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Identifying Market Preferences for High Selenium Beef

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Selenium is an element found in relatively high concentrations in crops and livestock raised on high-selenium soils located in North and South Dakota. Evidence suggests that a high-selenium diet such as would be obtained from consuming these products can reduce the risk of certain cancers. The region's livestock and grain producers are exploring potential high-selenium product marketing opportunities. A choice experiment was conducted to identify preferred attributes for a high-selenium beef product and the characteristics of potential market segments. In a national survey, participants chose between different levels of health claim approval and research, prices, and selenium origin. A multinomial logit regression model was estimated. Labeling reflecting scientific support linking selenium and reduced cancer risk, and natural-source selenium was ineffective. Marketing opportunities identified are consistent with existing functional food market segments and include consumers with higher income and education, 45 to 55 years of age, and with children.

Key Words: Choice Experiment, FDA approval, Functional Foods, Health Claim, Labeling, Selenium

IDENTIFYING MARKET PREFERENCES FOR HIGH SELENIUM BEEF

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INTRODUCTION

There is considerable interest in identifying means to reduce incidence of cancer, the second leading cause of death in the United States (American Cancer Society, 2006). To maintain or improve their health, Americans overwhelmingly believe food and nutrition are most important (International Food Information Council, 2006). Food selection is thus one venue being explored. Of particular interest are functional foods. Although no legal definition exists, a functional food is generally accepted in the literature to offer a benefit to a specific function in the body, beyond adequate nutrition, so as to improve health and well-being or reduce the risk of disease (Gibson and Williams, 2000). Seventy-eight percent of Americans consumed foods for functional and health benefits these foods provide in 2005 (International Food Information Council, 2006). Most consumed are those to reduce risk of heart disease and cancer.

Producers in regions of North and South Dakota are interested in investigating sales of their naturally high-in-selenium products as functional foods or for use as ingredients in functional foods. 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; Gerald Combs, personal communication, 16 July 2007). Research has demonstrated its link to reduced risk of some carcinomas (Clark et al., 1996). Deficiencies in selenium have been linked to decreased thyroid function, cardiovascular disease, cancers, and other health problems (Rayman, 2000).

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. However, in spite of existing evidence, selenium has not been approved for an unqualified health claim by the Food and Drug Administration (FDA) as a cancer protector or prevention aid.

Selenium was petitioned for validation of its role as an anti-carcinogenic. However, the FDA (2003) 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.'" Today, human health studies are further investigating the role of selenium intake in cancer protection. For example, the SELECT (Selenium and Vitamin E Cancer Prevention Trial) study involves more than 35,000 men from the U.S., Puerto Rico, and Canada (Lippman, et al., 2005). Even initial data will not be available until at least 2008.

Selenium level in foods is directly related to soil selenium levels in the region where the food is raised. The elevated selenium level of the soil is maintained in the plant, and resulting products produced from the plant material. Animals consuming high selenium plant material and grains will deposit that selenium not required for bodily processes and functions into their muscle tissue. Meat from these animals will have relatively high selenium levels.[1]

Currently, information about market potential for naturally high-in-selenium products, including beef, is limited. The level of selenium in food products is generally unknown to the consumer and participants throughout the marketing channel. One exception is a study on the market potential for high-selenium wheat commissioned by the South Dakota Wheat Commission. SJH and Company, Inc. (2004), who conducted the study, concluded that there is 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.[2] They also noted that such a product would need to be a "science-based value proposition", i.e., strong support for the selenium-health link claim would be necessary.

If selenium is approved by the FDA for labeling which identifies its role in preventing cancer, and beef producers and processors chose to target selenium-enhanced beef markets, premiums received would have to exceed the costs of testing the meat for selenium level and additional slaughtering and marketing costs. Estimating how much consumers value a high-selenium level attribute in beef was therefore the initial goal of this study.[3] The specific objectives of this study were to:
1. Identify preferred level of selenium beef attributes including price, origin of selenium, and label-claim made regarding the value of selenium as a cancer preventative, and
2. Identify market segments valuing a high-selenium beef product.

LITERATURE

Functional Foods and Functional Food Consumers

Growth has been rapid in the marketing of functional foods. They are firmly established in Japan, where the term reportedly originated. Those qualifying with respect to health maintenance are so labeled under FOSHU, Food for Specific Health Use (Stanton et al., 2001). European functional food markets are dominated by probiotics and prebiotic dairy foods. Probiotics include live microorganisms that improve the properties of the indigenous micro-flora in the host. Prebiotics are indigestible food ingredients that stimulate the growth or activity of bacteria in the colon. 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. A major factor in furthering of the American market will be the rules, testing, and context of health claims associated with specific functional foods. Also important will be well-targeted marketing campaigns.

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[1] Target level will depend on the availability and cost of high-selenium ingredients, and the health-claim range identified (e.g., definition of "high selenium").
[2] Contrary to the thoughts of end-users, SJH and Company, Inc. found academics to be optimistic about market potential for a high-selenium wheat product.
[3] As is discussed later in the manuscript, shoppers did not prefer the high-selenium product.

The typical functional food consumer is female, between 35 and 55 years of age, and well educated, has a high income, and is actively interested in health (Stanton et al., 2001). Maynard and Franklin (2003) identified market segments for a specific functional food category with promise as a cancer preventative, conjugated linoleic acid dairy products, to be those with children or health-conscious consumers in the household. These groups exhibited a higher willingness to pay (WTP). Willingness to pay among some respondents was dependent on the medical community's support of the cancer-fighting evidence.

Gilbert (2000) highlighted the importance of defining the consumer target for functional foods, their priorities, and what motivates their purchases. The 1999 HealthFocus® Trend Report found that 93% of American shoppers desire foods *naturally* nutritious in key vitamins and minerals, considerably more than those who agreed that supplements (62%) and fortified foods (55%) are important. Just over half of shoppers, 54%, believed that foods could reduce medicine or drug use. The 11% who strongly agreed were labeled "food as medicine shoppers"; they are often the target of functional food products entering the market. Seventy-eight percent of "food as medicine shoppers" reported reading labels versus 63% of all shoppers. And, they were more than twice as likely as other consumers to believe labels are regulated but were also more likely to be skeptical of label claims. 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) concurs 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.

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; they were less receptive to those from a meat product. Willingness to pay (and other measures of acceptance) varied regionally. Forty-four percent of Canadians surveyed were skeptical about the validity of nutrition claim information and West, et al. suggested that this implies the government must employ the assistance of nutritionists and health care professionals to disseminate information about the value of functional foods. Although the average consumer was willing to pay a premium for a functional food product, some were willing to buy the product only if offered at a discount. Seventy-two percent 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 considered less healthy to begin with (e.g., potato chips).

Selenium

Consideration of the market potential for a *naturally* high-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 animal's muscles (meat), and that organic selenium sources are better absorbed in the meat. Beef is already an important source of selenium for North Americans (Shi and Spallholz, 1994). Furthermore, beef from cattle consuming plant material growing or grown in seleniferous areas has an elevated selenium level. For example, Hintze et al. (2001) report that beef raised in a moderately seleniferous area averages 0.7 micrograms selenium per gram or 70 micrograms

selenium in a 100 gram beef serving. This compares with selenium intakes of 96 mg/day (for women) and 120 mg/day (for men) Combs (2001) suggests would be sufficient to sustain an optimal cancer-protection target level of 120 mg/ml. Hintze et al. (2002) demonstrated that a high-selenium ration is effective in helping steers coming off non-seleniferous grasses 'catch-up' in selenium level with counterparts raised on high-selenium soils within two months. Resulting selenium levels were found to be similar across cuts within individual steers. Lawler et al. (2004) found Se concentrations in semitendinous muscle to be lower for control steers and those fed an inorganic Se source (sodium selenate) than for steers fed organic sources of selenium including high-selenium wheat or hay.

Although evidence supports an elevated selenium level in products raised on high-selenium soils or feeds, the link between human selenium consumption and cancer does not (yet) benefit from unqualified FDA support. The FDA response to a 2002 Health Claim Petition from Wellness Lifestyles, Inc. regarding selenium and reduced risk of certain cancers, and selenium anticarcinogenic effects concluded that there was not enough significant scientific evidence to satisfy petitioned claims. Five intervention cancer trials were submitted with the petition as scientific evidence. The only trial pertinent to the conditions of the U.S. population, the Nutritional Prevention of Cancer Trial, showed no effect of selenium supplementation on the non-melanoma cancer that was primarily tested (Clark et al., 1996). Analyses following the study suggested selenium supplementation led to potential reductions in certain and total cancers for which the study was not designed. Risk of cancer mortality, total cancer cases, and lung, colorectal, and prostate incidences were reduced with selenium supplementation of 200 mg/day (Combs, 2001). Of 25 observational studies submitted and 11 additional observational studies recognized by the FDA, none were able to show the effects of selenium separately from those of other nutrients. However, four observational studies focusing on prostate cancer did show a significant inverse relationship between selenium intake and prostate cancer.

Although the FDA concluded there was insufficient evidence for the proposed claims, it allowed that existing evidence was strong enough to support qualified health claims as long as they were appropriately worded and not misleading to consumers. Two claims proposed by the FDA (2003) were as follows:

1. "Selenium may reduce the risk of certain cancers. Some scientific evidence suggests that consumption of selenium may reduce the risk of certain forms of cancer. However, FDA has determined that this evidence is limited and not conclusive."

2. "Selenium may produce anticarcinogenic effects in the body. Some scientific evidence suggests that consumption of selenium may produce anticarcinogenic effects in the body. However, FDA has determined that this evidence is limited and not conclusive."

Health Claim Labeling

There remains debate regarding the role of the FDA as a regulator of health-claim labeling. Supporting the need for FDA approval is the importance of a government standard to reduce incidences of misleading consumers, and that such a standard should rely on compelling scientific evidence. Opponents argue that the arduous process required for FDA approval reduces information for consumers and hampers efforts by firms to educate consumers about the relationship between nutrients and disease and human health. While research in general supports

that consumers do trust NutriFacts labels, evidence from the literature also generally indicates that consumers do not trust unsupported health claims and are not aware of associated government regulation. As such, health-claims on food packages may not be effective if not FDA sponsored (Garretson and Burton, 2000).

Roe, Levy, and Derby (1999) evaluated consumer reliance on health claims. They found that, in the presence of a health claim, consumers were more likely to limit their search for nutrition information to the front panel compared to looking at the back-of-package NutriFacts information panel. This was particularly true for lesser-educated consumers. Regardless of nutrition search methods and strategies, consumers were more likely to consider a product healthier and have higher purchase intentions when it featured a health claim. Consumers viewed both health and nutrient content claims as representing health information and, generally, both types of information had the same impact on consumers' opinions and choices. The presence of a health claim also raised product rating on health attributes not offered in the claim (halo effect).

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, Creyer, and Burton (2003) considered how consumers' attitudes and purchase intentions among primary household shoppers were affected by nutrition information and a heart healthy claim on packaged foods and restaurant menus. When the heart-healthy logo was present, shoppers generally believed that the food would reduce the likelihood of heart disease or stroke. Positive nutrition information led to more positive attitudes towards the food product, nutrition, and reduction of disease risk, and increased purchase intentions. Nutrition information and health claims were not interactive in consumers' decisions and intentions on packaged food. The heart-healthy claim did not influence evaluations or disease risk perceptions when nutrition information, favorable or unfavorable, was present for packaged food items, and only added information affecting disease perceptions for restaurant menu items. The authors concluded that consumers generally prefer to trust nutrition facts when available and use the health claim as a second resource.

Wansink (2003) tested three front health claim label alternatives (long, short, and no label) with a more informative back label. Participants were asked to record their thoughts when they read the labels, and thoughts were evaluated as attribute-specific or general evaluations. Attribute thoughts are generally accepted to indicate the consumer has interpreted the label and its specific information better than a general evaluative thought. When attribute-specific thoughts are supportive of the claim or label, higher levels of persuasion can be achieved. All three front labels generated relatively the same number of thoughts but the nature of these thoughts varied. Consumers who saw short claims recorded more positive attribute-specific thoughts, increasing the believability and persuasiveness of the health claim. Wansink concluded that combining short health claims on the front of the package with full health claims on the back leads consumers to more fully process the claim and believe it.

Hooker (2005) investigated the ability of undergraduate students to differentiate scientific research supporting multiple levels of qualified health claims. They proposed a little-known health benefit and a hypothetical functional food product (wheat crackers with soy products to help prevent cancer and heart disease). They used the four-level FDA label system to clarify how strongly the claim is backed with scientific evidence. Level A pertains to "unqualified health claims" where no disclaimer is necessary since they meet the significant scientific agreement (SSA) standard. Levels B, C, and D represent decreasing levels of scientific evidence, and thus need to be accompanied by a disclaimer. Participants reacted more positively to products bearing claims A, B, or C than products with no claim or level D. Participants were unable to distinguish between levels A, B, or C health claims. Use of a "report card" on the label aided participants in differentiating health claims. Participants relied more heavily on NutriFacts labels than front label claims.

Recently, the Federal Trade Commission (2006) released comments resulting from a public meeting regarding consumer perceptions of health claims. They concluded that the FDA's "language only" claims are not effective in communicating the scientific support for diet-disease relationships; that the current language allowed on these health claims does not convey scientific certainty to consumers (but that changes in language may render them effective); that the "report card" format consistently helps consumers rank scientific certainty; and that the literature shows widely varying consumer interpretations of qualified health claims tested.

METHODS

The health claim of interest in the current study reflects a link between a naturally high-in-selenium beef product and cancer incidence. It was noted that the U.S. functional food market has focused on vitamin and mineral fortification, but the literature demonstrates an interest in natural functional foods. Assessing consumers' WTP for a high-selenium beef product is an essential step in evaluating the economic viability of producing and marketing this product. An individual's WTP will depend on how the product's inherent and marketed attributes, including selenium level, affect the individual's utility. Although WTP will vary among individuals, as identified in the literature, cost-effective marketing usually requires identification of market segments. For example, middle-aged men might be willing to pay more than younger men for perceived prostate cancer preventative characteristics because they are more susceptible to that form of cancer in the near term. Consumers with a personal association to a cancer victim or survivor might also be willing to pay more since they have a direct emotional link with cancer and its effects. We were concerned with identifying potential market segments for high-selenium beef.

Survey Design

Two focus groups were held to aid in developing and refining the survey instrument. In April, 2006, a focus group was held with seven staff members in the Department of Agribusiness and Applied Economics at North Dakota State University (NDSU). Included were three males and four females whose ages ranged from 23 to 56. The purpose was to refine objectives, agenda, and content and style of questions for a subsequent focus group, and to narrow the choice of beef products and labels to be considered by survey respondents. A second focus group was conducted (May). Participants were paid $20. Specific objectives were to gain information about consumers' labeling preferences; evaluate consumers' knowledge of

functional foods and selenium; and determine product attributes with potential to be combined with selenium level and attribute ranges to be represented in the survey instrument. The focus group was conducted according to recommendations specified in Krueger (1988).

Faculty and staff at NDSU, ages 25-55, were invited to participate. Other screening criteria included primary household shopper status, healthy food purchaser, and beef consumer. Eight women participated in the focus group. Half indicated they use dietary supplements, five indicated they were overweight, and half had an immediate family member who currently has or at one time had cancer. Other demographic and behavioral statistics are shown in Table 1.

Table 1. Demographic and behavior information of focus group participants.

	Range	Average	Standard Deviation
Age	30 – 49	41	6.3
Number of children	0 – 3	1.8	1.3
Age of youngest child	1 – 14	9.2	4.6
Number of household members	2 – 5	3.5	1.0
Years in profession	2 – 25	15.5	8.3
Grocery shopping occurrences/month	3 – 20	7.5	5.6
Beef purchases (lb) /week	1 – 9	5.1	3

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 actual term "functional food." This concurs with the literature (e.g., International Food Information Council, 2006).

Three different styles of labels were pictured on cuts of beef (steaks and hamburger) and displayed for participants to examine. Short labels were simple and were comprised of phrases such as "contains selenium" or "high in selenium." Medium labels had the short phrase with some additional information referring to selenium's relation to cancer prevention. A large, very informative label was also used and placed on the back of the package with a link to it on a short front label.

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 the large label was described as containing too much information. Participants in general indicated they "would never read that much." 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. Participants did not like the label placed over too much of the actual meat product, indicating they like to see the meat they are buying. For beef cuts in particular (compared to ground beef), participants noted that the visual attractiveness of the cut was the primary purchase-motivating attribute (e.g., marbling and color). A final point from the discussion suggested a "catchy" aesthetically-appealing label be used.

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 to support a locally-based product and economy given the natural soil placement of selenium in the Dakotas (e.g., Dakota-raised beef).

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. Adamowicz et al. (1998) describe CE as an extension of the dichotomous choice (DC) method but with more than two alternative bundles with different attributes so that preferences of those attributes can be estimated. The method follows Lancaster's theory of utility maximization, where consumers demand the attributes of a good. It also more closely mimics a consumers' typical shopping experience than do DC experiments, allows for cross-price elasticities to be easily determined between new and existing products, and can obtain results similar to those found using revealed preference methods. Alpizar, Carlsson, and Martinsson (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. Furthermore, there may be inconsistency among participants' responses across choice questions, and responses may be influenced by the complexity of the decision.

Stated preference methods in general are usually hypothetical, and therefore WTP estimates may be biased (Silva et al., 2007; Lust et al., 2005). Bias may be the result of the embedding process. 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 (Goldberg and Roosen, 2005). 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.

A CE was selected for the current project. It provides the opportunity for multiple attributes to be evaluated and forces the participant to focus on attribute tradeoffs. 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 (www.zoomerang.com accessed May 7, 2007).

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 the market price. Health claim levels were that of FDA level A, FDA level C, and a suggestion based on recent research. As earlier noted, FDA level A health claims are unqualified, reflecting significant scientific agreement about the validity of the disease-diet relationship. Levels B, C,

and D correspond to qualified health claims where the evidence is progressively weaker (Federal Trade Commission, 2006). The origin attribute referred to the label design, as well as the wording, and used “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.

A common starting block in developing choice sets is a full factorial design, which includes all possible combinations of attributes and attribute levels. However, as was the case for this experiment, these are often too large and awkward for meaningful evaluation. Efficient and optimal design reduction techniques can be created using D-optimality. 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.

Please read the following product description for a new product.

Selenium is an essential trace mineral to our health and 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 just where the store's label was. Please respond as though you are going to purchase this sirloin steak. All pictures following this steak are of steaks similar to the one in this picture. Choice "D" is the standard steak without any selenium labeling 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 15 demographic and behavioral questions. They were included to aid in identifying market segments for high selenium beef.

Zoomerang MarketTools administered the survey to panelists. Respondents were limited to consumers 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 responses used for analysis.

Survey Population

Respondents were predominately female (77%) and white (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%). The largest group (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.

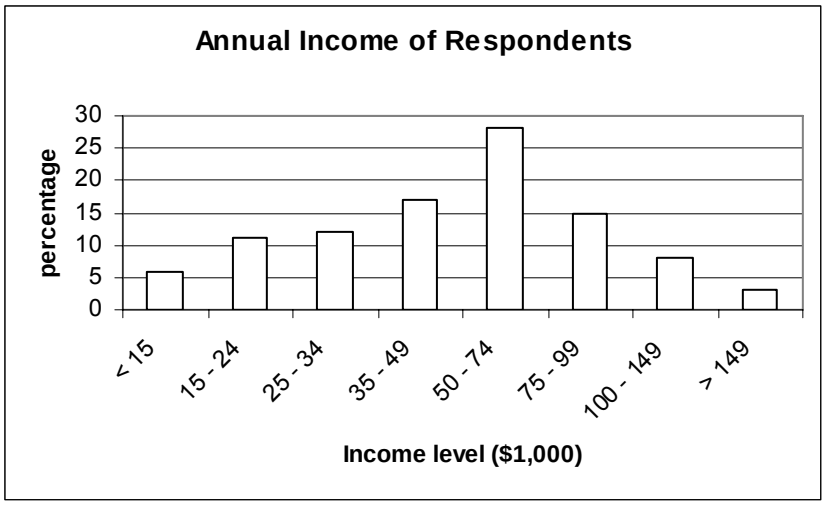

Figure 2. Income of respondents

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

Data were analyzed using Limdep® (Greene, 1998). 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. Standard errors on estimated coefficients were low. Except for the product-specific attributes, only statistically significant variables are discussed. Results are shown in Table 2. 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 FDA level A, FDA level C, or recent research health claims. These claims include 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. 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.

The "Naturally Rich in Selenium" label was excluded from the model. Presumably respondents did not differentiate between this label and the "Naturally Rich in Selenium" label with a North Dakota border. Only the label border differed, and this only slightly (i.e., the North Dakota label border was in the shape of North Dakota which is, in retrospect, very similar to the rectangle otherwise used).

Table 2. Health claim preferences

Variable (Health Claim Interaction)[a]	Coefficient and Sign	Standard Error	Level of Significance	Marginal Effect
FDA Level A Health Claim	-1.837	0.398	0.0000	
FDA Level C Health Claim	-1.576	0.455	0.0050	
Recent Research Health Claim	-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 (A)	0.613	0.067	0.0000	13.926
Functional Food Purchaser (C)	0.567	0.077	0.0000	2.029
Functional Food Purchaser (R)	0.833	0.076	0.0000	-0.890
≥ $50,000 household income (A)	0.171	0.065	0.0083	10.916
≥ $50,000 household income (C)	0.412	0.076	0.0000	9.992
≥ $50,000 household income (R)	0.249	0.071	0.0005	0.451
Age 35 – 45 (A)	0.302	0.154	0.0489	-0.337
Age 35 – 45 (C)	0.210	0.179	0.2409	3.814
Age 35 – 45 (R)	0.329	0.168	0.0506	-1.267
Age 45 – 55 (A)	0.171	0.064	0.0083	10.916
Age 45 – 55 (C)	0.412	0.076	0.0000	9.992
Age 45 – 55 (R)	0.249	0.071	0.0005	0.451
Age 55 – 65 (A)	0.566	0.103	0.0000	-0.562
Age 55 – 65 (C)	0.624	0.125	0.0000	-0.492
Age 55 – 65 (R)	0.697	0.111	0.0000	-1.073
Exercise 0 days / week (A)	-0.276	0.100	0.0059	10.916
Exercise 0 days / week (C)	-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 (A)	0.232	0.086	0.0071	3.887
Exercise 1-2 days / week (C)	-0.651	0.101	0.5186	-0.855
Exercise 1-2 days / week (R)	-0.170	0.923	0.0652	3.411
Exercise 3-4 days / week (A)	0.263	0.083	0.0015	-6.257
Exercise 3-4 days / week (C)	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 (A)	0.167	0.105	0.1117	-5.272
Exercise 5-7 days / week (C)	0.300	0.121	0.0709	-0.855
Exercise 5-7 days / week (R)	0.113	0.111	0.3085	-0.850
High blood pressure (A)	0.162	0.066	0.0142	2.048
High blood pressure (C)	0.216	0.076	0.0045	-2.295
High blood pressure (R)	0.123	0.072	0.0879	-1.006
Hispanic / Latino / Spanish (A)	0.586	0.261	0.0247	-0.350
Hispanic / Latino / Spanish (C)	0.577	0.291	0.0472	0.384
Hispanic / Latino / Spanish (R)	0.582	0.305	0.0568	1.945
Tobacco User (A)	0.108	0.064	0.0915	5.978
Tobacco User (C)	-0.130	0.076	0.0879	7.255
Tobacco User (R)	0.822	0.071	0.2443	0.297

a. Parentheses following the noted attribute indicate it is an interaction term in the model with A (FDA level A labeling), C (FDA level C labeling), and R (research supports label).

Marginal effects of socio-demographic variables are included (table 2). Marginal effects 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), mathematically written as

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

As measured by the size of the marginal effects, the most influential variables towards preference of the health claims are consistent with previously-identified attributes of functional food shoppers. Those who intentionally purchase functional foods preferred FDA health claims A and C, especially A, which is logical in that they would be more likely to understand the significance of an FDA health claim. Individuals with household incomes of $50,000 or greater preferred all three of the health claims at highly significant levels and the marginal effect is important for level A and C claims. Being in the 45 to 55-year-old age category increased preference for FDA level A and C health claims. Marginal effects for other age categories were relatively small although those 55 to 65 years of age consistently did not prefer steak with an included health-claim.

Those who exercise not at all or one to two times per week preferred FDA level A health claims, while those exercising more did not prefer the level A health claim. Those with at least a 4-year undergraduate degree preferred FDA level A and C health claims (Table 3). Hispanic respondents' preference for all three health claims was significant, but marginal effects were small and conflicting. Tobacco users preferred Level A and C health claims.

Although panelists were queried about the incidence of six health issues within their immediate family, 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 FDA level C health claim. Those respondents having children exhibited positive preference for the FDA level A health claim.

Table 3. Health claim preferences: Attributes with an inconclusive effect on health claim

Variable (Health Claim Interaction) [a]	Coefficient and Sign	Standard Error	Level of Significance	Marginal Effect
Has at least a 4-year Degree (A)	-0.154	0.071	0.0317	3.124
Has at least a 4-year Degree (C)	0.160	0.078	0.0403	3.703
Gender (R)	-0.227	0.083	0.0061	0.487
Has children (A)	0.138	0.067	0.0450	6.687
Married (C)	-0.141	0.073	0.0538	-2.486
Black / African American (R)	0.670	0.264	0.0112	0.153
Arthritis in immediate family (R)	0.339	0.073	0.0000	0.670
Cancer in immediate family (R)	-0.214	0.082	0.0088	0.297
Diabetes (C)	-0.154	0.081	0.0572	5.295
Heart Disease (R)	-0.181	0.087	0.0366	1.472
Osteoporosis (A)	0.224	0.099	0.0231	-0.169
Osteoporosis (R)	0.167	0.107	0.1175	0.384
Four Steaks / Month (A)	-0.208	0.064	0.0012	-4.733
Four Steaks / Month (R)	-0.144	0.070	0.0406	-0.834

a. Parentheses following the noted attribute indicate it is an interaction term in the model with A (FDA level A labeling), C (FDA level C labeling), and R (research supports label).

SUMMARY AND CONCLUSIONS

Summary

Cancer is an enormous health concern. Selenium is an element that has been scientifically demonstrated to have some cancer preventative characteristics. Thus, livestock and grain producers are exploring potential high-selenium food marketing opportunities. A choice experiment was conducted to identify preferred attributes for a high-selenium beef product and characteristics of potential market segments. Participants were able to choose between different levels of health claim approval and research, prices, and selenium origin.

Data were obtained from a nationwide Internet survey that was limited to primary grocery shoppers of a household who were at least 25 years of age. Participants were asked to choose among four beef products within each of six choice sets. They were informed before choosing that all steaks were equal, with the only differences being in labels (and attributes indicated thereon) and prices as they appeared on the survey instrument. Data were analyzed using Limdep®. The dependent variable was choice. Independent variables included attribute levels of the choice product and socio-demographic and behavioral variables.

Unexpectedly, shoppers did not prefer a high-selenium beef product, even when its role in cancer prevention was supported by the FDA. Functional food purchasers, high-income, and middle-aged respondents preferred high-selenium labeled beef supported by FDA approval, as did respondents who did not exercise (much) or used tobacco.

Conclusions

The first objective of this study was to identify the preferred level of selenium 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. Therefore, willingness to pay was not determined. 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). 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, the use of the former requires some understanding among shoppers that healthy bone growth is important.

It is possible that a general lack of knowledge about selenium resulted in it making the beef product less desirable. Focus group participants revealed that selenium “sounds bad.” The same type of perception (i.e., negative interpretation of an attribute considered value-added for marketing) has been found for irradiated beef (e.g., see He, Fletcher, and Rimal, 2005). 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 (2006) attributed a substantial drop 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, Chen, and Yoshida (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 argue 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 here. Their hypotheses are worth considering in investigating why consumers did not prefer high-selenium beef over the conventional beef in the current study.

Labeling or proclaiming selenium origin based upon the "Naturally Rich in Selenium," "Naturally Rich in Selenium" with a North Dakota border, and "Selenium Fortified" labeling was ineffective. These labels might need to be further differentiated to be effective. Another obvious possibility is that consumers may not care how the product became high in selenium, although this hypothesis is suspect based on research demonstrating consumer preferences for natural foods. In retrospect, use of "locally-grown" labeling may have better differentiated the product for the national audience than the use of a North Dakota border.

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 claims. Those with children preferred the FDA A health claim in contrast to those consuming at least four steaks per month, who did not prefer the FDA A 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 product, especially among the older age categories (e.g., 55 to 65 year olds). Also 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 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, Cohen, and Bloom (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 important to future studies as was demonstrated by He, Fletcher, and Rimal (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 a little-understood element in their food. This may be the most important limitation of this research, since promotion of a substance whose role in health is largely unknown to the public can be difficult and costly. It was not particularly effective for irradiation, although consumer resistance may be higher regarding the process of irradiation than elevated selenium levels.

There is opportunity to learn from prior experience for example, 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, 2006), this group may be a good starting point.

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