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Identifying Market Preferences for High Selenium Beef

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Abstract

Selenium is an element found in relatively high concentrations in crops and livestock raised on high-selenium soils. Evidence suggests that a high-selenium diet can reduce the risk of certain cancers. A choice experiment was conducted to identify preferred attributes for a high-selenium beef product and the characteristics of potential market segments. Labeling reflecting scientific support linking selenium and reduced cancer risk, and natural-source selenium was ineffective in forming the general population of respondents. Marketing opportunities identified are consistent with existing functional food market segments and include targeting consumers with higher incomes and education, 45 to 55 years of age, and with children.

Keywords: Choice Experiment, FDA approval, functional foods, health claim, labeling, selenium

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Background

Producers in regions of North and South Dakota are interested in investigating marketing opportunities for their naturally high-in-selenium products in the functional food category. Functional foods are firmly established in Japan, where the term reportedly originated (Stanton et al. 2001). European functional food markets are dominated by probiotics and prebiotic dairy foods. Vitamin- and mineral-fortified functional foods are more common in the U.S. market, which is underdeveloped compared to its counterparts in Europe and Japan.

According to Childs (1997) and Stanton et al. (2001), the typical functional food consumer in the United States was classified as female, middle-aged, well educated, of high income, and actively interested in health. Subsequent literature reports inconsistencies in identifiying the effect of socio-demographic characteristics on purchasing behavior regarding functional foods. It also identifies additional factors affecting attitudes and purchasing intentions for functional foods, including those high in Selenium (Se). For example, Cox and Bastiaans (2007) report attitudes about the importance of consuming Se-enriched foods among Australians depend on the efficacy of the product in reducing cancer risk and the respondent's fear of cancer, self-efficacy and vulnerability to cancer.

Other literature supports the idea that willingness to pay (WTP) for functional attributes depends on the specific product under consideration (Munene 2006, Cox and Bastiaans 2007, Hailu et al. 2009), with those perceived as healthy and appearing more credible in their claim as functional foods (Annunziata and Vecchio 2011, Siró et al. 2008).

Maynard and Franklin (2003) identified market segments for a specific functional food category with promise as a cancer preventative (conjugated linoleic acid dairy products), are consumers with children or health-conscious consumers in the household. Willingness to pay among some respondents was dependent on the medical community's support of the cancer-fighting evidence.

Gilbert (2000) reported that 93% of American shoppers desire foods *naturally* nutritious in key vitamins and minerals, considerably more than those who agree that supplements (62%) and fortified foods (55%) are important. This concurs with Davis and Finley (2003), Cox and Bastiaans (2007) and Sloan (2012) who report that consumers believe vitamins and minerals are more beneficial when naturally sourced from food. The 11% reported by Gilbert who strongly agreed foods could reduce drug use were labeled "food as medicine shoppers"; they are often the target of functional food products entering the market. Positive health claims had a slightly higher appeal overall to these shoppers than a claim of fear. For example, "helps to maintain healthy cholesterol" was slightly favored over "may reduce risk of heart disease." Schmidt (2000) concurred that positive statements are better received and provides additional support for the importance of the role of the medical community, dieticians, and nutritionists in marketing functional foods. Siró et al. (2008) argue that positive claims are better for some products while labeling indicating their role in reducing risk is better for others.

West et al. (2002) used stated choice experiments to estimate WTP for functional foods (e.g., anti-cancer tomato sauce) among Canadians. They found a majority were willing to pay a premium, especially if the functional property added to foods was derived from plants, although 44% were skeptical about the validity of nutrition claim information. West et al. suggested that this skepticism implies the government must employ the assistance of nutritionists and health

care professionals to disseminate information about the value of functional foods. Seventy-two percent of respondents were willing to pay for a functional attribute in a *meat product* that reduced heart disease. The authors suggested this may reflect a higher percentage of consumers willing to pay a premium for foods that are generally considered less healthy to begin with (e.g., potato chips or, as the case for the current study, steak), conflicting with findings by Annunziata and Vecchio 2011 and Siró et al. 2008.

Health claim labeling for other foods has also generally been found to be effective. For example, Roe, et al. (1999) found that consumers were more likely to consider a product healthier and have higher purchase intentions when it featured a health claim. The presence of a health claim also raised product rating on health attributes not offered in the claim (referred to as the halo effect). Length of claim can influence its effectiveness. Wansink (2003) tested three front health claim label alternatives (long, short, and no label) with a more informative back label. Consumers who saw short claims recorded more positive attribute-specific (versus general evaluative) thoughts, increasing the believability and persuasiveness of the health claim.

Garretson and Burton (2000) investigated nutrition facts label and health claim (low in fat and high in fiber) effects on Arkansas consumers' attitudes, purchase intentions, perceptions of disease risk, and diet-disease knowledge. Most consumers relied on nutrition facts information rather than claims. When compared to conditions without health claims, inclusion of a diet-disease health claim led to a marginal reduction in cancer and heart disease risk perception. Kozup et al. (2003) found that a heart-healthy logo generally indicated to primary household shoppers that the food would reduce the likelihood of heart disease or stroke. Nutrition information led to more positive attitudes towards the food product, nutrition, and reduction of disease risk, and increased purchase intentions.

Selenium

Selenium is an essential trace mineral necessary for appropriate function of the immune system, muscle function, successful reproduction, and peak brain function. It also functions at the catalytic centers of several antioxidant and thyroid hormone regulating enzymes (Rayman 2000; Combs 2007). Deficiencies in selenium have been linked to decreased thyroid function, cardiovascular disease, cancers, and other health problems (Rayman 2000)[1].

Selenium was first recognized as having some nutritional importance half a century ago (Schwarz and Foltz 1957), and, shortly thereafter Shamberger and Frost (1969) suggested a link between selenium and cancer risk (Combs 2000). They observed an inverse relationship between U.S. local cancer rates and geographical distribution of selenium in American forage crops.

Consideration of the market potential for a *naturally* high-in-selenium beef product is encouraged by evidence indicating the meat from beef cattle consuming high-selenium feeds maintains an elevated selenium level, that the selenium is well distributed throughout the

[1] The Selenium and Vitamin E Cancer Prevention Trial (SELECT), involving more than 35,000 men from North America, was conducted to investigate the effect of oral supplementation of SE, Vitamin E, and Se + Vitamin E on prostate cancer (Lippman et al. 2005). Although no preventative effect was identified, El-Bayoumy (2009) and Rayman and Combs (2009) offer compelling arguments to further examine the role of Se in various doses and forms on the cancer development processes.

animal's muscles (Hintze et al. 2002), and that selenium from natural sources is better absorbed in the meat (Lawler et al. 2004). Beef is already an important source of selenium for North Americans (Shi and Spallholz 1994). And, beef from cattle consuming plant material growing or grown in seleniferous areas has an elevated selenium level. Hintze et al. (2001) report that beef raised in a moderately seleniferous area averages 70 micrograms selenium in a 100 gram beef serving. This compares with daily selenium intakes of 96 micrograms (for women) and 120 micrograms (for men) Combs (2001) suggests would be sufficient to sustain an optimal cancer-protection target level.

Selenium was petitioned for validation of its role as an anti-carcinogenic. The Food and Drug Administration (FDA) concluded that there was not significant scientific agreement about the science underlying the statements that 'Selenium may reduce the risk of certain cancers' and that 'Selenium may produce anti-carcinogenic effects in the body.' However, the FDA did allow that existing evidence was strong enough to support qualified health claims as long as they were appropriately worded and not misleading to consumers (FDA 2003).

Currently, information about market potential for naturally high-in-selenium products, including beef, is very limited. The only known study is one considering the market potential for high-selenium wheat. SJH and Company, Inc. (2004) concluded that there was currently little industry support among wheat processors (end-users), and that marketing a high-selenium product would involve a complicated educational component and a not inconsequential level of risk. This agrees with Cox and Bastiaans (2007) who report that people don't recognize Se as an antioxidant. SJH and Company, Inc. also noted that a high-Se product would need to be a "science-based value proposition", i.e., strong support for the selenium-health link claim would be necessary. Further, for business viability, premiums received for selenium-enhanced products would have to exceed the costs of testing for selenium level and additional processing and marketing costs.

Objectives

In the current study, the key objective is assessing perceptions and effect of a health claim linking a naturally high-in-selenium beef product and cancer incidence. Assessing consumers' WTP for a high-selenium beef product is an essential step in evaluating the economic viability of producing and marketing this product and was the primary goal of this research. Cost-effective marketing usually requires identification of market segments. Therefore, the second objective is to identify potential market segments for high-selenium beef.

Methods

Survey Design

A focus group was conducted in May 2006[2]. Specific objectives were: to gain information about consumers' labeling preferences; evaluate consumers' knowledge of functional foods and selenium; determine product attributes with potential to be combined with selenium level and attribute ranges to be represented in the survey instrument; and facilitate selection of the range of price-premiums considered. The focus group was conducted according to recommendations

[2] An initial focus group was assembled with seven staff members in the Department of Agribusiness and Applied Economics at North Dakota State University consisting of three males and four females, ages 23 to 56.

specified in Krueger (1988). Focus group members did not participate in the subsequently-described choice experiments.

Eight women participated in the focus group, each indicating they were the primary household shopper and purchased beef. Half used dietary supplements and half had a history of cancer in their immediate family. Participants were only vaguely aware of selenium and had very little knowledge of its relation to cancer or the research that supports its role in cancer-prevention. Several commented that the word selenium itself "sounds bad." Most participants were aware of the availability of functional foods in the marketplace and in fact purchased them (e.g., calcium-enriched orange juice), but few were familiar with the specific term "functional food."

Different styles of labels were pictured on cuts of beef (steaks and hamburger) and displayed for participants to examine. Participants commented that short labels did not provide enough information. Their use elicited slightly negative perceptions. Medium labels with suggestions from research were most accepted and preferred, and a large label was described as containing too much information. FDA approval of selenium as a cancer preventative was generally accepted as positive and was described as likely to result in a slightly higher WTP for a beef product rich in selenium. After the moderator explained current research regarding selenium as a potential cancer-preventative, participants initially indicated they would be willing to pay a premium ranging from 0 to 10%. Individual follow-up discussions with the four participants with cancer incidences in their immediate family extended the maximum premium to 15%. Participants also indicated that a premium might be paid in order to support a locally-based product and economy given the natural soil placement of selenium in the Dakotas.

Experimental Design and Data

Because selenium-rich beef products considered in the current study are not commercially available, only stated preference methods of non-market valuation were considered. Choice experiments (CE) consider choices among products varying by attribute and follow Lancaster's theory of utility maximization (see Appendix) (Lancaster 1966). They more closely mimic a consumers' typical shopping experience than do dichotomous choice (DC) experiments, which allows cross-price elasticities to be easily determined between new and existing products, and can produce results similar to those found using revealed preference methods. Alpizar et al. (2003) also argue that it is more difficult for participants to strategically respond to queries in a CE compared to DC because of the number of unknown attributes in the CE.

A disadvantage of CE is that only discrete choices are observed, which complicates estimation of WTP and demand. There may also be inconsistencies among participants' responses across choice questions, and responses may be influenced by the complexity of the decision. Specifically, Gao and Schroeder (2009) found that WTP for product attributes depends on the number of attributes consumers consider and how they are related to one another.

Further, as is true for stated preference methods in general, CE are frequently hypothetical, and therefore WTP estimates may be biased (Silva et al. 2007, Lusk et al. 2005). Of particular note is the potential for embedding (Goldberg and Roosen 2005). Embedding occurs when respondents use their hypothetical premium to 'vote' for a product or attribute when in fact they would not

actually pay a premium for it. To overcome this problem, recent work has included the use of 'incentive compatible' contingent valuation studies where the participant has a non-zero probability of being required to purchase one or more of the goods they are evaluating.

Choice experiments have been used to test WTP for a variety of products with considerable focus on hypothetical products and those with credence attributes, such as is the case with the current study. For example, Olynk, et al. (2010) used CE to estimate WTP for credence attributes of milk and pork related to production practices. Bai et al. (2013) used a CE to calculate WTP for milk traced under different certificate issuers.

CE, a conditional logit model, was selected for the current project. The dependent variable was choice (one of the four choices in each set). Independent variables included attribute levels of the choice product and socio-demographic and behavioral variables. The experiment was approved by the NDSU Institutional Review Board; and provided to Zoomerang Market Tools, an online survey company that manages survey panelists, to administer during the fall of 2006[3]. Data were analyzed using Limdep® (Greene 1998).

Attributes and levels of each attribute were identified and grouped into choice sets. The experimental design of the survey consisted of three attributes: premium, health claim, and origin, each with three levels. Premium levels were set at 5%, 10%, and 15% of current local market price. Health claim levels were that of FDA level A (unqualified), FDA level C (qualified), and a suggestion based on recent research (research suggested). The FDA level A health claim is unqualified, reflecting significant scientific agreement about the validity of the disease-diet relationship (Federal Trade Commission 2006). A level C claim is qualified. An example of a level C health claim is "A diet high in selenium may reduce the risk of cancer but the scientific evidence is limited and inconclusive" (Federal Trade Commission 2006, p. 3). The level R health claim used in the current study is not recognized by the FDA and does not indicate FDA support.

The origin attribute referred to the label design, as well as the wording, and was represented by "naturally rich in selenium" and "selenium fortified" phrases on the labels. The "naturally rich in selenium" phrase was used within a plain rectangular border as well as a North Dakota border, thus creating the third level within this attribute.

Orthogonal reductions in the full factorial design were made using SAS® macros, resulting in 18 choice sets. Three surveys of six questions each were used for the experiment, also selected using SAS® macros. Figure 1 shows an example choice set and the verbiage instructing respondents.

[3] Although firms have added and continue to add to the market products with identified health benefits, to the best of our knowledge, there are no products that contain an FDA health claim related to the use of selenium. Furthermore, none of the high-selenium products that are on the market result from the type of extended, multi-owner marketing channel characterizing beef production. This process can result in considerable product heterogeneity, requiring that individual carcasses be tested for level of selenium and any other marketed attribute associated with its composition. Finally, the research provides insight into marketing food products with credence attributes unfamiliar to consumers.

Please read the following product description for a new product.

Selenium, an essential trace mineral to our health, has shown some recent evidence of having cancer prevention qualities. The beef product shown below is a top sirloin steak. The white-out area is where the store's label was. Participants were asked to respond as though they were going to purchase this sirloin steak. Choice "D" is the standard steak at the current market price and without any selenium labeling or known levels of selenium at the current market price.

Figure 1. Instructions and example of choice set offered to shoppers

Each of the surveys began with a series of five beef consumption questions and ended with 15 demographic and behavioral questions included to aid in identifying market segments for high selenium beef. Respondents were limited to consumers living in the United States and serving as their household's primary grocery shopper, at least of age 25, and who regularly purchased beef and meals that included beef. Numbers completed for the three surveys were 485, 484, and 507, for a total of 1,476 responses. Data were cleaned to omit incomplete entries, entries by those who were not the primary shopper, or those who did not consume beef, and those entries with extreme outliers, such as shopping for groceries 100 times per month. A total of 172 responses were omitted resulting in 1,304 completed surveys.

Survey Population

Respondents were predominately female (77%) and Caucasian (89%). Age distribution was 16% (25 to 34 years), 28% (35 to 44), 32% (45 to 54) 18% (55 to 64), and 6% (65 and older). Sixty-one percent of respondents were married and nearly half (48%) reported having children in the household.

Participants were asked to identify the highest level of education they had completed according to the following categories: high school diploma or equivalent (25%), some college (33%),

associate's degree (12%), bachelor's degree (18%), and graduate studies or more (11%). A slight majority (53%) of respondents had full-time employment status followed by homemaker (21%), retired (16%), part-time (8%), and student (2%). Figure 2 shows the distribution of income of respondents.

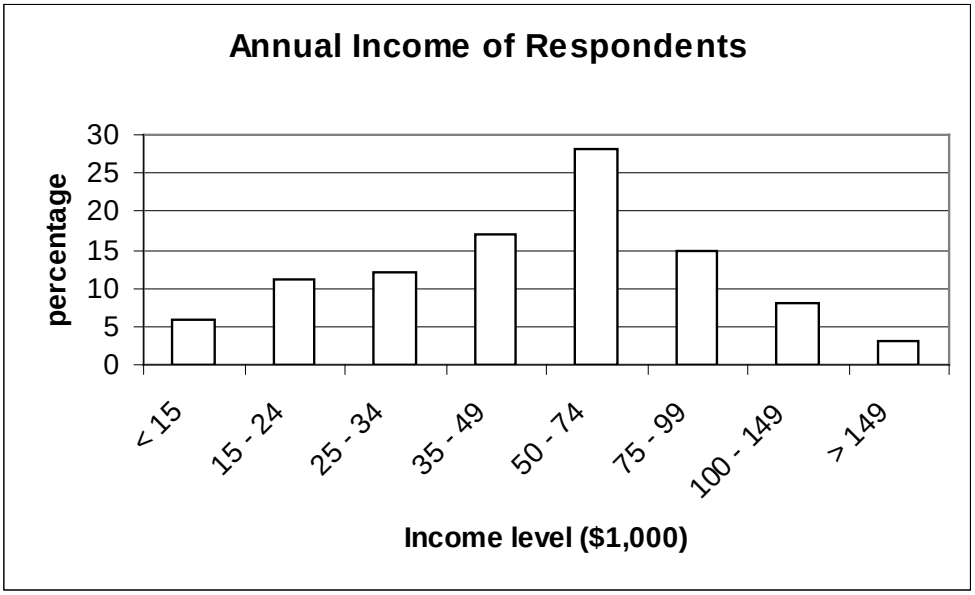

Figure 2. Income of Respondents

Two-thirds of respondents reported intentionally purchasing functional foods, one-third used tobacco products, and half reported taking dietary supplements. Fifty-six percent indicated they did not consume alcoholic drinks during an average week, and another 24% reported drinking an average of only one to three drinks weekly. Panelists were asked if they had a variety of health conditions in their immediate family. Half indicated high blood pressure, 39% arthritis, 33% diabetes, 25% cancer, 23% heart disease, and 11% osteoporosis. Twenty-eight percent reported no incidences of these health conditions among their immediate family members.

Results and Discussion

Results of the conditional logit model indicate a good fit (Table 1). Standard errors on estimated coefficients were low. The base case for this model is the "none" alternative: the standard steak labeled only 'Beef' and with market pricing (i.e., no premium).

Unexpectedly, respondents did not prefer the unqualified, qualified, or research suggested health claims. These claims included the words "cancer" and "selenium"; both words may have elicited negative thoughts about the product. As expected, the sign on the premium coefficient was negative, but it was not significant.[e] The "North Dakota Naturally Rich in Selenium" and "Selenium Fortified" labels also were not significant. Willingness-to-pay was not estimated because consumers expressed less (not more) willingness to purchase a high selenium beef product. Alternatives with a price-discount attribute were not included in the model.[4]

[4] A reviewer noted that the relatively small range of price premiums considered may have contributed to the lack of statistical significance for price.

Table 1. Health Claim Preferences

Variable (Health Claim Interaction)[a]	Coefficient and Sign	Standard Error	Level of Significance	Marginal Effect
Unqualified FDA Health Claim (U)	-1.837	0.398	0.0000	
Qualified FDA Health Claim (Q)	-1.576	0.455	0.0005	
Research Suggests Health Claim (R)	-2.190	0.437	0.0000	
Price	-0.679	0.444	0.1265	
North Dakota Label	0.269	0.040	0.4978	
Fortified Label	0.499	0.040	0.2126	
Functional Food Purchaser (U)	0.613	0.067	0.0000	13.926
Functional Food Purchaser (Q)	0.567	0.077	0.0000	2.029
Functional Food Purchaser (R)	0.833	0.076	0.0000	-0.890
Has at least a 4-year Degree (U)	-0.154	0.071	0.0317	3.124
Has at least a 4-year Degree (Q)	0.161	0.078	0.0403	3.703
Has at least a 4-year Degree (R)	0.014	0.077	0.851	2.007
≥ $50,000 household income (U)	0.171	0.065	0.0083	10.916
≥ $50,000 household income (Q)	0.412	0.076	0.0000	9.992
≥ $50,000 household income (R)	0.249	0.071	0.0005	0.451
Age 35 – 45 (U)	0.302	0.154	0.0489	-0.337
Age 35 – 45 (Q)	0.210	0.179	0.2409	3.814
Age 35 – 45 (R)	0.329	0.168	0.0506	-1.267
Age 45 – 55 (U)	0.171	0.064	0.0083	10.916
Age 45 – 55 (Q)	0.412	0.076	0.0000	9.992
Age 45 – 55 (R)	0.249	0.071	0.0005	0.451
Age 55 – 65 (U)	0.566	0.103	0.0000	-0.562
Age 55 – 65 (Q)	0.624	0.125	0.0000	-0.492
Age 55 – 65 (R)	0.697	0.111	0.0000	-1.073
Exercise 0 days / week (U)	-0.276	0.100	0.0059	10.916
Exercise 0 days / week (Q)	-0.212	0.117	0.0709	-0.416
Exercise 0 days / week (R)	-0.561	0.110	0.0000	1.734
Exercise 1-2 days / week (U)	0.232	0.086	0.0071	3.887
Exercise 1-2 days / week (Q)	-0.651	0.101	0.5186	-0.855
Exercise 1-2 days / week (R)	-0.170	0.092	0.0652	3.411
Exercise 3-4 days / week (U)	0.263	0.083	0.0015	-6.257
Exercise 3-4 days / week (Q)	0.145	0.095	0.1271	-0.855
Exercise 3-4 days / week (R)	0.649	0.088	0.4610	4.926
Exercise 5-7 days / week (U)	0.167	0.105	0.1117	-5.272
Exercise 5-7 days / week (Q)	0.300	0.121	0.0131	-0.855
Exercise 5-7 days / week (R)	0.113	0.111	0.3085	-0.850
Tobacco User (U)	0.108	0.064	0.0915	5.978
Tobacco User (Q)	-0.130	0.076	0.0879	7.255
Tobacco User (R)	0.822	0.071	0.2443	0.297

Note. Parentheses following the noted attribute indicate it is an interaction term in the model with U (unqualified FDA labeling), Q (qualified FDA labeling), or R (research supported labeling).

The "Naturally Rich in Selenium" label was excluded from the model. Presumably, respondents did not differentiate between this label and that differing only by use of a North Dakota border. The North Dakota label border was in the shape of North Dakota which is, in retrospect, very similar to the rectangle otherwise used.

Marginal effects of socio-demographic variables included in Table 1 represent the effect of a change in attribute 'm' of alternative 'j' on the probability that the individual would choose alternative 'k' (where k may or may not equal j) (Greene 1998, p. 531), mathematically shown in equation 1.

$$(1)\ \delta_{jk}(m) = \partial \Pr ob[y_i = k] / \partial x_{ji}(m) = [1(j = k) - P_j]P_k\beta_m$$

As measured by the size of the marginal effects, the most influential variables towards preference for the health claims are consistent with previously-identified attributes of functional food shoppers. Those who intentionally purchase functional foods preferred the FDA health claims, especially the unqualified claim, which is logical in that they would be more likely to understand the significance of an FDA-supported health claim. Self-identifying as using supplements did not have a significant effect on preference. Individuals with household incomes of $50,000 or greater preferred all three of the health claims at highly significant levels and the marginal effect was important for the FDA claims. Being in the 45 to 55-year-old age category increased preference for the FDA health claims. Marginal effects for the age categories of 35-45 and 55-65 years-old were negative when significant but relatively small. Those with at least a 4-year undergraduate degree preferred the FDA health claims. Those who exercise not at all or one to two times per week preferred the FDA unqualified health claim, while those exercising more did not. Those exercising up to four days per week preferred the research suggested health claim. Tobacco users preferred the stronger FDA health claims.

Men preferred the research suggested health claim, but the marginal effect was small (Table 2). Gender was insignificant for the FDA health claims. Married respondents held less preference for the qualified FDA health claim, although preference for the other health claims was insignificant. Those respondents having children exhibited positive preference for the unqualified FDA health claim. Those who purchased at least four steaks per month did not prefer the unqualified FDA or research suggested health claims, although the marginal effect for the research suggested claim was small. Preference for the qualified FDA health claim was insignificant. Those who did not consume alcohol preferred the unqualified FDA health claim and the marginal effect was relatively large. The marginal effects for the other two health claims were insignificant. Hispanic respondents' preference for all three health claims was significant, but marginal effects were small and conflicting.

Although panelists' responses about the incidence of six health issues within their immediate family were included in the model, only high blood pressure was significant for each health claim, and the effects were conflicting. Respondents with diabetes in their immediate family had a preference for the qualified FDA health claim. Surprisingly, an incidence of cancer in the family did not significantly affect preference for either FDA health claim. And, although it had a significant effect on preferences for the research suggested health claim, the marginal effect was

small. Those with incidences of heart disease and arthritis also preferred the research suggested health claim but, again, the marginal effects were small.

Table 2. Health claim preferences: Interactions with an inconclusive effect on health claim

Variable (Health Claim Interaction)[1]	Coefficient and Sign	Standard Error	Level of Significance	Marginal Effect
Male (R)	-0.227	0.083	0.0061	0.487
Married (Q)	-0.141	0.073	0.0538	-2.486
Has children (U)	0.138	0.067	0.0450	6.687
Four Steaks / Month (U)	-0.208	0.064	0.0012	-4.733
Four Steaks / Month (R)	-0.144	0.070	0.0406	-0.834
Non-drinker	0.481	0.144	0.0008	10.916
Hispanic / Latino / Spanish (U)	0.586	0.261	0.0247	-0.350
Hispanic / Latino / Spanish (Q)	0.577	0.291	0.0472	0.384
Hispanic / Latino / Spanish (R)	0.582	0.305	0.0568	1.945
High blood pressure (U)	0.162	0.066	0.0142	2.048
High blood pressure (Q)	0.216	0.076	0.0045	-2.295
High blood pressure (R)	0.123	0.072	0.0879	-1.006
Diabetes (Q)	-0.154	0.081	0.0572	5.295
Cancer in immediate family (R)	-0.214	0.082	0.0088	0.297
Heart Disease (R)	-0.181	0.087	0.0366	1.472
Arthritis in immediate family (R)	0.339	0.073	0.0000	0.670
Osteoporosis (U)	0.224	0.099	0.0231	-0.169
Osteoporosis (R)	0.167	0.107	0.1175	0.384

Note. [1]Parentheses following the noted attribute indicate it is an interaction term in the model with U (unqualified FDA labeling), Q (qualified FDA labeling), or R (research supported labeling).

Conclusions

The primary objective of this study was to identify the preferred level of beef attributes, including price, origin of selenium, and label-claim made regarding the value of selenium as a cancer preventative. As expected, consumers preferred a lower priced product although this preference was not significantly different than zero. Health claims had a negative effect on preference compared to the control steak. This may be due to the fact that the word "cancer" was used on the label. Gilbert (2000) and Schmidt (2000) argue that a positive claim has higher appeal than a claim of fear or negative claim (e.g., can reduce risk of cancer), and, food marketers often abide by the rule of thumb not to use a disease name on a label if possible (e.g., using 'supports healthy bone growth and maintenance' rather than 'prevents osteoporosis'). However, in the current work, the link between the scientific effects of Se on the body and cancer incidence would be unknown to most consumers.

It is also possible that a general lack of knowledge about selenium produced negative thoughts about the selenium-enhanced product. Focus group participants agreed that selenium "sounds

bad." The same type of perception (i.e., negative interpretation of an attribute considered value-added for marketing) was found for irradiated beef (e.g., see He et al. 2005; Nayga et al. 2006). Furthermore, even with a reported health benefit, interest in a high-selenium beef product may have been outweighed by the uncertainty of its other potential consumption effects. International Food Information Council Foundation (2006) attributed a substantial drop over time in the number of Americans who strongly agreed certain foods may have additional benefits to confusion in light of the vast amount of conflicting research they are exposed to. Hu et al. (2006) found that Japanese consumers viewed a genetically-modified attribute of bottled canola oil more negatively when they were provided with neutral or somewhat supportive information about biotechnology than when they received no such information. The authors introduced the hypothesis that this information may have caused an "alarmist effect" related to uncertainty about this credence attribute. They too offered information overflow as another possible explanation. They argued that information about the diet-disease relationship and an endorsement by a trusted entity are necessary for effective marketing of an un- or little-known credence attribute such as that considered in the current research. Their hypotheses are worth considering in investigating why consumers did not prefer high-selenium beef over the conventional beef in the current study.

Labels proclaiming the beef to be Naturally Rich in Selenium (both with and without a North Dakota border) and to be Selenium Fortified did not affect willingness to purchase. Further differentiating the labels may increase their effectiveness. For example, additional verbiage that more clearly identifies the state-origin of the beef might be included such as Bosworth et al (2014) did with their Utah's Own labeling for ice cream. Another possibility is that consumers may not care whether the product's elevated selenium level is natural or is the result of fortification, although this is contrary to existing literature for some other foods (e.g., see Sloan 2012, Cox and Bastiaans 2007, and Davis and Finley 2003).

This study further aimed to identify potential market segments for high-selenium beef. In general, functional foods are more frequently purchased by consumers with higher education and income. This held true in the current study as income levels greater than $50,000 or having at least a bachelor's degree had a positive influence on preference for the FDA health claim labeled beef. Those with children and those who did not consume alcohol preferred the unqualified FDA health claim in contrast to those consuming at least four steaks per month, who did not prefer this health claim. Based on the literature, gender was expected to affect preference but did not. Those in the 45 to 55-year-old age range preferred FDA health claims and may be a viable market segment for a high-selenium beef product. Current research supports that elevated selenium intake works short-term to prevent cancer rather than being a preventative requiring long-term consumption. This information was not provided to participants, but its inclusion may increase preference for the high-selenium products, especially among older consumers.

Not well explained is why disease incidence among an immediate family member did not consistently influence preference for the high-selenium product. Perhaps the wording of the question to include only immediate family members was too inclusive (e.g., incidence among friends, colleagues, or others may also cause individuals to consider more carefully the potential for disease). It also may be that those with a history of cancer in their family are tested at a younger age and more regularly for the disease or otherwise take action to prevent cancer and

therefore feel more secure. Our inability to create a disease-exposed market segment for this product is somewhat contrary to conventional wisdom (e.g., see Mark-Herbert 2003) and calls for further investigation.

Another interesting finding is that those with less health-oriented lifestyles, including those who do not exercise (much) and who use tobacco preferred the health claim labeled beef. This is consistent with the concept of risk compensation where a remedy reduces the perceived risk of a risky behavior (e.g., tobacco use) so individuals may "trade away" some of the reduced risk by engaging in riskier behavior. For example, Bolton et al (2006) found that a remedy message for a nicotine replacement product increased smoking intentions, and a remedy message for debt consolidation loans increased risky financial behavior intentions. In other words, remedy messages hurt those consumers most in need of help; those already engaged in risky behavior with a "high problem" status.

Further Work

Lessons can no doubt be learned through detailed investigation of successful (and unsuccessful) campaigns to introduce functional foods. Identifying a well-articulated health claim will be very important to future studies as was demonstrated by He et al. (2005) and Frenzen et al. (2000) about irradiation. Consumer resistance to irradiation was unexpected given the scientific evidence supporting its use to improve the safety of food. Due to a widespread lack of knowledge, point of purchase information about selenium may be beneficial to inform consumers about the benefits and hopefully remove the consumers' fear of including more of a little-understood element in their food. This may be the most important limitation for the industry, since promotion of a substance whose role in health is largely unknown to the public is difficult and costly. And, it was not particularly effective for irradiation, although consumer resistance may be higher regarding the process of irradiation than elevated selenium levels.

For example, like selenium, fluoride is a naturally-occurring substance absorbed by plants from the soil that builds up in animal tissues, and is toxic to humans at high levels. Fluoride was perceived negatively until consumers were educated and comfortable enough with their level of understanding to make informed purchase decisions. Local municipalities moved forward the cause of fluoride by adding it to local drinking water and it was not until later that it was commercially offered in products by enterprising firms. Perhaps selenium enhancement needs to first move to a point of public interest to facilitate inclusion in privately produced and marketed food products. As medical and other healthcare professionals remain the most believable source for health and nutrition information (International Food Information Council Foundation 2006), this group may be a good starting point.

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Appendix

The Lancaster (1966) model provides a natural setting to analyze consumer preferences in a discrete choice setting. In this model, individuals derive utility (U) from the preference of health attribute (z), which is embodied (along with economic attributes) in the product he/she consumes.

Utilities derived from preference are not directly observable. The observable variables are the product attributes (*a = label clearly-S or not label clearly-NS*) and a vector of individual characteristics (*x*). The random utility model assumes that the utility derived by individual i from the perceived health benefits can be expressed as:

$$(1)\quad U_{ai} = V_{ai} + \varepsilon_{ai}$$

where U_{ai} is the latent utility level attained by the i^{th} individual, V_{ai} is the explainable part of the latent utility that depends on the value attributes (e.g., clarity of Selenium label) and the economic outcomes, and ε_{ai} is the 'unexplainable' random component in U_{ai}.

The utility maximizing individual will choose to consume a particular food variety if and only if $V_S + \varepsilon_s > V_{NS} + \varepsilon_{NS}$ or equivalently if $\varepsilon_i = \varepsilon_{NS} - \varepsilon_S < V_S - V_{NS}$. Since ε is unobservable and stochastic in nature, the individual's choice is not deterministic and cannot be predicted exactly. Instead, the probability of any particular outcome can be derived. The probability that individual i will choose to eat a particular food variety on the basis of clearly labeled health attributes is given by:

$$(2)\quad p_i = prob(\varepsilon_{NS} - \varepsilon_S < V_s - V_{NS}) = prob(\varepsilon < V_s - V_{NS})$$

Describing the density function of ε by f (ε), the above probability is given by:

$$(3)\quad P_i = \int_{\varepsilon} Z_i (\varepsilon_i < V_S - V_{NS}) f(\varepsilon_i) d\varepsilon_i$$

where Z_i is an indicator variable, a binary term that equals 1 when the utility from selenium and proper labeling exceeds the utility from absence of selenium or poor labeling.