Valuation of Temp-Time's Fresh-Check® Indicator on Perishable Food Products in Belgium

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Abstract: Consumers are becoming acutely attentive to the factors that influence food safety and food wholesomeness. The food industry is well regulated, yet there is still illness that results from contaminated fresh food products. Recent food contamination outbreaks and concerns with how food is grown have created an almost hypersensitive food consumer. The TempTime Corporation is a leading international manufacturer in time-temperature sensitive indicators for fresh food products. This company's aim is to provide consumers with more information about exactly what happens to their product from the initial packaging of the product to the time of consumption. Their product, called Fresh-Check®, is about the size of a postage stamp, and is affixed to the outer packaging of fresh food products. It is used in conjunction with the use-by-date to ensure a safe and fresh product. This paper focuses on consumer perceptions of the Fresh-Check indicator in Belgium. We employed the contingent valuation survey method to capture Belgian consumer's overall perception, willingness to pay, preference, and acceptance for Temp-Time's Fresh-Check® indicator on fresh food products.

Consumers around the world are becoming acutely attentive to factors influencing food safety and wholesomeness. Rules and regulations for food safety are more stringent than ever, yet there is still illness resulting from contaminated food products. Recent food recalls, especially those connected with E. coli 0157H7, are major concerns for some consumers. Additionally, there are still diseases such as Bovine Spongiform Encephalopathy (BSE), Avian Influenza (AI) and Foot and Mouth Disease (FMD) that raise food safety concerns in the minds of consumers. Furthermore, issues such as genetically modified organisms (GMO's) and foods being produced with antibiotics and other synthetics are of concern to consumers. These issues have almost created a hypersensitive food consumer. The United States and Europe have implemented some of the safest food systems in the world, but also have the some of the most fickle consumers.

Food safety, quality, and freshness are products of a food's environment from product packaging to consumers. Consumers may want access to information about their food's environment. Traditionally, color, smell, resilience, and texture would be indicators of a product's environment, but when fresh products are on a styrofoam tray tightly wrapped in plastic you aren't able to fully employ traditional indicators of freshness (Lewis 2002). Often there are food systems shocks such as power outages, improper storage/refrigeration, inefficient employees, and other circumstances which can create a situation where a fresh product may go out of temperature compliance.

The Centers for Disease Control and Prevention (CDC) estimates 76 million illnesses, 325,000 hospitalizations, and 5,000 deaths happen each year in the U.S. because of food borne illness. Each year only approximately 200,000 cases are reported. (Mead, et.al. 2000). Nearly 40% of these cases come from too much bacterial growth in product (Stuppa B, 2007). Among the reported food borne illness cases in 1999 salmonellosis was the most prevalent with 17.7% and campylobacteriosis was second

with 14.8%. Each of these bacterium are associated with fresh products, so a study using Fresh-Check® indicators on fresh meat products would be very plausible (Mead, et. al. 2000). In 2002 there were 66 recalls in the United States concerning Listeria or E. coli with fresh meat products totaling 60 million pounds of meat (Nayga, et. al. 2006). "Any mishandling of a food along the way [in the distribution channel] can have a significant impact on its overall quality" says, Carol Lewis, journalist for *FDA (Food and Drug Administration) Consumer Magazine*. Lewis also points out an elderly person, smoker, or even a woman wearing perfume may not be able to detect foods which have a slightly rancid smell. This supports the assertion there may be a need for a visual based technology that will lower food borne illness risk for consumers. The Fresh-Check® indicator may provide the added information consumers need about the environment of their product throughout the cold chain. This labeling device could protect consumers during cold chain breakdown, or allow them to protect themselves during home use.

This paper focuses on Belgian consumer's perceptions about food safety and food quality with respect to a time-temperature indicator called Fresh-Check®. Our objectives are to gauge consumers overall perception, willingness to pay, preference, and acceptance of the Fresh-Check® indicator. Further study may also reveal the indicator will be a useful tool in the cold chain, retail outlets, and consumer's home refrigerators.

Explanation of Technology

Fresh-Check® indicators are manufactured by a company called TempTime which is headquartered in Morris Plains, New Jersey. They also have a European branch with offices in Paris and London. The indicators are about the size of a postage stamp, and are affixed to the outside packaging of temperature sensitive pharmaceuticals and fresh food products. The application of this technology started with the World Health Organization when they applied it to vaccines in Africa. It helped prevent medical

workers from using vaccines that had lost their effectiveness because they had been subject to time or temperature abuse. The workers were also able tell which bottle was the oldest, or had undergone some temperature abuse, and use it first (Stuppa, A 2007). The indicators use a color reference system to indicate effectiveness. If the inside of the indicator is lighter than the outer color reference it means the vaccine is viable; if the inside is darker than the color reference the vaccine has lost its effectiveness. These indicators have revolutionized how vaccines are administered, and have had a positive effect on human health in on both the African and Asian continents (Stuppa, A 2007).

This technology may also have expanded relevant applications in the fresh food industry. Similar to the vaccine indicators, the active color reagent is contained inside a color reference circle. The reagent can be calibrated based on the specific temperature range in which a wide array fresh food product must be stored. Bacterial and spoilage test are done on individual products to find out thresholds for each product. Indicators are then calibrated based on each product's specific threshold. When the active reagent circle is lighter than the color reference circle the product is safe to use. If the product is subject to time or temperature abuse the active reagent becomes slightly 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 now. If the product has been subject to excessive time or temperature abuse since the product was packaged the active reagent will become darker than the color reference portion indicating the product should not be consumed. (Stuppa A, 2007).

According to Guy Stuppa, Commercial Manager at Temp-Time Paris, the color change is irreversible; it is continuous and tamper proof. It uses a chemical polymerization reaction governed by Arrhenius's equation $k = A \circ e - [Ea/RT]$ (Stuppa B, 2007). It, in conjunction with the use-by/best-before dates, gives consumers adequate

information about their food products. Stuppa states, “It can be a powerful tool when taste, smell, or quality appraisal cannot predict the freshness of the food.” “It can also indicate how much time bacteria have had to proliferate on food.” Depending on volume bought the indicators cost between $.025 and $.035 per package.

Fresh-Check® indicators may be able to combat some of the abuses in the cold chain by detecting and revealing the shocks that are possible. Young children, pregnant women, and the elderly are especially at risk to these cases of abundant bacterial growth (Stuppa B, 2007). This stems from bacteria, fungi, parasites, viruses, and their toxins. People become sick when they have eaten food that has had time for micro-organisms to grow and multiply in their food (Buzby 2001). For the most part food deteriorates because of bacteria, yeasts, and molds growing in the food. Given the proper conditions bacteria can divide in the time span of 20 minutes (Lewis 2002). Not only does this cause the concern for illness, but food spoilage is a concern for retailers as well. Fresh-Check® indicators may be able to give consumers a better idea of exactly what has happened to their fresh products throughout the cold chain process. Additionally, consumers may be able to use the time-temperature indicators in their home refrigerators when they are trying to determine if the product is safe or not. Use-by-dates are not safety dates; instead they should be seen as a good-faith promise of freshness (Lewis 2002). The use-by-date cannot account for a shock in the cold chain process.

The European Union requested a study on Fresh-Check® indicators be conducted by an independent laboratory. The study was carried out in Finland at the Department of Chemistry, National Veterinary, and Food Research Institute. It concluded the use of Fresh-Check® indicators was justified, and the color change showed good correlation with the sensory and microbiological quality of the products being tested (Stuppa A, 2007). The indicators are already being used in Monoprix, Wagon-Lits, and Ooshop in

Europe, Marriot, Texas American Beef, and Jennie O' Turkey in the U.S., and at Milco, Barakat, and Citychef in the Middle East (Stuppa B, 2007).

Related Literature

Many studies have been conducted about food labeling and food safety which provide valuable information for analyzing time-temperature sensitive indicators. Two Finnish economists, Terhi Latvala and Jukka Kola, analyze food safety aspects and food quality issues. They surveyed 1,640 consumers, and when asked what they pay closest attention to on a package of fresh beef the response was first the expiration date and secondly the color. Price was the fourth most important factor for Finnish consumers.

Latvala and Kola's (2004) study also pointed out when buying fresh beef Finnish customers put salmonella and E.coli O157:H7 over all other factors of concern (Environmental contaminants, Synthetic Residues, GMO's, Too Much Fat. etc…) This fact may be a positive attribute for Fresh-Check® indicators. Fifty-nine percent of the respondents in this study were willing to pay more to get additional information; however 41 percent were not willing to pay more because they felt the product was already safe enough (Latvala and Kola 2004). In the Finnish study out of the 41% of people who were unwilling to pay more they cited the reasons of: present labels guarantee the safety and quality, cannot afford higher prices, and labeling guarantees nothing as their highest reasons for zero willingness to pay (Latvala and Kola 2004). This factor must be considered when analyzing the Fresh-Check® indicators.

Xavier Gellynck et. al. (2006) reveal several factors about people's trust perceptions in the Belgian food system. Consumers are increasingly getting more information on their food packages. Two important topics are discussed in this paper, consumer interest in traceability as a response to quality concerns and information on meat labels. (Gellynck et. al. 2006).

A description of food wholesomeness was given, and several questions were asked about the concept of traceability and country of origin labeling. Consumers were shown four meat labels, and then asked to choose their preferred label. Findings revealed the most used items on the labels were the expiration date, meat type, weight, and price. Items like nutritional value, origin, and brand were seen as less significant by consumers. Only around 10% indicated they would pay a price premium for meat with extra information (Gellynck et. al. 2006). This may reinforce the theory that people feel comfortable with the present food labeling schemes.

When consumers were given the chance to look at the labels and then choose, the label with little or no traceability information on it was rejected, and the most preferred label was the one with the most traceability and origin information. However, since the origin said Belgium, and the study took place in Belgium there is high probability for bias (Gellynck et. al. 2006). Consumers do possibly have a subconscious response to labels on packaging; Fresh-Check® labels may play a subconscious role in providing an added measure of safety in consumer's minds.

Caswell and Padberg (1992) look at the comprehensive theory behind food labels. Labels go far beyond just providing the basic product attributes such as manufacturer, type of product, and price. They state, "There are many third-party uses consumers get from their food labels such as impact on product design, advertising, consumer confidence in food quality, and consumer education on diet and health."

Caswell and Padberg also note food labels add to consumers' information bases and help influence buying decisions. Food markets work better with additional information; therefore, competition is created when there is more information available to consumers. However, nearly two-thirds of consumers make their purchase decisions in the store while shopping an average one hour per week. Consumers evaluate over 15,000

products on the complex information that labels provide in a very short amount of time. When a shopper is in a hurry labels become less important as their decision making accuracy breaks down. Advertising, price, and previous use experiences have a more significant impact on many consumers' decisions than labels (Caswell and Padberg 1992).

Caswell reminds us labels should have a broad array of purposes in addition to revealing point of purchase information (Caswell and Padberg 1992). It may be determined Fresh-Check® indicators provide useful point of purchase information; however, it will be important to test whether they will also be useful a tool at home. Consumers may value labeling systems independently of the value they place on the label as a shopping tool. Some people perceive a sense of trust and security from labels; they know the label is there if they should decide to use it. It also helps them feel confident in the safety of food manufacturing and quality. (Caswell and Padberg 1992).

Wim Verbeke and Ronal Ward look at consumer's reactions to beef labeling in Belgium. A survey with 278 Belgian respondents was analyzed. There were four categories for consumers to answer. The first was "mandatory government regulated information," like meat type and sell-by-date. The second was "indication of quality" such as seal or stamp that would infer a quality guarantee. The third regarded traceability, and the fourth regarded country of origin labeling. Expiration date was overwhelmingly the most important factor. Traceability and country of origin labeling both received low scores. The characteristics that provided direct information into the quality of beef or the quality guarantee were ranked just after expiration date and slaughter date (Verbeke and Ward 2003). This shows consumers strong importance on quality. If the Fresh-Check® indicators can influence consumer's opinions of quality of fresh food products they may be a viable type of label to use.

Data and Methods

When consumers evaluate goods their quality aspects can be divided into search goods, experience goods, and credence goods (Latvala and Kola 2004). Search goods are goods in which the consumer can accurately determine the product's quality before it's purchased. Oftentimes search goods are known aspects like color, and will not have a large effect on nutrition and food safety (Caswell and Mojduszka 1996).

Experience goods are goods where quality can only be measured after the product is consumed. Taste is an experience good. A consumer can infer quality properties based on the taste of their food item. Quality must be signaled to consumers if there is to be a price premium for experience goods. Experience goods will play a role with quality attributes such as food safety and nutrition (Caswell and Mojduszka 1996).

Credence goods are goods in which quality cannot be obtained even after consumption, therefore the consumer must rely on the manufacturer for an appropriate level of quality (Latvala and Kola 2004). Credence goods require an authority figure such as a governmental agency, or organization that consumers can trust to lend information on credence attributes (Caswell and Mojduszka1996).

When looking at food safety many fresh food products will fall into the credence category because it is hard for the consumer to tell about the safety and quality of their food without information from a third party. Costs are highest when implementing safety policies credence goods. Consumers must also put their trust the manufacturer, wholesaler and retailer to ensure the food they purchase is safe. Fresh-Check® indicators may help move credence goods to search or experience goods. Consumers may also not have to rely on a 3rd party for all of their safety and quality information. They may be able to infer some of that on their own with the Fresh-Check® indicators. The cost may be internalized if people actively search out goods with Fresh-Check® indicators. Will

these additional costs per package, outweigh the risks associated with purchasing a credence good with limited information?

To help answer this question we interviewed grocery store managers and food/packaging technologists to gauge industry attitudes towards Fresh-Check® indicators. We found there are issues with people's knowledge of these indicators and a general sense of distrust associated with them. Additionally, some retailers wonder if they will be throwing out product that is still saleable. During interviews with retailers, questions about consumer abuse were raised. Some retailers believe consumers may abuse the product buy leaving it in a hot car or on the counter too long before refrigerating. They don't want product damaged by the consumer to be returned (Eskew 2007).

Peter Ragaert, a technological advisor for Pack4Food at the University of Ghent in Belgium, pointed out time-temperature indicators cannot mirror the actual state of the food with 100% accuracy. He stated modified atmospheric packaging creates a different environment inside the package than outside the package. Since the Fresh-Check® indicator is on the outside of the package it may not accurately predict the actual state of the product. He felt traditional labeling, such as use by dates, is still the best measure and tracking the cold chain process would provide answers to food mishandling in the cold chain. Ragaert points out new food technology will increase costs and be a problem for retail outlets that operate on very thin margins in products like milk, for example (Ragaert 2007). These are valid concerns when addressing food safety issues, and will need to be taken into account during a study of Fresh-Check® indicators.

We constructed a consumer survey to try and accurately capture their perceptions about the Fresh-Check® indicators. The subjects were randomly approached outside seven different grocery stores in and around Ghent, the third largest city in Belgium.

Subjects were told students at the University of Ghent were doing a project on food safety and quality and were given a survey with 10 initial questions about their food purchasing decisions. The second page of the survey presented a picture of a Fresh-Check® indicator on a product and a short description of how the Fresh-Check® indicator worked. Then they were asked to fill out 18 more questions about their perceptions of the Fresh-Check® indicators and their demographic information.

There were 252 mail-in survey responses. Subjects were asked their gender, age, employment, civil status, number of children, and education level. There were 183 female respondents and 67 male respondents; however, this is not surprising because women are traditionally the primary shopper for the household. To capture the primary household shopper, subjects were approached in front of grocery stores. There were 195 subjects who were the primary shopper for the household and 56 who were not. Forty-one respondents said they were still living at home, 45 were single, and 161 were married. Ninety-eight respondents were reported to have zero children, 91 respondents had 1-2 children, 46 respondents had 3-4 children, and 6 respondents had 5 or more children. The age of the respondents is given below.

Age

<20	20-29	30-39	40-49	50-59	60-69	70-79	>80
9	55	47	74	33	9	8	1

When asked about their employment subjects were given eight choices to describe themselves: office worker, teacher, student, laborer, self employee, retiree, other, and executive. The representation of the subject's employment status is represented below.

Employment

Office Worker	Teacher	Student	Laborer	Self Employee	Retiree	Other	Executive
71	39	34	33	31	20	18	3

The table below shows us 139 or 57% of our respondents have education beyond secondary school, and about 90 of them have some sort of a secondary education. This is

a representative sample. In 2005 62% of Belgians were seeking schooling beyond secondary education according to UNESCO.

Highest Education Level Completed

Primary	*Technical Sec.	*Special Sec.	*General Sec.	Higher Ed. Non-University	University
14	44	13	33	89	50

***Note: Secondary education in Belgium is divided into three parts: Technical--technical approaches, Special--preparation in a specific area i.e. art or music, General--broad preparation for higher education**

Empirical Results

The contingent valuation method was used to collect data in this study. Several studies cite evidence that hypothetical values reported in surveys often exceed actual values. In 1993 a study conducted by a National Oceanic and Atmospheric Administration set the "divide by two" rule. This meant hypothetical values should be cut in half to correct for hypothetical bias. Many studies have been done to try and correct for this bias; however, to our knowledge, there isn't a perfect model for eliminating bias in contingent valuation studies (Ash 2007). Realizing there is a chance for bias, we found the following results.

When asked about food purchasing decisions 44.4 % shop more than three times per week. Respondents that shopped between one and three times per week totaled to 50.3%. Twenty-seven percent of respondents purchase fresh meat products more than three times each week, while 57% of respondents purchase fresh meat products between one and three times per week. One must note purchasing products such as fresh meat may occur more frequently for the average Belgian consumer than for U.S. consumers.

	Everyday	>3 times/week	<3 times/week	1 time/week	<1 time/week
Frequence of Food Purchasing	33	79	63	64	13
Frequence of Fresh Meat Product Purchasing	12	57	89	53	38

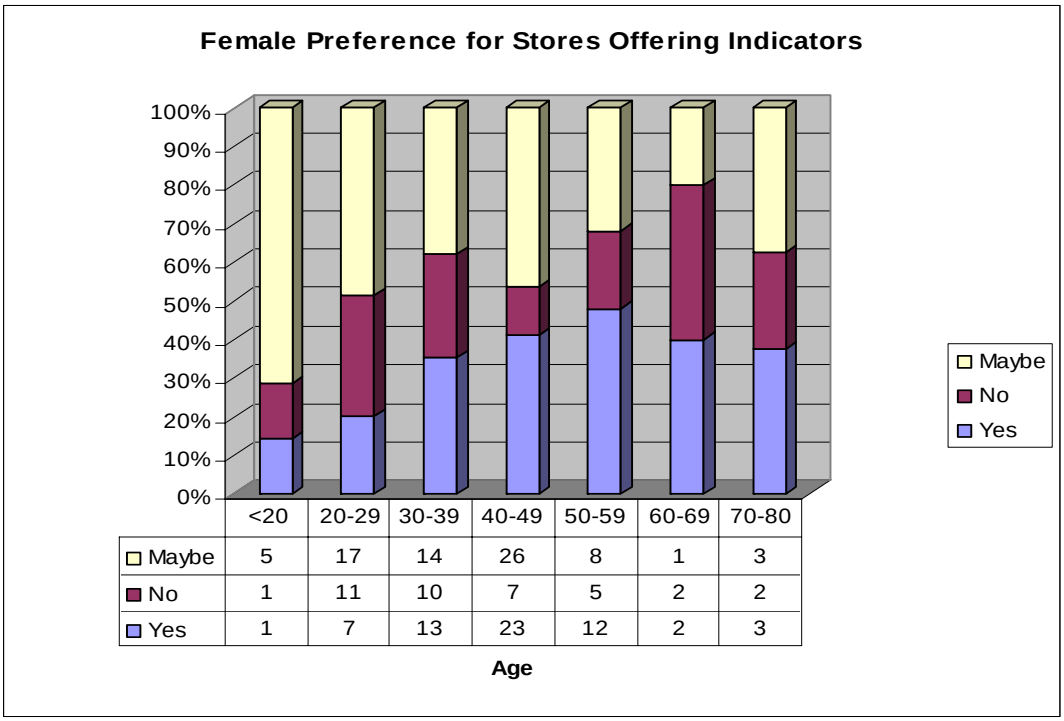
Respondents had an overwhelmingly positive response to the fresh check indicators in the preference portion of the survey (see table below). Nearly 75% of respondents saw a benefit for using Fresh-Check® indicators. And 21% recorded

'maybe' for seeing a benefit for Fresh-Check® indicators. Additionally, 71% said they saw Fresh-Check® as a significant food safety advantage, and 57% percent would rather buy a product with a Fresh-Check® indicator on it. This is consistent with Caswell and Padberg's findings that more information may make consumers feel safer. They know the indicator will be there should they need to use it in a food safety incident.

	Yes	No	Maybe
Brand Recognition for Fresh Meat Products	37%	63%	
Been or Known Someone who has gotten sick from Fresh Meat Products	26.3%	73.2%	
See a Benefit for Fresh-Check® Indicators	74.4%	4.4%	21.2%
More Likely to Buy Product with Fresh Check® Indicator	58.0%	16.8%	25.2%
See Fresh Check® Indicator as Significant Food Safety Advantage	71.7%	7.6%	20.5%
Preference for Buying Product with Fresh Check® Indicator	57.3%	8.5%	34.3%
Prefer Shopping at Stores that offer Fresh Check® Indicators	34.5%	24.1%	41.4%

For females, 72.6% of all respondents, 35% would prefer to shop at a store that used Fresh-Check® indicators, and 41% responded 'maybe' to the preference for shopping at a store that used Fresh-Check® indicators. This demonstrates the possibility of a niche market where people may be willing to switch stores to gain access to Fresh-Check® indicators. No strong tendencies were revealed for male shoppers.

Figure 1



	<20	20-29	30-39	40-49	50-59	60-69	70-80
Maybe	5	17	14	26	8	1	3
No	1	11	10	7	5	2	2
Yes	1	7	13	23	12	2	3

When combining gender, age, and preference for a store offering an indicator, women in their 40's-60's had the greatest preference (See Figure 1). This gives us a more accurate description of the target market for Fresh-Check® indicators. There is also a significant number of 'maybe' responses in figure 1 and throughout the paper. This may signal more information about this new technology may be needed.

Figure 2

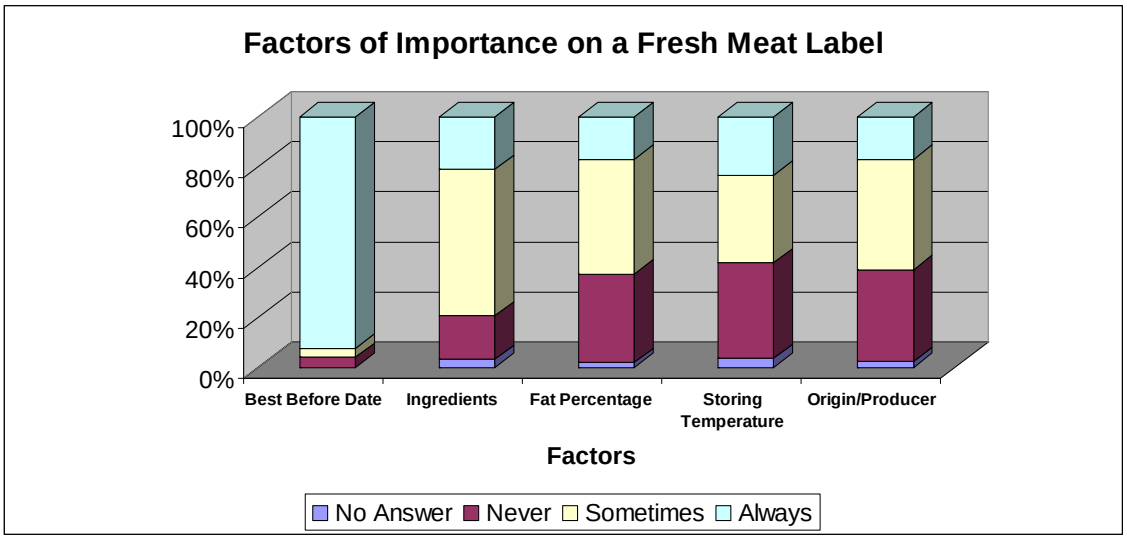


Figure 2 indicates what attributes people recognize on their meat labels. As other cited literature points out the most common response to this question is the best before or use-by-date; this was also true in our survey. Fresh-Check® indicators are to be used in conjunction with use-by-dates and will not replace them. About 30% of people 'always use' the storage temperature. Ingredients, fat percentage, and origin/producer are 'always used' by 25% or fewer respondents.

A modified Likert scale is used below to show consumer responses when asked about the indicator and about certain factors in the industry. We assigned the values of -3, -2, and -1 on the left side of neutral; we assigned the values 1,2,3 on the right side of neutral, and neutral itself is assigned a value of zero. Then we averaged each response to

create a tool for comparison. Of the 248 respondents 151 of them showed at least some confidence in the indicator. We found confidence in the indicator's average to be .90, slightly above neutral. Additionally, 175 respondents thought the product would be at least somewhat useful in the home. An average of 1.31 was recorded for usefulness in the home. This shows a moderately positive response.

	None	2	3	Neutral	4	5	Complete
Confidence in Indicator	4	3	7	83	72	62	17
Usefullness at Home	7	7	7	53	44	67	64
Safety in Belgian Meat Products	2	1	19	73	79	49	26
Importance of Packaging	23	17	9	85	41	32	32
Importance of Price	10	5	11	62	56	45	59

When analyzing industry wide perceptions, 154 respondents felt confident in the safety of Belgian meat products; this may indicate they feel the product is already safe enough. The average response was .92, just above neutral. It is interesting to note confidence in the Belgian meat supply and confidence in the indicator are very close. Next, we looked at the importance placed on packaging; 105 people placed at least some importance on packaging. However the average response was only .37; we can see it is much closer to neutral. This fact is important to note when analyzing Fresh-Check® indicators. The indicator must provide specific usefulness; it can't be seen as just another part of the package. Finally, we looked at the importance of price; 160 people said price was at least somewhat important. The average was 1.10 which shows price moderately above neutral.

Regarding the additional amount subjects are willing to pay for a Fresh-Check® indicator, we see the summary below.

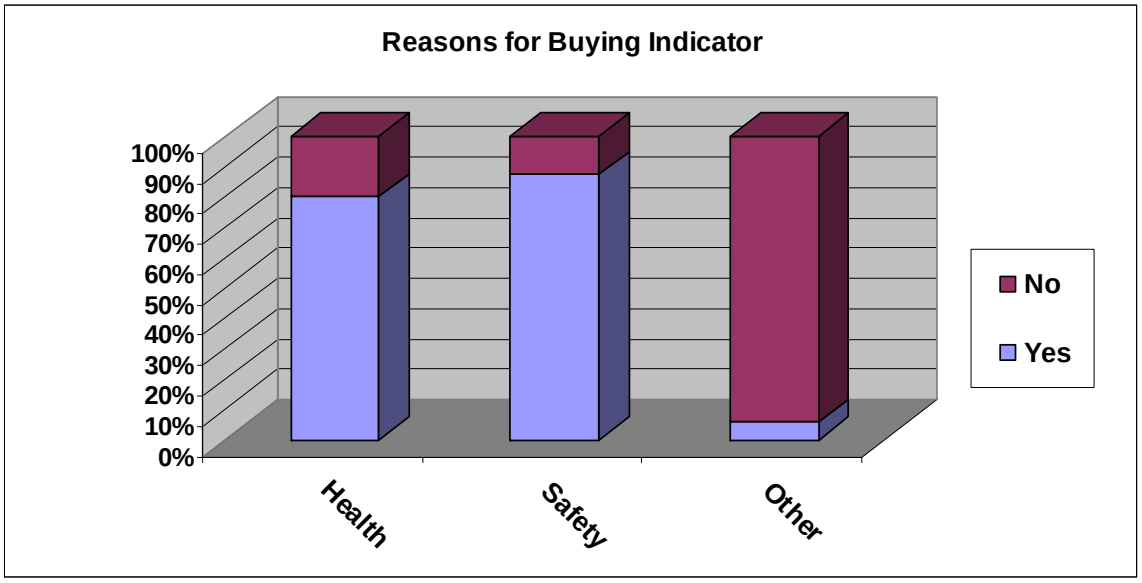
	0 Cents	10 Cents	20 Cents	30 Cents	40 Cents	50 Cents	> 50 Cents
Willingness to Pay	16	104	35	34	11	35	7

If we take a weighted average of these results respondents said they were willing to pay an average of .225 cents more for a product with an indicator on it. Even if we use the

"divide by two" rule that the NOAA study suggests, we can still say Belgian consumers will pay .1125 cents more for products with the indicators. Since the indicators only cost .03 cents per unit there could be a potential gain of at least .0825 cents.

In the *Data and Methods* section we suggested fresh food products had certain credence characteristics. These indicators may partially shift some goods from credence goods, where consumers must rely on a third party for information, to experience goods where consumers can use the information they have to make purchasing decisions. We also mentioned retailers were concerned with the extra cost associated with the indicators. This information will help us inform retailers of the potential gains that could be associated with the indicator during future study.

Figure 3



If respondents answered 'yes' to purchasing a Fresh-Check® indicator, safety was cited as the largest reason for buying, approximately 90% (See Figure 3). Health was close behind approximately 82%. This adds validity to the assertion that in the current environment, people are concerned about the health and safety aspects of their food.

Conclusions and Implications

This study focuses on finding Belgian consumers perceptions, willingness to pay, acceptance, and preference for the Fresh-Check® indicator. Based on our results, we found subjects had a moderately positive response to Fresh-Check®. Seventy-five percent of subjects perceived a benefit for using this indicator, and 71% perceived it to be useful as a food safety and quality device. They were also willing to pay an average of .225 cents more for a product with an indicator on it apposed to one without an indicator. The cost of the indicator is only .025 to .035 cents per package. When asked if they would buy a product with an indicator over 80% said they would for health or safety reasons. Consumers did put less slightly less trust in their trust of the technology behind the indicator; it had a weighted average of .9 which is slightly above neutral. Fifty-seven percent of subjects would purchase a fresh food product with an indicator over one without an indicator as compared to 17% who would not. Thirty to forty percent of women in their 40's-60 would even be willing to switch stores to gain access to the indicators. Accounting for the bias of the contingent valuation method, we feel Belgian consumers would still have a positive response to the Fresh-Check® indicators.

Additional preliminary analysis of the survey data indicate the production process, product quality, and look are primary factors utilized in making purchase decisions. Production process includes: production method, labeling, safety and health; food quality includes: quality, freshness, taste, and trustworthiness; look includes: appeal and color. Due to the central role product freshness plays in determining quality and because the Fresh-Check® indicator is a reliable gauge of product environment throughout the supply chain, it is reasonable to expect that consumers could shift fresh food products from credence to experience goods.

Based on our research a certain target market could be defined for Fresh-Check® indicators. It would most likely be directed toward women in their 40's-60's who may have children and are very conscious of the foods they eat and feed their families. Many of the survey questions had a significant proportion of 'maybe' responses indicating consumers may not be fully educated about this product. Further education and research on these indicators will be needed. Additionally, research in the cold chain and retail markets is needed to determine the future success of this product.

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