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Consumers' Preferences for Citrus Fiber-Added Ground Beef

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Abstract

Adding fiber to ground beef can increase the health benefits of consuming ground beef products and can provide new market opportunities for the beef industry. The current study analyzes the impact of consumers' preferences for citrus fiber-added ground beef after offering consumers samples of 1%, 3%, and 5% citrus-added ground beef meatballs. The results of the current study show that there is a market for citrus fiber-added ground beef, but the price premium is not high. Current consumers of organic and grass-fed beef, and those who are concerned about the fat content of ground beef are the potential target customers for the sale of citrus fiber-added ground beef.

Keywords: ground beef, citrus fiber, consumer preferences, willingness-to-pay (WTP)

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Introduction

Red meat, such as beef, is a nutritious food for human consumption that has high-quality protein, rich in B vitamins and minerals, such as iron (Aberle et al. 2001). However, many studies associate the consumption of meat products with coronary heart disease (CHD), obesity, and diabetes (Micha et al. 2010; Lajous et al. 2011). Therefore, ground beef and other beef products are commonly considered unhealthy food choices for humans due to the presence of saturated fats that increase the risk of high cholesterol levels. Another important factor related to the human diet, especially in the US, is the low consumption of dietary fiber. Dietary fiber is a necessary food ingredient that promotes health by reducing cholesterol and the risk of heart disease. Earlier studies have suggested that dietary fiber intake causes a decrease in total cholesterol and low-density lipoprotein in plasma through the excretion of bile acids (Gallaher et al. 1992). Dietary fiber also lowers the risk of colon cancer (Kritchersky 1990; Rodriguez et al. 2006).

Before producers decide whether or not to manufacture citrus fiber-added ground beef meatballs and supply them to consumers, producers must consider the potential economic profits and costs. Consumers' willingness-to-pay for different ground beef attributes, such as organic or local, has been analyzed in the literature. However, no previous study has analyzed consumers' willingness-to-pay for citrus fiber-added ground beef meatballs. The current study analyzes consumers' preferences for such meatballs. Adding fiber to ground beef can increase the health benefits of consuming ground beef products and can provide new market opportunities for the beef industry. This will positively impact human health while increasing the sales and profits for beef production. The citrus fiber used for this study is obtained through a relatively easy procedure. Peel of citrus is washed, dried, and then grounded. This powder is then mixed into the ground beef. Using the $0.54 / ounce unit price for citrus fiber powder, the cost of adding citrus fiber is $0.09, $0.27, and $0.45, respectively for 1%, 3%, and 5% citrus fiber added ground beef per pound. The results of the current study can be used by producers, Extension educators, and also by policymakers in determining whether government support is needed to promote the production of healthy ground beef products.

Using a consumer panel of 160 surveys, the current study analyzed consumers' willingness-to-pay for citrus fiber-added ground beef. The results showed that consumers are willing to pay a positive price premium for citrus fiber-added ground beef, but the price premium is not very high. Low-fat content was found to be the most influential factor, having a positive impact on the price premium. Hence, targeting consumers for whom low-fat content is an essential attribute will increase the chances of getting a price premium for citrus fiber-added ground beef. On the other hand, consumers concerned about price are less likely to pay a price premium. The remainder of this article is organized as follows: in the next section, we provide a review of the literature. Then, the data and econometric model are presented. Subsequently, the factor analysis method used for the econometric analysis is explained. Finally, the results are delineated and conclusions posited.

Literature Review

Food quality attributes can be classified as; search, experience, and credence attributes (Anderson and Anderson 1991). Search attributes are those that can be observed prior to consuming the product, such as price and color (Bureau and Marette 2000). Experience attributes

can only be observed after consuming the product, such as taste and texture (Bureau and Marette, 2000). Lastly, credence attributes are those that cannot be known for sure, even after consuming the product, such as organic and locally grown (Bureau and Marette 2000).

Previous studies looked at the impact of nutritional information (i.e., the credence attributes) on consumers' willingness-to-pay for meat products. Yang and Woods (2013) analyzed consumers' willingness-to-pay for ground bison. Bison meat has better nutritional value (including higher protein and lower fat) than chicken, beef, and pork. Their results showed that consumers informed about the better nutritional value of bison are willing to pay more. Yang and Woods (2013) found that this nutritional information variable had higher marginal effects in the regression analysis than the demographic, income, and location variables, signifying the importance of nutritional information on consumers' willingness-to-pay a price premium.

Wang et al. (2011) analyzed the impact of information on consumer preferences for grass-fed and organic meat products. Their results showed that information about the attributes of grass-fed beef and organic beef are especially influential on consumers who do not have preexisting information about these types of beef. Thus, consumers' willingness-to-pay increases with information if the consumers do not have preexisting knowledge. Wang et al. (2011) also found that if attributes related to taste (i.e., experience attributes) are seen as necessary by consumers, then they are less likely to pay a price premium for grass-fed and organic ground beef over conventional ground beef. On the other hand, if the manner in which beef is raised (i.e., credence attributes) is important to consumers, then they are more likely to pay a price premium for grass-fed and organic ground beef over conventional ground beef. Wang et al. (2011) found that none of the variables related to demographics are statistically significant for consumers' willingness-to-pay for organic ground beef.

Grannis et al. (2000) used a survey conducted in the Rocky Mountain region to analyze consumers' willingness-to-pay for natural beef products. Their results found that consumers ranked "no use of hormones" and "no antibiotics" as the most critical attributes for ground beef. In contrast, the attribute "locally grown" was ranked the lowest for ground beef. Sixty-seven percent of the respondents indicated that they would be willing to pay a 12% premium to buy natural ground beef over conventional ground beef. However, there was not a perfect linear relationship between consumers' ranking of the importance of "no use of hormones" or "no antibiotics" and the price premium to be paid for natural ground beef. However, it was found that consumers who have eaten natural ground beef in the past are more likely to pay a price premium than consumers who have not eaten natural ground beef. Hence, previous experience with non-traditional beef products might lead to a higher price premium.

Jensen et al. (2014) analyzed consumer preferences in Tennessee for beef products labeled "Tennessee beef." The results showed that consumers in Tennessee, on average, are willing to pay a 20% price premium to buy ground beef labeled "Tennessee beef." This study also found that customers ranked consuming safe, healthy, and nutritious food higher than keeping the food prices low. This result signified the importance of safe and nutritious ground beef for consumers. Freshness and product safety are found to positively influence consumers' willingness-to-pay a price premium to buy ground beef labeled "Tennessee beef." Demographic variables, such as age, education, and income, are not statistically significant factors impacting the willingness-to-pay for ground beef labeled "Tennessee beef" over conventional ground beef. Jensen et al.

(2014) also found that consumers' preferences varied by region. Lastly, the consumers who stated that they did not consume ground beef cited health concerns as the major reason.

Gao and Schroeder (2007) analyzed the impact of additional information on consumers' willingness-to-pay for different food quality attributes. Their results showed that when consumers indicated a willingness-to-pay for attributes, such as locally raised beef, consumers might actually be referring to quality attributes that were not listed on the survey. Therefore, a consumer might associate locally raised beef with better nutritional values (thus indicating a willingness-to-pay) that might or might not be correct about locally raised beef. Hence, it is essential for food companies to provide information on the nutritional benefits of their food products.

Overall, some studies found a positive price premium for beef products with different food quality attributes, but other studies did not. Thus, it is difficult to make a generalization, as these studies targeted certain regions; consumers' preferences might differ in other regions (Gedikoglu and Parcell 2014; Jensen et al. 2014). Hence, there is a need to conduct a study on consumers' willingness-to-pay for fiber added ground beef to measure the price premium that consumers might pay for this product.

Data

Data for the current study was collected through a three-day consumer panel comprised of 161 students, staff, and faculty at the University of Missouri. The panels were given four different samples of ground beef meatballs containing either zero, 1%, 3%, or 5% added citrus fiber. The percentages chosen were determined through a texture profile that included a physico-chemical analysis. Five percent is the maximum amount of citrus powder that ground beef can absorb without becoming crumbly.

The Food and Drug Administration recommends 25 grams of dietary fiber per day for adults and children (Food and Drug Administration 2015). Based on the authors' calculations, a typical five ounce serving of meatballs containing 1% added citrus fiber contains 4.7% of the daily recommended dietary fiber consumption. A five-ounce serving size of meat balls with 3% and 5% added citrus fiber contains 14.14% and 23.57% fiber, respectively. Consequently, meatballs containing higher levels of citrus fiber provide greater health benefits. Each participant was given a sample from each category of the fiber-added meatballs, plus a sample of meatballs with nothing added. Participants were advised that the samples only differed in respect to the percentage of citrus fiber added. Hence, all other characteristics of the meatballs were the same across the samples. Consumers were then given a survey asking them to rank different attributes of the meatballs. The survey analyzed their willingness-to-pay a price premium over conventional ground beef prices that contain the three levels of added citrus fiber (see Appendix for the survey).

The survey provided information about the benefits of citrus fiber, stating: "Citrus powder is rich in both soluble and insoluble dietary fiber. Consuming food with dietary fiber can help with maintaining a healthy weight and lowering [the] risks of diabetes and heart disease." To measure consumers' willingness-to-pay for citrus fiber-added ground beef, the specific question in the survey asked: "Suppose that you are in a grocery store buying ground beef. The price of conventional ground beef chuck (with 80% lean and 20% fat) is $4.48/lb. What price premium

per pound over the price of conventional ground beef chuck [$4.48/lb.] would you be willing to pay for ground beef chuck with the following attributes?" For each percentage of added citrus fiber (i.e., 1%, 3%, and 5%), the following choices were given: (1) no price premium, (2) $0.45 (10% price premium), (3) $0.90 (20% price premium), (4) $1.35 (30% premium), and (5) $1.80 (40% price premium).

Table 1 provides the summary statistics and description of the variables for a sample size of 160. The taste attribute was ranked the highest by the survey respondents. This attribute was followed by texture. These two attributes were ranked higher than the price attribute, which was ranked as the third most influential factor when purchasing ground beef. The credence attributes were ranked the lowest. The highest-ranked credence attribute was the low-fat content, followed by the beef being a product of the U.S.A. Organic beef, locally grown beef, and grass-fed beef were not ranked as important qualities influencing consumers' decision to purchase. Overall, the survey provided some evidence that search, experience, and credence attributes are ranked differently. Our results suggest that producers might want to analyze local consumer preferences instead of focusing on national trends. For example, there is an increasing interest nationally in organic and grass-fed beef, but these attributes were not ranked as important by the survey respondents in the current study. Hence, instead of investing in these costly production practices, the beef producers in Mid-Missouri might be better off selling their products labeled as a product of the U.S.A.

Table 1. Variable Names, Description, Means, and Standard Deviations (N = 160)

Variable	Description	Mean	Standard Deviation
Price	[1]Range: 0 = Not Important; 1 = Somewhat Important; 2 = Very important	1.44	0.58
Taste		1.83	0.41
Color		1.43	0.58
Texture		1.63	0.60
Product of U.S.A.		1.06	0.75
Organic Beef		0.54	0.66
Locally Grown Beef		0.66	0.68
Grass-fed Beef		0.68	0.69
Low Fat Content		1.25	0.72
Dependent Variables			
Willingness-to-pay for 1% citrus fiber-added ground beef over conventional ground beef (per lb.)	Range: $0; $0.45; $0.90; $1.35; $1.80	$0.35	$0.43
Willingness-to-pay for 3% citrus fiber-added ground beef over conventional ground beef (per lb.)	Range: $0; $0.45; $0.90; $1.35; $1.80	$0.55	$0.42
Willingness-to-pay for 5% citrus fiber-added ground beef over conventional ground beef (per lb.)	Range: $0; $0.45; $0.90; $1.35; $1.80	$0.65	$0.50

Note. [1]The range is the same for all the independent variables.

Table 2. Distribution of Willingness-to-Pay (WTP) Values (N = 160)

	$0	**$0.45**	**$0.90**	**$1.35**	**$1.80**
WTP for 1% added citrus fiber	48%	34%	11%	4%	1%
WTP for 3% added citrus fiber	22%	45%	21%	9%	1%
WTP for 5% added citrus fiber	23%	29%	30%	11%	5%

The average price premiums for citrus fiber-added beef were $0.35 for 1% citrus fiber, $0.55 for 3%, and $0.65 for 5%. Thus, the highest price premium was for 5% citrus fiber-added ground beef, although it also had the highest standard deviation. Table 2 provides the distribution of willingness-to-pay values for percentages 1, 3, and 5. Fifty-two percent of the survey respondents are willing to pay a price premium to buy 1% citrus fiber-added ground beef. Seventy-eight percent of the respondents are willing to pay extra for 3% citrus fiber-added ground beef and seventy-seven percent for 5% citrus fiber-added ground beef. Overall, the survey data showed there is a demand for citrus fiber-added ground beef. Price premium levels of $0.45 and $0.90 were the highest price premiums chosen by the survey respondents for those who are willing to pay more. A comparison of average price premiums with the cost of adding citrus fiber, $0.09 for 1% citrus fiber, $0.27 for 3%, and $0.45 for 5%, reveals that the average price premium covers the cost of adding citrus fiber for each percentage level. Thus, there are opportunities for beef producers to increase their profits by adding citrus fiber into ground beef.

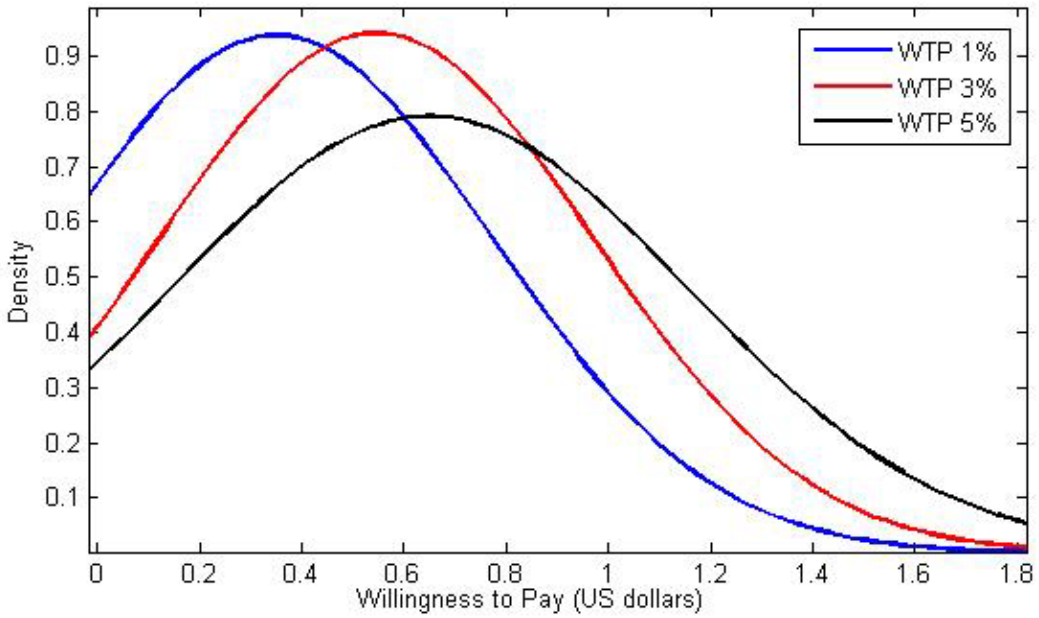

Figure 1. Estimated probability density function for normal distribution of willingness-to-pay (N = 160).

Note. WTP 1% stands for willingness-to-pay for 1% citrus fiber-added ground beef. Similarly, WTP 3% and WTP 5% stand for willingness-to-pay for 3% citrus fiber-added ground beef and willingness-to-pay for 5% citrus fiber-added ground beef, respectively.

In addition to the summary statistics, a probability density function was estimated using MATLAB®, assuming a normal distribution for willingness-to-pay values for three levels of citrus fiber-added ground beef. The results are presented in Figure 1. The distribution for 5% citrus fiber-added ground beef was more widely dispersed than the other two distributions. Distributions for 1% and 3% citrus-added ground beef were more skewed to the right, meaning that they are less likely to obtain high price premiums.

Econometric Model

Econometric analysis was conducted to identify the factors that impacted consumers' willingness-to-pay. There are two alternative econometric procedures for this situation: the ordinary least squares (OLS) model and the ordered probit model. For the OLS model, the dependent variable—willingness-to-pay (WTP)—is assumed to have a continuous distribution. The advantage of this model is that regression coefficients can be easily interpreted in terms of the magnitude of the impact of the independent variables on the dependent variable. However, for the current study, the dependent variable is a categorical variable, which means that the estimated coefficients in an OLS model will cause estimates for the dependent variable to be out of the range given in the survey. In contrast, an ordered probit model takes into account the categorical and increasing structure of the dependent variable. For this study, we provide the results from the ordered probit model.

Ordered Probit Model

To implement the ordered probit model, the random utility from consuming citrus fiber-added meatballs, which is a latent variable, can be represented analytically as (Greene 2008):

$$(1) \quad U_i^* = \mathbf{x}_i' \boldsymbol{\beta}_i + \varepsilon_i$$

where $\mathbf{x}_i'$ is the vector that includes the values for the variables that form the deterministic part of the latent variable; $\boldsymbol{\beta}_i$ is the vector that includes the coefficients to be estimated; ε_i is the error term; and *i* denotes an individual observation. The error term, ε_i, is assumed to have a normal distribution with a mean of zero and a variance of one. The latent variable, U_i^*, is unobserved, but the willingness-to-grow is observed. Let $\mu_1 < \mu_2 < \mu_3 < \mu_4$ be unknown threshold parameters; then the willingness-to-grow is obtained as

$$\begin{aligned} (2) \quad WTP_i = y_i &= \$0 && \text{if } U_i^* \le \mu_1 \\ &= \$0.45 && \text{if } \mu_1 < U_i^* \le \mu_2 \\ &= \$0.90 && \text{if } \mu_2 < U_i^* \le \mu_3 \\ &= \$1.35 && \text{if } \mu_3 < U_i^* \le \mu_4 \\ &= \$1.80 && \text{if } \mu_4 < U_i^* \end{aligned}$$

Given that the error term has a normal distribution, the probability of each outcome for the dependent variable can be represented as

$$
\begin{aligned}
(3)\quad & \Pr\left(y_i = \$0 \middle| \mathbf{x}_i\right) = \Phi\left(\mu_1 - \mathbf{x}_i'\boldsymbol{\beta}_i\right) \\
& \Pr\left(y_i = \$0.45 \middle| \mathbf{x}_i\right) = \Phi\left(\mu_2 - \mathbf{x}_i'\boldsymbol{\beta}_i\right) - \Phi\left(\mu_1 - \mathbf{x}_i'\boldsymbol{\beta}_i\right) \\
& \Pr\left(y_i = \$0.90 \middle| \mathbf{x}_i\right) = \Phi\left(\mu_3 - \mathbf{x}_i'\boldsymbol{\beta}_i\right) - \Phi\left(\mu_2 - \mathbf{x}_i'\boldsymbol{\beta}_i\right) \\
& \Pr\left(y_i = \$1.35 \middle| \mathbf{x}_i\right) = \Phi\left(\mu_4 - \mathbf{x}_i'\boldsymbol{\beta}_i\right) - \Phi\left(\mu_3 - \mathbf{x}_i'\boldsymbol{\beta}_i\right) \\
& \Pr\left(y_i = \$1.80 \middle| \mathbf{x}_i\right) = 1 - \Phi\left(\mu_4 - \mathbf{x}_i'\boldsymbol{\beta}_i\right)
\end{aligned}
$$

where $\Phi(.)$ is the cumulative distribution function for the standard normal distribution (Greene 2008). The log-likelihood function for the entire sample of size *N* can be obtained as (Greene 2008).

$$(4)\quad \ln L = \sum_{i=1}^{N} \sum_{j=0}^{1.80} I(y_i = j) \ln \Pr(y_i = j)$$

The maximum likelihood estimation of the $\boldsymbol{\beta}_i$ coefficients is obtained by taking the derivative of the log-likelihood function with respect to each coefficient included in $\boldsymbol{\beta}_i$ and equating it to zero (Greene 2008).

Marginal Effects for Ordered Probit Regression

The marginal or partial effect of a continuous variable x_k can be calculated as (Wooldridge 2006).

$$(5)\quad \frac{\partial P(y = j|\mathbf{x}_i)}{\partial x_k} = \left[\phi\left(\mu_{j-1} - \mathbf{x}_i'\boldsymbol{\beta}_i\right) - \phi\left(\mu_j - \mathbf{x}_i'\boldsymbol{\beta}_i\right)\right]\beta_k$$

where $\phi(.)$ is the probability density function for the standard normal distribution, which is valued as the mean of the independent variables; this measures the partial impact of the independent variable, x_k, on the probability of having the dependent variable take the value *j*. For a discrete variable, x_k, such as a dummy variable, the partial effect can be calculated as follows:

$$(6)\quad \Phi(B_0 + B_1 x_1 + \ldots + B_j + \ldots + B_k x_k) - \Phi(B_0 + B_1 x_1 + \ldots + B_k x_k)$$

where x_k is equal to 1 in the first parenthesis, and x_k is equal to zero in the second parenthesis.

Factor Analysis

Besides conducting the regression analysis, statistical factor analysis was conducted to identify the variables, related to consumer preferences; those can be grouped together for a focused marketing plan (Sharma and Kumar 2006; Johnson and Wichern 2002). Factor analysis was also used to handle the multicollinearity problem in the regression analysis that resulted from having

highly correlated independent variables (Sharma and Kumar 2006; Johnson and Wichern 2002). The main objective of the factor analysis is to describe the variance-covariance structure of some variables using lower number of unobservable and random quantities, which are called the common factors (Johnson and Wichern 2002). The orthagonal factor analysis model can be structured as follows. The observed values of consumer preferences for citrus fiber-added ground beef attributes can be represented by the observable random vector $\boldsymbol{Z}$, with p components, with mean $\boldsymbol{\mu}$ and covariance matrix $\boldsymbol{\Sigma}$ (Johnson & Wichern 2002). In a factor analysis model, $\boldsymbol{Z}$ is linearly dependent on unobservable random variables, $F_1, F_2, \dots, F_m$, which are called common factors, and p additional sources of variation, $\varepsilon_1, \varepsilon_2, \dots, \varepsilon_p$, which are called errors. The factor analysis model then can be represented as:

$$(7) \quad \boldsymbol{Z} - \boldsymbol{\mu}_{p \times 1} = \mathbf{L}_{p \times m}\mathbf{F}_{m \times 1} + \boldsymbol{\varepsilon}_{p \times 1}$$

where $\mathbf{L}$ is the matrix of factor loadings, which includes the loading of the j^{th} variable of the k^{th} factor l_{jk}. Hence, the factor model model represents the p deviations, $X_1 - \mu_1, X_2 - \mu_2, \dots, X_p - \mu_p$, in terms of random variables $F_1, F_2, \dots, F_m$ and $\varepsilon_1, \varepsilon_2, \dots, \varepsilon_p$, which are unobservable (Johnson & Wichern 2002). We can construct the covariance structure of the orthogonal factor model as follows: $\text{cov}(\boldsymbol{\varepsilon}) = \boldsymbol{\xi}$, where ξ is a diagonal matrix, $\text{cov}(\boldsymbol{Z}) = \boldsymbol{\Sigma} = \mathbf{L}\mathbf{L}' + \boldsymbol{\xi}$, $\text{cov}(\mathbf{F}) = \mathbf{I}$, $\text{cov}(\boldsymbol{\varepsilon}, \mathbf{F}) = \mathbf{0}$. Hence, $\boldsymbol{\varepsilon}$ and $\mathbf{F}$ are independent and the common factors $F_1, F_2, \dots, F_m$ are uncorrelated with each other. The factor loading matrix can be represented as $\text{cov}(\boldsymbol{Z}, \mathbf{F}) = \mathbf{L}$. The estimates of the factor loadings are then found using the principal component method as:

$$(8) \quad \hat{\mathbf{L}} = \left[\sqrt{\widehat{\lambda_1}}\widehat{\mathbf{e}_1} \vdots \sqrt{\widehat{\lambda_2}}\widehat{\mathbf{e}_2} \vdots \cdots \vdots \sqrt{\widehat{\lambda_m}}\widehat{\mathbf{e}_m}\right]$$

where $\widehat{\lambda_k}$ and $\widehat{\mathbf{e}_k}$ are the estimates of the eigenvalue-eigenvector pairs for $\boldsymbol{\Sigma}$ (Johnson & Wichern, 2002). The eigenvalue estimates, $\widehat{\lambda_k}$, represent the contribution of the k^{th} factor to the total sample variance. In the current, study both p and m were 5.

Results

Factor Analysis

Results of the factor analysis are reported in Table 3, in the Kaiser rotated form, which makes interpretation of the factor loadings easier and keeps the model structure unchanged (Johnson and Wichern 2002). Since common factors are unobservable, the interpretation of common factors involves an unavoidable subjective process (Johnson and Wichern 2002). Hence, authors' interpretation of the common factors for this study is also subjective. Organic beef, locally grown beef, and grass-fed beef variables had the highest loadings for factor 1. Factor 2 had the highest factor loading from the variables taste, color, and texture. The variable "product of the U.S.A." had the highest loading for factor 3. Similarly, the price and low-fat content had the highest loadings for factors 4 and 5, respectively. For factor 5, the fact that low-fat content has the highest factor loading among different variables and the other variables have much lower factor loadings, except for the taste variable, we interpret this factor as low-fat content. Since taste variables have higher loadings on factors 2 and 3, and the highest on factor 3, we included the taste variable in interpretation of factor 3. The readers should be careful, as indicated above, the

interpretation of common factors involve a subjective process. Overall, the experience attributes (taste and texture) were grouped into the same factor, whereas the search attributes (price and color) and credence attributes were grouped separately into different factors.

Table 3. Rotated Factor Loadings (N = 160)

Variables	Factor 1 λ=1.80	Factor 2 λ=0.85	Factor 3 λ=0.21	Factor 4 λ=0.17	Factor 5 λ=0.03
Price	-0.25	-0.06	-0.03	0.31	-0.01
Taste	-0.02	0.37	0.02	0.22	0.11
Color	0.04	0.42	0.26	-0.14	-0.04
Texture	0.04	0.57	0.07	0.00	0.02
Product of U.S.A.	0.18	0.23	0.46	-0.01	0.04
Organic Beef	0.74	-0.03	-0.02	-0.02	0.02
Locally Grown Beef	0.64	-0.07	0.30	0.07	-0.07
Grass-fed Beef	0.80	0.09	0.01	-0.06	0.01
Low Fat Content	-0.01	0.19	0.14	0.06	0.19

Regression Analysis

Regression diagnostics were done for multicollinearity, heterogeneity, and endogeneity. The variance inflation factor (VIF) was used to check the multicollinearity among the independent variables. The rule of thumb is that multicollinearity exists for variables with a VIF larger than 10 (Chen et al. 2003). Although the VIF did not detect a multicollinearity problem, significant correlations were detected among the variables. Instead of dropping a correlated variable from the regression and causing biased estimators, factor scores from the factor analysis were used to address the issue without omitting any variables (Sakar et al. 2011; Eyduran et al. 2010; Sangun et al. 2009; see Johnson and Wichern 2002, p. 510 for the calculation of factor scores). Factor scores are reported in Table 4. Heterogeneity robust standard errors were used to prevent the heterogeneity problem in the regression analysis. Lastly, endogeneity was tested to prevent an omitted-variable bias. The Hausman test for endogeneity was conducted (Wooldridge 2006). The Wald test for the null hypothesis, stating that the independent variables are exogenous, could not be rejected at the 10% significance level (Wooldridge 2006). Hence, endogeneity was not a problem for the current study.

Table 4. Factor Score Estimates (N=160)

Variables	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Price	-0.043	-0.022	-0.012	0.271	-0.007
Taste	-0.001	0.215	-0.028	0.203	0.087
Color	-0.014	0.233	0.155	-0.137	-0.065
Texture	-0.013	0.389	-0.014	0.011	-0.014
Product of U.S.A.	0.023	0.104	0.336	-0.020	0.044
Organic Beef	0.327	-0.048	-0.109	0.016	0.050
Locally Grown Beef	0.212	-0.139	0.325	0.156	-0.121
Grass-fed Beef	0.457	0.113	-0.162	-0.079	0.039
Low Fat Content	-0.016	0.079	0.089	0.051	0.172

Table 5 reports the results for the ordered probit regressions. As there were three levels of citrus fiber added to the ground beef, there are three regression results to report with respect to willingness-to-pay for 1%, 3%, and 5% citrus fiber-added ground beef. For all three of the regression models, the Wald chi-square test statistics for the overall significance of the regression were significant at the 1% level for the first two regressions and at the 10% level for the third regression, demonstrating that all of the regressions were significant This compensates for the low R-squared values. It is common to obtain small R-squared values in the social sciences as it is difficult to predict consumer behavior (Wooldridge 2006; Gedikoglu and Parcell 2014). However, given that all the regressions were statistically significant, the regressions are all considered to be informative.

Table 5. Results for Ordered Probit Regression Analysis

Variables	WTP for 1Percent CF[1]		WTP for 3 Percent CF[2]		WTP for 5 Percent CF[3]	
	Coeff.	Robust Std. Err.	Coeff.	Robust Std. Err.	Coeff.	Robust Std. Err.
Factor 1 (Organic, Locally Grown, Grass-fed)	0.34***	0.102	0.33***	0.108	0.13	0.095
Factor 2 (Taste, Color, Texture)	-0.05	0.142	0.20	0.145	0.16	0.145
Factor 3 (Product of U.S.A.)	-0.27	0.182	-0.34**	0.173	-0.12	0.164
Factor 4 (Price)	-0.63***	0.236	-0.53**	0.224	-0.14	0.190
Factor 5 (Low Fat Content)	1.20***	0.428	1.11***	0.424	0.92**	0.422
N	160		160		160	
Pseudo R-squared	0.068		0.070		0.024	
Wald chi-square (5)	28.68		25.25		9.91	
p-value for Wald chi-square	0.000		0.000		0.077	

Note. [1]Indicates willingness-to-pay a price premium for 1% citrus fiber-added ground beef over conventional ground beef.
[2] Indicates willingness-to-pay a price premium for 3% citrus fiber-added ground beef over conventional ground beef.
[3]Indicates willingness-to-pay a price premium for 5% citrus fiber-added ground beef over conventional ground beef.
Three asterisks (***) indicate significance at the 1% level, two asterisks (**) at the 5% level, and one asterisk (*) at the 10% level.

Factor 1 had a positive and significant impact on both 1% and 3% citrus fiber-added ground beef. Therefore, as the value of factor 1 increased for a consumer, the consumer became more likely pay a price premium. This result is consistent with the results of Grannis et al. (2000). Factor 2 was not found to be statistically significant for either of the regressions. On the other hand, factor 3 was only statistically significant for 3% citrus fiber-added ground beef. The higher the value of factor 3, the less likely that the consumer was willing to pay a price premium. The coefficients for factor 3 at the 1% and 5% citrus-added levels were also negative but not statistically significant. Factor 4 had a negative and statistically significant impact for both 1% and 3% citrus fiber-added ground beef. This finding is consistent with the results of Yang and

Woods (2013) and Wang et al. (2011). Lastly, as seen by all of the regressions, factor 5 had a positive and highly significant statistically impact on consumers' willingness-to-pay a price premium. This is the only factor found to be significant for all of the regressions. For 5% citrus fiber-added ground beef, factor 5 was the only statically significant variable. Therefore, if producers focus on the low-fat content attribute (i.e., factor 5), they are more likely to obtain a positive price premium for all three levels of citrus fiber-added ground beef. Not finding factors 1 or 4 and finding only factor 5 significant for 5% citrus fiber-added ground beef might indicate "health consciousness," which might be associated with having the highest percentage of citrus-fiber, might be a more important determinant than price or other factors. This result is similar to the results of Jensen et al. (2014) and Yang and Woods (2013), which found that health aspect is more important than price aspect for beef products.

In Table 6, the marginal effects for the ordered probit models are reported for all three regressions. A care should be given, when interpreting the marginal effects for ordered probit.

Table 6. Marginal Effects for Ordered Probit Regression Analysis (N = 160)

	Regression: *Willingness-to-pay for 1% Citrus Fiber-added Ground Beef*				
	Price Premium Levels				
Variables	**$0**	**$0.45**	**$0.90**	**$1.35**	**$1.80**
Factor 1 (*Organic, Locally Grown, Grass-fed*)	-0.135	0.056	0.047	0.022	0.010
Factor 2 (*Taste, Color, Texture*)	0.021	-0.009	-0.007	-0.003	-0.002
Factor 3 (*Product of U.S.A.*)	0.107	-0.045	-0.037	-0.017	-0.008
Factor 4 (*Price*)	0.252	-0.105	-0.088	-0.041	-0.018
Factor 5 (*Low Fat Content*)	-0.477	0.199	0.167	0.077	0.035
	Regression: *Willingness-to-pay for 3% Citrus Fiber-added Ground Beef*				
	Price Premium Levels				
Variables	**$0**	**$0.45**	**$0.90**	**$1.35**	**$1.80**
Factor 1 (*Organic, Locally Grown, Grass-fed*)	-0.093	-0.022	0.066	0.044	0.006
Factor 2 (*Taste, Color, Texture*)	-0.056	-0.014	0.040	0.026	0.004
Factor 3 (*Product of U.S.A.*)	0.094	0.023	-0.066	-0.044	-0.006
Factor 4 (*Price*)	0.148	0.036	-0.105	-0.070	-0.010
Factor 5 (*Low Fat Content*)	-0.311	-0.075	0.219	0.146	0.020

Table 6. *Continued*

	Regression: *Willingness-to-pay for 5% Citrus Fiber-added Ground Beef*				
	Price Premium Levels				
Variables	**$0**	**$0.45**	**$0.90**	**$1.35**	**$1.80**
Factor 1 (*Organic, Locally Grown, Grass-fed*)	-0.039	-0.012	0.021	0.019	0.012
Factor 2 (*Taste, Color, Texture*)	-0.049	-0.015	0.026	0.024	0.014
Factor 3 (*Product of U.S.A.*)	0.038	0.012	-0.020	-0.018	-0.011
Factor 4 (*Price*)	0.044	0.014	-0.023	-0.021	-0.013
Factor 5 (*Low Fat Content*)	-0.279	-0.087	0.148	0.135	0.083

The sign of the marginal effect changes across choices for a variable. For example, in the ordered probit regression, if a variable is found to have a positive impact on the probability of paying a price premium, then the marginal effect for this variable will be negative for $0 and positive for the other price premium levels. Factor 5 (low-fat content) had the highest negative marginal effect of $0 for 1% citrus fiber-added ground beef. On the other hand, factor 4 (the price) had the highest positive marginal effect for $0. However, the marginal effect of factor 5 was almost twice the marginal effect of factor 4. As expected, factor 5 (low-fat content) had both a positive and the largest marginal effect on the positive price premium levels: $0.45, $0.90, $1.35, and $1.80. Therefore, if the low-fat content of ground beef is important to a consumer, it significantly increases the likelihood of paying a positive price premium.

The marginal effects for 3% and 5% citrus fiber-added ground beef show similar patterns. Factor 5 (low-fat content) had the highest negative marginal effect on the willingness-to-pay levels of $0 and $0.45 for both regressions. On the other hand, factor 5 has the highest positive marginal effect on the willingness-to-pay levels of $0.45, $0.90, and $1.35 for both regressions. Regarding factor 4, price, had high positive marginal effects on the willingness-to-pay levels of $0 and $0.45 and high negative positive marginal effects on $0.90, $1.35, and $1.80. As with 1% citrus fiber-added ground beef, the marginal effects for factor 5 (low-fat content) were much higher than those of factor 4 (price). Overall, low-fat content and price (factors 4 and 5) were the most influential factors impacting the willingness-to-pay for citrus fiber-added ground beef. Other factors, such as taste and product origin (U.S.A.) were not as influential as the low-fat content and price.

Conclusion

Beef is a nutritious food for human consumption, with high-quality protein (Aberle et al. 2001). However, consuming beef products is often associated with coronary heart disease, obesity, and diabetes (Micha et al. 2010; Lajous et al. 2011). Therefore, ground beef and other beef products are commonly known as unhealthy food choices, due to the presence of saturated fats being correlated with high cholesterol levels in humans. Another key factor related to the human diet,

especially in the US, is the low consumption of dietary fiber. Dietary fiber is a necessary food ingredient that promotes health by reducing cholesterol and the risks of heart disease. Adding fiber to ground beef can increase the health benefits of consuming ground beef products and can provide new market opportunities for the beef industry. This will positively impact human health while increasing sales and profits for the beef industry.

By using a consumer panel, the current study analyzed consumers' preferences for citrus fiber-added ground beef meatballs. The results showed that consumers were willing to pay a positive price premium, but it was not very high. The average price premium was $0.35, $0.55, and $0.65, respectively, for 1%, 3%, and 5% percent citrus fiber-added ground beef. A comparison of average price premiums with the cost of adding citrus fiber, $0.09 for 1% citrus fiber, $0.27 for 3%, and $0.45 for 5%, revealed that the average price premium covers the cost of adding citrus fiber for each percentage level. Thus, there are opportunities for beef producers to increase their profits by adding citrus fiber into ground beef.

The regression results show that consumers concerned with getting lower fat contents in ground beef are more likely to pay a price premium for citrus fiber-added ground beef. Consequently, targeting these consumers should increase the prospect of getting a positive price premium for citrus fiber-added ground beef. The low-fat content attribute also had a much higher impact on the price premium than the following attributes: organic, grass-fed, and/or locally grown beef. Although targeting consumers who are interested in organic, grass-fed, and/or locally grown beef products increases the likelihood of obtaining a price premium; focusing on consumers concerned with low-fat provides the highest chance for producers to receive a price premium. Hence, product differentiation based on the health attribute can lead to a higher price premium. Price had the highest negative impact on the price premium. Hence, price-concerned consumers are not likely to be buyers of citrus fiber-added ground beef.

In the current study, samples of citrus fiber-added ground beef were presented to the consumers. Thus, reliable data on factors such as taste and texture were obtained, but future research is needed to expand the geographical scope of the study. Internet or mail surveys can be conducted with respondents from a wider geographic region. As the current study was conducted on a university campus, it is expected that the consumers are highly educated. Hence, future studies are needed to include a more heterogeneous sample.

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Appendix. Consumer Survey

Citrus Powder: Citrus powder is rich in both soluble and insoluble dietary fiber. Consuming food with dietary fiber can help with maintaining a healthy weight and lowering [the] risks of diabetes and heart disease.

1. Suppose that you are in a grocery store to buy **ground beef**. The price of a conventional *ground beef chuck* (with 80% lean and 20% fat) is $4.48/lb. What is the price premium per pound *over* the price of conventional ground beef chuck [$4.48/lb.] would you be willing to pay to buy a ground beef chuck with the following attributes? (Please check one for each attribute).

Attributes	**None 0**	**$0.45 1**	**$0.90 2**	**$1.35 3**	**$1.80 or More 4**
Ground Beef Chuck with 1% Citrus Powder	[ ]	[ ]	[ ]	[ ]	[ ]
Ground Beef Chuck with 3% Citrus Powder	[ ]	[ ]	[ ]	[ ]	[ ]
Ground Beef Chuck with 5% Citrus Powder	[ ]	[ ]	[ ]	[ ]	[ ]

2. When purchasing **ground beef**, how important to you are the following attributes? (Please check one for each attribute).

	Extremely Important 2	**Somewhat Important 1**	**Not Important 0**
Price	[ ]	[ ]	[ ]
Taste	[ ]	[ ]	[ ]
Color	[ ]	[ ]	[ ]
Texture	[ ]	[ ]	[ ]
Product of U.S.A.	[ ]	[ ]	[ ]
Organic Beef	[ ]	[ ]	[ ]
Locally grown Beef	[ ]	[ ]	[ ]
Grass-fed Beef	[ ]	[ ]	[ ]
Low Fat Content	[ ]	[ ]	[ ]