effect on demand for the indicators. If the mid-point of the price range (\$0.15) from which elasticity was calculated is increased by one percent, demand for the indicators on meat would fall by approximately 0.14 percent and demand for salad would fall by approximately 0.25 percent.

Conclusions and Implications

This research shows that consumers do place value on freshness indicators. While it is true that a large majority perceived meat and salad products to be both safe and fresh, the study showed that there are still people who have reservations about the food they purchase; freshness indicators provide one way to address these reservations. Even though most respondents considered current levels of freshness or safety to be adequate, respondents in this study still overwhelmingly attributed advantages to the indicators. In addition to general freshness and safety advantages, nearly 90 percent felt that the indicators would help them monitor freshness and storage conditions in the home environment. This is consistent with Caswell and Padberg's (1992) findings which suggest that more information may provide assurance to consumers. The consumer knows the indicator will be there should he or she need to use it in a time or temperature compliance incident. This conclusion is also supported by the respondents' stated preferences. Ultimately these considerations were reflected in the respondents' preferences, with an overwhelming majority choosing the meat and salad packages with indicators over those packages without.

If, as suggested here, consumers place a value on the additional assurance provided by the indicators, they are fairly insensitive to the corresponding increases in price. Three-quarters of respondents were willing to pay some amount for the indicator on fresh meat, and nearly two-thirds of respondents were willing to pay some amount for the indicator on bagged salad. Based on the empirical models estimated in the study the demand for indicators was very inelastic. That said, the product in question does appear to make a difference. The demand for indicators within the context of fresh meat was less elastic than was demand within the context of bagged salads. This is a potentially important finding and suggests that characteristics of the product will affect the success of efforts to commercialize the indicators. The results of this study suggest that consumers may see a greater need for the indicator on fresh meat; therefore, fresh meats may be particularly promising products for further market tests. Since this study only looked at two products, it will be important to establish on which products consumers want freshness indicators and in which

markets they will be most viable.

Identifying a market segment where specific food safety strategies are valued may be the best approach for a device such as the freshness indicator. Work by Schroeder et al. (2007) shows that willingness to pay for safety assurances can increase linearly or exponentially across consumer segments. Consequently, some consumer groups are likely to be willing to pay much more for the increase in assurance provided by the indicators. Results presented above suggest that women were more likely to switch to a brand with the freshness indicator and respondents with children were more likely to feel the indicator was useful at home. Results also show that younger people with less education are more likely to pay for the freshness indicator.

Finally, there may be marketing advantage for stores or brands using freshness indicators. The vast majority of respondents said they would switch from their usual brand to a brand with a freshness indicator, and over half of respondents said they would prefer to shop at a store which offered the indicator over a store that did not. Manufacturing firms and retail grocery stores that use the freshness indicator can demonstrate a "we care" or "we're concerned" image for their certain store or brand, which may provide them with a freshness or safety advantage.

One limitation of the methods used in this study is that consumer willingness to pay was elicited within a hypothetical context. Consequently additional research is needed to gauge how consumers will value indicators in an actual purchase situation. In addition, there is the need to see how consumers respond when there is no interaction with investigators and survey materials.

Further study is also needed to assess other benefits to firms in the food distribution system. For example, the indicators provide an additional tool for monitoring inventory and reducing waste by allowing firms to move products with the least shelf life. This may help reduce product loss. Retailers will be able to ensure the products they are selling have been kept in temperature compliance and have not extended their usable shelf life based on their storage environment, thereby providing superior benefits to their customers.

That said, there could be drawbacks to the indicators that would warrant further study. Even though the cost is relatively small, product margins on many grocery retail products are tight and the indicator cost can be significant in some product contexts. In addition, there may be potential for customer abuse in that customers could transport or store products improperly and then return them when the indicator suggests they are no longer fresh. Additionally, some retailers have expressed concerns that the defrosting cycle of the coolers may darken the indicators and they would need to discard product that is still viable for sale. However, according to one manufacturer of freshness indicators, these concerns have been raised in the past and are not a significant issue. Perhaps the biggest challenge for firms and companies that use this technology will be educating consumers on how the technology works and how it can be beneficial for them.

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