Research Paper 2015-2 **November 2015**

Economics Research Report Series

Consumers' Preferences and Willingness to Pay for Ground Bison

by

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Economics Research Report No 2015-2

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Abstract

A consumer sensory panel study in conjunction with consumers' willingness to pay experiment for 93% ground bison, 93% ground beef, and 80% ground beef was conducted in Sioux Falls, SD. The average, bid for 93% ground bison was $0.38 per lb. higher than the average bid for 80% ground beef. On an average, bids for 93% ground bison were lower than the bids for 93% ground beef by $0.28 per lb. providing nutrition information significantly increased panelists' bids for both 93% ground bison and 93% ground beef. On an average, bids for 93% ground bison, and 93% ground beef, by the panelists with nutrition information were higher as compared to the panelists in the control group by $1.23 and $0.47 per lb., respectively. Highly significant factors impacting the premium for 93% ground bison are the availability of nutrition information, ability to identify bison, and presence of 7-18 years old children in the household. Our analysis demonstrates that informing the potential bison consumers of bison nutrition have potentially a large pay off. The analysis also shows that the 93% ground bison is competing with 93% ground beef, and the factors which impacting 93% ground bison and 93% ground beef are more or less similar.

Keywords: bison, consumer preferences, willingness to pay, experimental auctions

JEL Codes: Q11, Q13

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Acknowledgements

This research was funded through a grant titled “Identifying Consumer Preferences to Improve Bison Marketing,” by the USDA/Agricultural Marketing Service (Grant no: FSMIP 12-25-G-1513). Matching funds for the research were provided by the Inter Tribal Buffalo Council, 2497 West Chicago Street, Rapid City, SD 57702, and Agricultural Experiment Station, South Dakota State University, Brookings, SD 57007. We are thankful for their support.

We are greatly thankful to the consumers who took their valuable time to participate in the study. Without their participation, this study would have not been possible.

We are also thankful to numerous economics and animal science graduate and undergraduate students, who relentlessly helped with conducting this very time consuming research. Finally, we are thankful to Dr. Larry Janssen, and Dr. Evert Van der Sluis of the economics department for reviewing an earlier version of this research report, and making valuable suggestions. Last but not the least, all omissions and errors are the responsibility of authors.

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Executive Summary

The objectives of this research are to identify consumer preferences with regards to ground bison, factors which influence purchase of ground bison meat, and consumers' willingness to pay for ground bison meat. The study employed an experimental auction approach to discover consumers' willingness to pay for ground bison and true valuation of ground bison. The experimental auction is a less hypothetical valuation method as compared to other instruments. We also conducted a consumer sensory panel study in conjunction with consumers' willingness to pay experiment to identify different product attributes important to consumers.

The study was conducted in Sioux Falls, SD, and utilized three products, 93% ground bison, 93% ground beef, and 80% ground beef. In total 91 consumers participated in the study. On average the participants had completed a four years college degree, were married, and had the average household size slightly over 2. Half of the participants were over 40 years old, with the vast majority being Caucasian. Average income per household was in the 50 to 75 thousand dollars category. Male to female ratio among panelists was 1 to 1. Panelists were asked to complete a survey covering their meat purchasing behavior, eating preferences, knowledge about bison and beef, and socioeconomic and demographic information.

The sensory tasting part of the study was conducted according to the standards set by American Meat Science Association 1995. Panelists were asked to taste and rate three color coded samples of cooked ground meat products for different attributes. The taste panels were kept "blind" about the identities of the samples, and two rounds of sensory tasting were held. In each round, after tasting the three color coded meat samples, panelists were asked to evaluate and rate each sample for like of texture and tenderness, like of juiciness, like of flavor, and overall like of eating quality using a 10-point hedonic scale (1=extremely dislike; 10=extremely like).

From the average rankings perspective, the 93% ground beef was most favored in terms of each of the four characteristics. The average rankings for 93% ground bison were significantly lower than the rankings for 93% ground beef. The differences in sensory panel rankings for 93% ground bison and 80% ground beef were mixed and these differences were not significant.

Before participating in the ground meat experimental auction, the panelists were explained the procedure, and were asked to participate in an auction for three different candy bars to gain hands on experience of the auction experiment. During the experimental auction of the meat products, for

reference purpose, the area retail prices for 80% ground beef, ground bison, and 93% ground beef ($4.49, $5.99, and $4.99 per lb., respectively) were posted on the board for participants to see. Panelists in half the sessions were also provided with nutritional information for the three ground meat products, which was drawn from USDA's National Nutrient Database. The panelists in the other half sessions were treated as a control group. Panelists were asked to simultaneously bid (in $ per lb.) for each of the three color coded ground meat products, and were encouraged to bid exactly the amount they believed the product was worth to them as those who "win" a binding auction, would be obligated to purchase one-pound package of the product at the auction purchasing price. In total, five rounds of meat auction were conducted, the winning round for each meat product was randomly drawn from the five rounds, and the bid winners were asked to buy a one pound packet of the respective color coded ground meat at the auction purchasing price.

The analysis of sequential pairs of rounds show that panelists made some adjustments in bids for the second round. However, their adjustments did not change their respective rankings. For the remaining rounds, bids were not changed significantly. On the whole panelists' behavior was fairly consistent through different rounds. On an average, panelists were willing to pay $3.63, $4.01, and $4.29 per lb. for 80% ground beef, 93% ground bison, and 93% ground beef, respectively. The average, bid for 93% ground bison was $0.38 per lb. higher than the average bid for 80% ground beef, and this difference was not statistically significant. The average difference in bids for 93% ground beef and 80% ground beef was $0.66 per lb., which was statistically significant. On an average, bids for 93% ground bison were lower than the bids for 93% ground beef by $0.28 per lb., but this difference was not statistically significant.

Providing nutrition information significantly increased panelists' bids for both 93% ground bison and 93% ground beef. On an average, bids for 93% ground bison, and 93% ground beef, by the panelists with nutrition information were higher (compared to those in control group) by $1.23 per lb., and $0.47 per lb., respectively. Our estimate of the impact of providing nutrition information on willingness to pay for ground bison is higher than previously reported by Yang and Woods (2013). We believe that our estimates are more reliable as these are based on bids in experimental auction, where the participants were participating in an auction of goods, involving actual purchase of goods with money.

In order to identify the factors which impact the premiums for 93% ground bison, the premium for 93% ground bison was regressed over a number of bivariate dummy variables, depicting the socioeconomic characteristics of the panelists. The regression analysis of the bids show that highly significant factors impacting the premium for 93% ground bison are: a) availability of nutrition

information, b) ability to identify bison sample from the blind sensory experiment, c) presence of 7-18 years old children in the household. Other important factors impacting the premiums for 93% ground bison are: a) gender - female, b) age - 40 years or more, c) education - 4 or more years of college, and d) previous purchases of bison.

The regression analysis of bids further show that highly significant factors impacting the premium for 93% ground beef are: a) presence of 7-18 years old children in the household, b) married, c) age - 40 years or more, d) availability of nutrition information, and e) ability to identify bison sample from blind sensory experiment. Other important factors impacting the premiums for 93% ground beef are: a) gender – female, and b) education – 4 or more years of college.

Our analysis demonstrates that informing the potential bison consumers of bison nutrition have potentially a large pay off. Consumers who have bought bison before, and are familiar with the product have a greater preference and stronger demand for bison compared to those who are not familiar with bison. The analysis also shows that the 93% ground bison is competing with 93% ground beef, and the factors which impact the premium for 93% ground bison and 93% ground beef are more or less similar.

Consumers' Preferences and Willingness to Pay for Ground Bison

Introduction

Bison production is gaining numbers, both in terms of production and marketing. The Census of Agriculture, conducted in 2012, pegs the U.S. bison on private lands at 162,110 head. In addition bison on the public lands are estimated to be around 20,000 head (National Bison Association 2012). Accordingly, the actual size of the bison herd in United States is estimated to be about 182,110 head.

According to the 2012 Census, with a bison herd of 33,637 head and annual sales of over 11,000 head, South Dakota ranks number 1 in bison production and marketing. Other important bison production states include Nebraska, North Dakota, and Montana. During 2012, 53% of the bison sold in the United States originated in these four states (USDA/NASS/quick states).

The bison industry is fairly small scale with approximately 60,000 head of bison slaughtered per year compared to 125,000 beef cattle per day in the U.S. (USDA/FSIS, 2011). Bison are raised on the open range without antibiotics and growth hormones (Yang and Woods, 2013). Bison marketing outlets are limited, and most bison farmers sell directly to consumers, restaurants, wholesale outlets, or cooperatives (Gegner, 2001, p. 6).

Given that bison meat is a niche market, the U.S. bison market supply chain is not integrated and very little research on bison demand has been done. Thus, very little is known about consumer preferences for bison meat. Bison production is especially important for Native American tribes in South Dakota and neighboring states, and understanding consumers' preferences for bison demand can play an important role in boosting economic activity relating to production, processing and marketing of bison.

The overall objective of this paper is to identify consumer preferences with regards to ground bison, identify factors which influence the purchase of ground bison meat by consumers, and consumers' willingness to pay for ground bison relative to ground beef. Specifically, we are interested in revealing consumer preference and thereby consumers' willingness to pay (WTP) through experimental auctions for ground bison along with ground beef, in conjunction with sensory panel evaluation of ground bison and ground beef. The study's focus is on consumers from the Sioux Falls area of South Dakota. Findings of this study will aid in efforts to develop proper ground bison promotion targeting for specific consumer cohorts and pricing strategies by bison processors and producers in South Dakota and elsewhere. The results of this study will benefit bison producers in South Dakota and neighboring states in particular, and those in the United States in general.

Review of Literature

Compared to other commercial meats, bison provides a number of health benefits e.g., it is low in calories and cholesterol, but high in iron and vitamin B-12. In the absence of large supply chains, marketing outlets for bison meat are limited. Bison producers can sell directly to consumers, restaurants, wholesale outlets, cooperatives, or via the internet (Gegner, 2001). However, bison producers are under pressure to develop marketing and merchandising plans (Yang and Woods, 2013).

Meat purchasing behavior can be highly related to socio-demographic characteristics of buyers. Due to limited literature on bison consumer demand, we can draw information from demand studies on beef in general and grass-fed beef in particular. There is evidence to suggest that the market for grass-fed meat is substantial and expanding (Spiselman, 2006). Palatability of grass-fed beef has been extensively evaluated by trained taste panels, but often with conflicting results (French et al., 2000; Mandell et at., 1998; Schaake et al., 1993; May et al., 1992; Bidner et al., 1981; and Schroeder et al., 1980).

A number of studies have tried to identify consumers' WTP for meat products with different attributes. These studies have used experimental auctions to determine WTP after consumers had actually sampled the product (Lusk et al., 2001; Melton et al., 1996; Umberger et al., 2002; and Evans et al., 2011).

Yang and Wood (2013) assessed consumers' WTP for ground bison by surveying 2,644 consumers from five states (Illinois, Indiana, Ohio, Kentucky, and Tennessee) using an existing consumer panel maintained by Zoomerange.com, an affiliate of Market Tools, Inc. during mid-September, 2012. The respondents were asked about the extent to which they knew about health benefits associated with bison products, and were randomly distributed into two groups: one group was shown the nutrition comparison information and reference prices for fresh ground bison and premium ground beef; and the other control group was only shown the reference price for fresh ground bison and premium ground beef. They reported that over 60% of consumers don't know about the benefits of bison nutrition. They also reported that the respondents who knew bison nutrition are willing to pay about $2.68-$2.81 per lb. more compared to the respondents who did not know bison nutrition at all. They further reported that the respondents who were given bison nutrition information would like to pay about $0.40-$0.48 per lb. more for fresh ground bison compared to those not given nutrition information. They concluded that consumers show positive responses to bison nutrition information. They further concluded that younger male consumers with relatively higher education and comparatively higher incomes and families without children under age 6 also reveal strong interests in bison products.

Research Methods

Experimental auctions, broadly defined as non-cooperative games among competitive bidders, account for a large proportion of experimental economics studies. Such auctions allow researchers to assess consumers' WTP for novel market goods or to otherwise elicit privately held values that cannot be obtained via hypothetical research instruments. Evans et al. (2011) utilized a variant of the Becker-DeGroot-Marschak peudo-auction mechanism to identify consumer perceptions of and WTP for Appalachian grass-fed beef.

In this study, we are trying to elicit consumers' preferences and true valuation of ground bison in an experimental auction. The WTP identified in an auction is a less hypothetical valuation method as compared to other instruments. We employed a second highest price repeated experimental auction approach to discover consumers' WTP for ground bison. In the second highest price auction, the second highest price becomes the winning price, and those who bid the second highest or higher are the winners of the auction. The adoption of second highest price auction has the advantage of including an active market participation feature to engage off-margin bidders as well as reducing the incentive for strategic bidding by the participants in repeated auctions (Lusk and Shogren, 2007, pp 69-72)

Our study is novel in that we conducted a consumer sensory panel study in conjunction with a consumers' WTP experiment in order to identify different product attributes important to consumers, as well as to identify the amounts consumers are willing to pay for ground bison. The study was conducted in Sioux Falls, SD and covered three products, 93% ground bison, 93% ground beef, and 80% ground beef. To participate in the study, panelists needed to consume ground bison and ground beef, and were promised a payment of $30.00 for their time. After advertising in local newspapers, 91 consumer panelists were selected based on a set of predetermined demographic characteristics. Out of these, 7 panelists were used for pre-testing the instruments, procedures, and methods.

For participating in the panel study, the individual respondents were scheduled for one of the 10 panels, each consisting of 3-16 consumers. The first panel was used for pre-testing, and remaining 9 panels for collecting the data for analysis. After arriving at the research facility, panelists were briefed regarding the objectives and sponsors of the research. The participants were informed about the protocol of the research involving human subjects. The panelists were also informed that their participation in the study was voluntary, and that they were free to leave any time during the study. The panelists were then asked to review and sign the "Informed Consent Document for Human Participation in Research" document (a copy of which is shown in the Appendix). After this, panelists were asked to participate in sensory tasting of the three cooked ground meat products.

The sensory tasting part of the study was conducted according to the standards set by the American Meat Science Association 1995 guidelines. Ground meat patties were cooked on an electric clamshell grill to 71°C internally. After cooking, patties were allowed to rest for 5 minutes to allow for the juices to redistribute. Patties were then cut into 2.5 cm × 1.3 cm samples using a sample sizing guide, placed into Styrofoam bowls, covered with aluminum foil, and held in a warming oven at 60°C, until served. Samples were served to panelists in a randomized fashion, in private booths. Toothpicks, water, and saltines were also made available to panelists.

Panelists were asked to taste and rate three color-coded samples of cooked ground meat products for different attributes. The taste panels were kept "blind" about the identities of the samples, and the meat samples were referred to by their color codes. In choosing the colors for coding, the colors which could invoke positive or negative biases (for example, black, white, red, and blue) were avoided. Specifically, 80% ground beef, 93% ground bison, and 93% ground beef were assigned yellow, orange, and purple color codes, respectively. These color codes were maintained in all phases of the study, and for all groups of consumer panels.

After a practice run, two rounds of sensory tasting were held. In each round, after tasting the three color-coded meat samples, panelists were asked to evaluate and rate each sample for like of texture and tenderness, like of juiciness, like of flavor, and overall like of eating quality using a 10-point hedonic scale (1=extremely dislike; 10=extremely like). Participants were also asked to state which sample they preferred, or if they had preference among the three samples. Panelists were allowed to make their own notes about their preferences to help them decide the bids for different meat products later at the meat auction.

After completing the consumer sensory tasting part of the study, the panelists were asked to complete a survey regarding their meat purchasing, eating preferences, their knowledge about bison and beef, and their socioeconomic and demographic characteristics (a copy of the blank survey blank is shown in the Appendix). In the survey, panelists were also asked to guess the identity of each color-coded product, which they had sampled in sensory tasting and the ranking part of the study. After completing the survey, panelists were paid $30.00 each for their time to take part in the study, and asked to sign a receipt for the amount for the record (a copy of a blank receipt is shown in the Appendix).

After completing the survey, panelists were explained the procedure for the second price auction. To help the panelists fully understand the second price auction mechanism, participants were provided with written instructions for the candy bar auction (a copy of the instructions is shown in Appendix). After reviewing the instructions, they were asked to participate in one practice round of WTP auction for three different candy bars displayed in front of them. Before starting the practice

round of the candy bar auction, participants were provided with candy bid sheets (a copy is shown in the Appendix) and asked to simultaneously submit bids (in $/candy bar) for each of three candy bars, with an increment of $0.10 per bar. Participants were encouraged to bid exactly the amount they believed a particular candy bar was worth to them. Participants were reminded that if they "won" an auction, they would be obligated to purchase the candy bar at the auction purchasing price (except in case of the practice round).

After the practice round, the first round of the candy auction was conducted. After the participants entered their bids, the bid sheets were collected. The auction monitor tabulated and ranked the bids for each candy bar in the candy bid recording form (a copy is shown in the Appendix), and the round-winning price (second highest price) for each candy bar was announced. All bids which were equal to or higher than the round-winning price were declared as potentially winning bids for that particular candy bar in that round. The highest bid was not disclosed, but the panelists with the highest bid were also listed as potential winner for the round. Before starting the next round, the round-winning price and IDs of potentially winning bids for each candy bar were posted on the board for all participants to see.

Only two rounds of candy auctions were held. After completing the two rounds, the winning round for each candy bar was randomly drawn. The panelists with the potentially winning bids for the candy bar in the winning round were declared as bid winners, and the round-winning price became the auction purchasing price for that candy bar. Following this, the bid winners were asked to buy their candy bars at the respective auction purchasing price. By the end of the second round of the auction for the candy bars, the participants had fully grasped the auction procedure.

After completing the auction of the candy bars, the panelists were asked to participate in five rounds of WTP auctions for three color-coded ground meat products. Identities of the ground meat products were not revealed to the participants. Written instructions for ground bison and ground beef auction (a copy is shown in the Appendix) were provided to the participants. At the time of the experimental auction, 80% ground beef, ground bison, and 93% ground beef were being retailed at $4.49, $5.99, and $4.99 per lb., respectively. For reference purpose, these local retail prices were posted on the board for participants to see. It may be pointed out that ground bison was only available at one store, and that the available ground bison did not carry any label for lean percentage. Accordingly, the local retail price for ground bison posted on the board did not mention any lean percentage. Panelists in one half of the sessions were also provided with nutritional information for the three ground meat products. This nutritional information was drawn from USDA's National Nutrient Database (a copy is shown in the Appendix). The panelists in the other half of the sessions were treated as the control group. Panelists

were asked to simultaneously bid ($ per lb., in increments of ten cents) for each of the yellow, orange, and purple ground meat products on bison and beef bid sheet (a copy is shown in the Appendix). Participants were encouraged to bid exactly the amount they believed the product was worth to them. Participants were also reminded that if they "won" the auction, they would be obligated to purchase the one-pound package of the product at the auction purchasing price.

For round 1, panelists were given bid sheets and asked to simultaneously bid for all three ground meat products. After the panelists entered their bids, the bid sheets were collected, and the auction monitor recorded and ranked the bids for each meat product. The round-winning price (second highest price) for each product in that round was declared. All bids equal or higher than the respective round-winning price were declared as potentially winning bids for that particular meat product in that round. The highest bid was not disclosed, but panelists with the highest bid(s) and the second highest bid(s) were posted as the potential winners along with the round-winning price of each product in that round for all participants to see before the next round.

In total, five rounds of meat auctions were conducted. After completing five rounds, the winning round was randomly drawn for each meat product. The panelists with the potential winning bids for that meat product in the winning round were declared as bid winners, and the round-winning price became the auction purchasing price for that meat product. Following that, the bid winners were asked to buy one pound package of the respective color-coded ground meat at the auction purchasing price. Subject to availability, other participants were also given a chance to buy packages of different color-coded ground meat products at the respective purchasing prices of the auction session.

Data and Summary Statistics

Excluding those involved in pretesting, 84 panelists (in nine groups) participated in the dual experiment. The frequencies of demographic information for these panelists are summarized in Table 1. On average, the participants completed four year college degree, were married, and had an average household size of slightly over 2. Half of the participants were over 40 years old, with the vast majority being Caucasian. Average income per household was in the 50 to 75 thousand category. The male to female ratio among panelists was 1 to 1 (41 panelists were males and 41 were females).

Meat product purchasing frequencies among panelists are summarized in Table 2. Panelists reported that the most preferred beef product was steak (57%) followed by 93% ground beef (18%), and roast (13%). On the other hand, the most frequently purchased beef product by the panelists was 93% ground beef (49%) followed by 85% beef (21%), and steak (14%). Only 36% of the panelists reportedly purchased bison products during the preceding year. The most frequently purchased bison product by

the panelists was ground bison (30%) followed by bison steak (8%). The most preferred bison product was also ground bison (25%), followed by bison steak (8%).

Interestingly, the panelists' purchase frequency of beef products did not match well with their stated preference for different beef products. In contrast, the panelists' bison products purchase frequency matched reasonably well with their stated preference for different bison products. Only 38% of the panelists were able to identify the 93% ground bison correctly after sampling the color-coded samples of the three ground meat products.

Table 3 summarizes consumption frequencies of and preferences for selected meat products among panelists. In response to a question related to the consumption preferences for different meat products, beef was ranked first (with an average rank of 1.94), followed by chicken (with an average rank of 2.67). Pork and other meat products both showed a tie for third position (with an average rank of 3.10), while lamb, bison, and fish ranked fourth, fifth, and sixth, respectively. The rankings of consumption frequencies of these five meat products matched with the respective consumption preference ranks.

In response to a request to rank the eating preferences of the three meat products studied, panelists ranked 93% ground beef highest (with an average rank of 1.62), followed by ground bison (with an average rank of 1.88) and 80% ground beef (with an average rank of 2.51). However, when panelists were asked to indicate their consumption frequencies of the three meat products, panelists ranked 93% ground beef highest (with an average frequency of 1.25), followed by 80% ground beef (with an average frequency of 1.94), and 93% ground bison (with an average frequency of 2.79).

Results and Discussion

Eating Preferences and Consumption Frequencies

The eating preferences and consumption frequency questions were designed so that participants would provide an ordinal ranking for each of the seven protein sources with respect to their eating preference and eating frequency. The rankings ranged from 1 (the highest) to 7 (the lowest). The relative rankings for each of these seven protein sources with respect to eating preference and eating frequency were similar. As discussed earlier in the data section, beef and chicken were ranked as number 1 and 2, respectively. Pork and other meats were ranked as number 3, while lamb, bison, and fish were ranked as numbers 4, 5, and 6, respectively.

Spearman correlation coefficient estimates for the seven protein products with respect to eating preference are reported in Table 4. Beef preference is negatively related to chicken and fish consumption preferences. Pork consumption preference has no significant linear relation with any of the other six protein sources. The consumption preferences for bison, lamb, and other meats are all positively correlated. Chicken consumption preference is inversely related to beef consumption preference. Finally, fish consumption preference is positively related to other meats and negatively related to beef.

Table 5 provides Spearman correlation coefficient estimates for the seven protein source products with respect to frequency of consumption. Beef consumption frequency is negatively related to chicken and fish consumption frequency, and pork consumption frequency is negatively related to chicken consumption frequency. Bison consumption frequency is positively related to the consumption frequency for lamb, fish, and other meats, and chicken consumption frequency is inversely related to beef and pork consumption frequencies. Lamb consumption frequency is positively related to the consumption frequencies for bison, and other meats. Fish consumption frequency is negatively related to beef but positively related to bison. Other meat consumption frequency is positively related to bison, lamb, and fish.

Table 6 provides Spearman cross correlation estimates for the seven protein products with respect to preference to consume and frequency of consumption. For each of the protein category, the preference to consume is positively correlated with the respective frequency of consumption indicating a consistent behavior with respect to each of these protein sources. On the other hand, cross correlations between preferences and eating behavior for one individual protein relative to the other six protein sources are not symmetric. This suggests that the frequency of consumption is affected by other factors besides preferences, and consumers are facing constraints in their purchasing decisions. Relationships between each protein source and other protein sources are briefly discussed below.

a) Beef consumption frequency is positively correlated with consumption preference for bison and negatively correlated with consumption preference for chicken and fish. Beef consumption preference is not correlated with consumption frequencies of any of other six protein sources.

b) Pork consumption frequency is negatively correlated with the consumption preference for chicken and positively correlated with the consumption preferences for other meats. However, pork consumption preference is not correlated with the consumption frequency for any other protein source.

c) Bison consumption frequency is positively correlated with consumption preferences for lamb and other meat. However, bison consumption preference is positively correlated with beef, lamb, and other meat consumption frequencies.

d) Chicken consumption frequency is not correlated with consumption preference for any of the other six protein sources. However, chicken consumption preference is negatively correlated with consumption frequencies for beef and pork.

e) Lamb consumption frequency is positively correlated with consumption preferences for bison and other meats. Lamb consumption preference is also positively correlated with consumption frequencies for bison and other meat.

f) Fish consumption frequency is not correlated with consumption preference for any other protein sources. Fish consumption preference is negatively correlated with consumption frequency for beef.

g) Other meat consumption frequency is positively correlated with consumption preference for bison and lamb. Other meat consumption preference is positively correlated with consumption frequencies for pork, bison and lamb.

Sensory Tasting

The sensory tasting part of the study was conducted according to the standards set by the American Meat Science Association 1995 guidelines. Panelists were asked to taste and rate three color-coded samples of cooked ground meat products (80% ground beef, 93% ground bison, and 93% ground beef) for different attributes. The panelists were kept "blind" about the identities of the samples, and the meat samples were referred to by their color codes (yellow, orange, and purple). Two rounds of sensory tasting were held, and in each round, after tasting the three color-coded meat samples, panelists were asked to evaluate and rate each sample for: a) like of texture and tenderness, b) like of juiciness, c) like of flavor, and d) overall like of eating quality, using a 10-point hedonic scale (1=extremely dislike; 10=extremely like).

Average rankings of the three meats by the panelists, in terms of these four characteristics, are presented in Table 7. The table also presents a pairwise comparison of average rankings for these three meat samples. From an average rankings perspective, the 93% ground beef was the most favored in terms of each of the four characteristics. Pairwise comparisons confirm that the average ranking of 93% ground beef is significantly higher (at 1% level) than the average ranking of 80% ground beef for each of the four characteristics. The average ranking of 93% ground bison is significantly lower (at

1% level) than the ranking of 93% ground beef for each of the four characteristics (Table 7). In other words, the average ranking for 93% ground beef is also significantly higher than the average ranking of 93% ground bison for each of the four characteristics.

Considering juiciness, flavor, and overall like of eating quality, the 93% ground bison ranking is lower than the respective ranking for 80% ground beef. In terms of texture, the 93% ground bison ranking is higher than the 80% ground beef ranking. However, the difference in average ranking between 93% ground bison and 80% ground beef is not statistically significant for these characteristics.

The average ranking of 93% ground bison is higher than the average ranking of 80% ground beef for texture, while the average ranking of 93% ground bison is lower than the respective average ranking of 80% ground beef for juiciness, flavor, and overall like. However, the sensory panel ranking differences between 93% ground bison and 80% ground beef are not statistically significant.

Willingness to Pay

As noted in the research methodology section, the panelists were asked to participate in five rounds of WTP auctions for three color-coded ground meat products. The prevailing retail prices in the local market for 80% ground beef ($4.49 per lb.), ground bison ($5.99 per lb.), and 93% ground beef ($4.99 per lb.) were posted on the board for panelists to see as reference prices. The identities of the ground meat products were not revealed to the panelists. In some sessions, panelists were also provided with a nutrition information sheet for these three meat products, extracted from USDA (xxx). For each round, panelists were asked to simultaneously bid for all three ground meat products in $ per lb. Panelists' participation in the auction experiment was voluntary, and they were informed that they were free to not participate or stop participating any time during the experiment. Out of 84 panelists who participated in the sensory tasting part of the experiment and completed the socioeconomic survey, 82 panelists participated in the five rounds of WTP auction experiment.

After the panelists entered their bids for each round, the bid sheets were collected, and the auction monitor announced the winning price (the second highest price) for each product and for each round. Without disclosing the highest bid of the round, all bids equal to or higher than the round-winning price were declared potentially winning bids for that particular product in each round. The round-winning prices and the IDs of all potentially winning bidders for each product and the round were posted on the board for all participants to see before their participation in the next round. After completing five rounds, for each product, the winning round was randomly drawn, the panelists with the potential round-winning bids by product were declared as bid winners, and the round-winning price

became the auction purchasing price for that product. Bid winners were then asked to buy a one pound package of that product at the auction purchasing price. Although only one round was declared as a winning round after the completion of five rounds, the bids for each round represented the panelists' willingness to pay for the respective products. Accordingly, data on bids for all five rounds were used in the analysis.

Average bids for different products, by round, are reported in the top panel of Table 8. On average, panelists were willing to pay $3.63, $4.01, and $4.29 per pound of 80% ground beef, 93% ground bison, and 93% ground beef, respectively. Pairwise bid differences (for sequential rounds) were also computed and tested by applying two-tailed tests for statistical significance. Average bids of round 2 were significantly different from the average bids of round 1 (Table 8). The bids of subsequent rounds (3, 4, and 5) did not change significantly from the respective bids in the preceding rounds. Pairwise bid rank differences for sequential rounds were also computed and tested for statistical significance. Bid ranks in sequential rounds did not show any significant differences (Table 8).

The analysis of average bids for sequential pairs of rounds show that the panelists did learn from the first round. They made adjustments in their bids in round 2. However, these adjustments did not significantly change their respective rankings. Panelists did not significantly change their bids (or bid rankings) after round 2, indicating that, on the whole, panelists' behavior was fairly consistent in different rounds. Therefore, we can easily draw conclusions by comparing average bids for five rounds.

A comparison of average bids (for all 5 rounds) is presented in Table 9. On an average, bids for 93% ground bison were $0.38 per lb. higher than the bids for 80% ground beef, but this difference was not statistically significant. The average difference in bids for 93% ground beef and 80% ground beef was $0.66 per lb., which was highly significant. On an average, bids for 93% ground bison were lower than bids for 93% ground beef by $0.28 per lb., but this difference was not statistically significant.

The Impact of Nutrition Information

In order to see the impact of nutrition information on the panelists' willingness to pay for different ground meat products, 40 panelists were provided with a nutrition information sheet (NIS) compiled from USDA information (xxx), while the remaining 42 panelists were treated as the control group and were not provided with the NIS. The average bids for different products by the panelists who were provided the NIS, and those in the control group are also presented in Table 9. The average bid differences between 93% ground bison and 80% ground beef as well as between 93% ground beef and 80% ground beef were larger and were highly significant for the panelists who were provided with the NIS than for those not provided the NIS. In contrast, the average bid differences between 93% ground

bison and 80% ground beef as well as between 93% ground beef and 80% ground beef were much smaller and not statistically significant for the control group (the panelists without NIS). Interestingly, the average bid difference between 93% ground bison and 93% ground beef was not significant for the group with NIS but significant and in favor of 93% ground beef for the control group (Table 9).

The impact of the NIS was further investigated by comparing the average bids for each product for the panelists with NIS with the panelists in the control group. The results of this comparison are reported in Table 10. The average bid for 80% ground beef by the panelists with the NIS was lower by $0.13 per lb. as compared to the bids by panelists in the control group, and the difference was not significant. The average bid for 93% ground bison by the panelists with the NIS was higher by $1.23 per lb. as compared to the bids by the panelists in the control group, and the difference was highly significant. The panelists' response to the nutrition information in our study is higher than what was reported by Yang and Woods (2013) from a survey of 2,644 consumers from five states (Illinois, Indiana, Ohio, Kentucky, and Tennessee). They reported that respondents who were given bison nutrition information would like to pay about $0.40-$0.48 per lb. more for fresh ground bison compared to those who were not given nutrition information. However, they also reported that respondents who were knowledgeable about bison nutrition were willing to pay about $2.68-$2.81 per lb. more as compared to respondents who did not have knowledge of bison nutrition at all.

Yang and Woods (2013) provided only bison nutrition information to the survey participants. In contrast in our study, we provided nutrition information for all three ground meat products studied (i.e. 80% ground beef, 93% ground bison, and 93% ground beef) to the panelists who were participating in the experimental auction, except those in the control group. Accordingly, we believe, our estimates are better and more reliable. It may be noted that providing the NIS also led to higher bids for the 93% ground beef. The average bid for 93% ground beef by the panelists with NIS was higher by $0.47 per lb. compared to the average bid for 93% ground beef by the panelists in the control group, and the difference was statistically significant. This clearly shows that providing nutrition information to consumers can play a big role in promoting lean ground bison as well as lean ground beef.

Identifying the Factors Impacting the Premiums for 93% Bison

The panelists were simultaneously bidding on the three products (80% ground beef, 93% ground bison, and 93% ground beef). In this three goods world, the 80% ground beef can be considered as a base or reference product. Accordingly, the premiums panelists were willing to pay for 93% ground bison over 80% ground beef (PBISON) were calculated by deducting the bids for 80% ground beef from the bids for 93% ground bison. Similarly, the premiums panelists were willing to pay for

93% ground beef over 80% ground beef (PBEEF), were calculated by deducting the 80% ground beef bids from the bids for 93% ground beef. It may be noted that the panelists were permitted to bid $0.00 for any product, if they were not willing to buy that product. In some cases, the panelists did bid $0.00 for either 80% ground beef or 93% ground bison or 93% ground beef. This did result in a few extreme (negative and positive) values for both PBISON, and PBEEF.

In an effort to determine factors impacting the premium for 93% ground bison or PBISON was regressed over a number of bivariate dummy variables, representing the socioeconomic characteristics of the panelists. In order to provide a comparison, the premium for 93% ground beef or PBEEF, was also regressed over the same set of bivariate dummy variables, representing the socioeconomic characteristics of the panelists. With five rounds of bids and 82 panelists, the premium data consisted of 410 observations. The independent variables, capturing socioeconomic and other characteristics of the 82 panelists, were matched with the 410 premium data observations. The summary statistics for the dataset used in the premium analysis are presented in Table 11.

Specifically, the regression models estimated are as follows:

(1) $PBISON = \alpha + \beta_1 Gender + \beta_2 Children + \beta_3 Income + \beta_4 Married + \beta_5 Age + \beta_6 Education + \beta_7 Purchased + \beta_8 NIS + \beta 9 Identified + \varepsilon$, and

(2) $PBEEF = \alpha + \beta 1 Gender + \beta 2 Children + \beta 3 Income + \beta 4 Married + \beta 5 Age + \beta 6 Education + \beta 7 Purchased + \beta 8 NIS + \beta 9 Identified + \varepsilon$,

where:

PBISON = Premium for 93% bison over 80% beef, in $ per lb.,

PBEEF = Premium for 93% beef over 80% beef, in $ per lb.,

bivariate dummy variables (Gender, …, Identified) are as defined in Table 11, and

ε = Random error.

The regression analysis was conducted using SAS version 9.3. Initial diagnostics for the model indicated that there was no multicollinearity because the Variance Inflation Factor (VIF) estimates were all less than 2. However, heteroscedasticity was detected and a White correction procedure was implemented to generate heteroscedasticity-consistent standard errors (White, 1980, p. 822). The estimated regression models are reported in Table 12. Highly significant factors impacting the premium for 93% ground bison, PBISON, are: a) availability of nutrition information, b) ability to identify the bison sample from the blind sensory tasting experiment, c) the presence of 7-18 years old children in the household. Other factors impacting the PBISON are: a) gender - female, b) age - 40 years or more, c) education - 4 or more years of college, and d) previous purchases of bison - in preceding year.

Highly significant factors impacting PBEEF are: a) the presence of 7-18 years old children in the household, b) being married, c) age - 40 years or more, d) availability of nutrition information, and e) ability to identify bison sample from blind sensory experiment. Other factors impacting the premiums for 93% ground beef, PBEEF, are: a) gender – female, and b) education – 4 or more years of college.

The regression analysis of bids also demonstrates that there is potentially a very large payoff from providing bison nutrition information to consumers. Besides, consumers who bought bison before and are familiar with the product (can identify it by sampling) have a stronger demand for bison. The regression analysis further shows that the 93% ground bison is competing with 93% ground beef, and factors impacting the premium for 93% ground bison and 93% ground beef are more or less similar.

Concluding Remarks and Suggestions for Future Research

Based on sensory tasting of the color-coded samples, 93% ground beef was ranked highest in terms of each of the four characteristics, like of texture and tenderness, like of juiciness, like of flavor, and overall like of eating quality. The average sensory rankings for 93% ground bison were significantly lower than the rankings for 93% ground beef.

In the experimental auctions, panelists were willing to pay on an average $3.63, $4.01, and $4.29 per lb. for 80% ground beef, 93% ground bison, and 93% ground beef, respectively. On average the difference in bids for 93% ground bison and 80% ground beef was not statistically significant. The average difference in bids for 93% ground beef and 80% ground beef was $0.66 per lb., and was highly significant. The difference in average bids for 93% ground bison and 93% ground beef was not statistically significant.

Availability of nutrition information significantly increased panelists' bids for both 93% ground bison and 93% ground beef. Average bids for 93% ground bison and 93% ground beef by the panelists with nutrition information were higher compared to those in the control group by $1.23 per lb., and $0.47 per lb., respectively. The regression analysis of bids further shows that highly significant factors impacting the premium for 93% ground beef are: a) the presence of 7-18 years old children in the household, b) being married, c) age - 40 years or more, d) availability of nutrition information, and e) ability to identify bison by sensory tasting.

Our analysis demonstrates that informing the potential bison consumers of bison nutrition attributes have a potentially large payoff. Consumers who bought bison before and are familiar with the product also have a greater preference and stronger demand for bison than those who have not bought bison before and are not familiar with the bison. The analysis also shows that 93% ground bison

competes with 93% ground beef, and the factors impacting these meat products are similar.

In this study, the consumer preferences for 93% ground bison, along with 93% and 80% ground beef were studied, and only 91 consumers from Sioux Falls, SD, participated in the study. In the future, this study may be replicated with a larger sample of consumers from different regions of the United States. It may also be helpful to conduct sensory tasting experiments for different levels of leanness to accurately gage consumer tastes and preferences for ground bison to expand its acceptance among consumers.

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TABLES

Table 1. Frequencies of demographic information of panelists (n=84)

Variables		Frequency, %
Total No. of adults in household:	1	19.0
(Average=1.86)	2	77.4
	3	2.4
	>3	1.2
Children (7-18 years) in household:	1	0.15
Children (0-7 years) in household:	1	0.05
Gender:	Female	50.0
	Male	50.0
Age:	20-30 years	13.1
	30-40 years	13.1
	40-50 years	9.5
	> 50 years	64.3
Racial/ethnic group, panelist identifies with:	White Caucasian	98.8
	Native American	1.2
Marital status:	Single	20.2
	Married	67.9
	Divorced	8.3
	Widowed	2.4
	Separated	1.2
Level of education:	Elementary	1.2
	Some High School	0.0
	High School	6.0
	Some College	7.1
	Junior College	4.8
	4 year or more College	81.0
Annual household income:	< 15,000	2.4
	15,000 to 25,000	3.6
	25,000 to 50,000	33.3
	50,000 to 75,000	15.5
	75,000 to 100,000	31.0
	> 100,000	14.3

Table 2. Meat product purchase frequency among panelists (n=84)

Variables		Frequency, %
Who does the majority of shopping for household?	panelist	71.4
	spouse	27.4
	others	1.2
Who purchases meat products?	panelist	67.8
	spouse	20.2
	myself and spouse	6.0
	others	6.0
Most frequently purchased beef product?	steak	14.3
	roast	9.5
	93% ground beef	48.8
	85% ground beef	21.4
	80% ground Beef	3.6
	other cuts	1.2
	no response	1.2
Most preferred beef product?	steak	57.1
	roast	13.1
	93% ground beef	17.9
	85% ground beef	8.3
	80% ground Beef	1.2
	other cuts	1.2
	no response	1.2
Did you purchase a bison product during last year?	no	64.3
	yes	35.7
Most frequently purchased bison product?	bison steak	8.3
	bison roast	3.6
	bison ground	29.8
	bison other	3.6
Most preferred bison product?	bison steak	7.1
	bison roast	3.6
	bison ground	25.0
	bison other	0.0
Correctly identified color-coded meat products by tasting:	80% ground beef (Yellow)	47.6
	93% ground bison (Orange)	38.1
	93% ground beef (Purple)	36.8

Table 3. Meat product consumption frequency and preference among panelists (n=84)

Variables	1	2	3	4	5	6	7
Consumption preference rank (0=not							
(consumed, 1=highest, 7=lowest) for:	……. percentage response ……..….						
Beef (Avg. rank 1.94)	56.0	20.2	6.0	9.5	3.6	1.2	2.4
Pork (Avg. rank 3.10)	8.3	22.6	28.6	27.4	6.0	2.4	2.4
Bison (Avg. rank 3.36)	3.6	8.3	6.0	13.1	34.5	10.7	1.2
Chicken (Avg. rank 2.67)	20.2	32.1	23.8	13.1	7.1	2.4	1.2
Lamb (Avg. rank 3.07)	2.4	3.6	4.8	3.6	11.9	23.8	9.5
Fish (Avg. rank 3.40)	9.5	10.7	27.4	29.8	14.3	4.8	1.2
Other meat products (Av. rank 3.01)	3.6	0.0	2.4	2.4	6.0	15.5	22.6
Consumption frequency (0=not consumed,							
1=most often, 7=least often) for:	……. percentage response ……..….						
Beef (Avg. freq. 1.86)	53.6	22.6	11.9	7.1	1.2	0.0	2.4
Pork (Avg. freq. 2.81)	4.8	29.8	41.7	16.7	3.6	1.2	0.0
Bison (Avg. freq. 3.51)	0.0	2.4	3.6	6.0	31.0	17.9	7.1
Chicken (Avg. freq. 2.11)	36.9	33.3	19.0	7.1	1.2	1.2	1.2
Lamb (Avg. freq. 2.87)	1.2	0.0	1.2	3.6	14.3	20.2	10.7
Fish (Avg. freq. 3.58)	1.2	10.7	17.9	53.6	10.7	2.4	0.0
Other meat products (Av. freq. 2.81)	1.2	1.2	2.4	2.4	14.3	10.7	17.9
Eating preference rank (1=most							
preferred, 3=least preferred) for:	.. percentage response ..						
80% ground beef (Avg. rank 2.51)	10.7	27.4	61.9				
93% ground bison (Avg. rank 1.88)	40.5	31.0	28.6				
93% ground beef (Avg. rank 1.62)	48.8	40.5	10.7				
Monthly consumption frequency (0=not							
consumed, 1=most often, 3=least often) for:	.. percentage response ..						
80% ground beef (Avg. freq. 1.96)	20.2	63.1	16.7				
93% ground bison (avg. freq. 2.79)	2.4	13.1	83.3				
93% ground beef (Avg. freq. 1.25)	77.4	20.2	2.4				

Note: Percentages are based on all panelists, including those who did not consume a particular product. The sums for some rows do not equal to 100 as the data for panelists "not consuming" a product are not listed in the table.

Table 4. Consumption preferences Spearman correlation coefficients

Variables	Beef	Pork	Bison	Chicken	Lamb	Fish	Other Meat
Beef	1	-0.02	0.09	-0.21*	-0.01	-0.39**	-0.12
		(0.84)	(0.44)	(0.05)	(0.92)	(0.00)	(0.29)
Pork	-0.02	1	-0.05	-0.1	0.01	-0.07	0.03
	(0.84)		(0.69)	(0.36)	(0.91)	(0.56)	(0.79)
Bison	0.09	-0.05	1	0.03	0.43**	0.04	0.26*
	(0.44)	(0.69)		(0.76)	(0.00)	(0.74)	(0.02)
Chicken	-0.21*	-0.1	0.03	1	0.08	0	-0.05
	(0.05)	(0.36)	(0.76)		(0.48)	(0.99)	(0.62)
Lamb	-0.01	0.01	0.43**	0.08	1	0.16	0.39**
	(0.92)	(0.91)	(0.00)	(0.48)		(0.15)	(0.00)
Fish	-0.39**	-0.07	0.04	0	0.16	1	0.24*
	(0.00)	(0.56)	(0.74)	(0.99)	(0.15)		(0.03)
Other Meat	-0.12	0.03	0.26*	-0.05	0.39**	0.24	1
	(0.29)	(0.79)	(0.02)	(0.62)	(0.00)	(0.03)	

Note: n=84, the numbers in parenthesis are probabilities, * and ** indicate the significance at 5% and 1%, respectively.

Table 5. Consumption frequency Spearman correlation coefficients

Variables	Beef	Pork	Bison	Chicken	Lamb	Fish	Other Meat
Beef	1.00	0.00	0.02	-0.58**	-0.01	-0.18*	0.07
		(0.97)	(0.87)	(0.00)	(0.95)	(0.10)	(0.55)
Pork	0.00	1.00	-0.09	-0.24*	0.07	-0.10	0.14
	(0.97)		(0.43)	(0.03)	(0.54)	(0.39)	(0.21)
Bison	0.02	-0.09	1.00	0.06	0.58**	0.19*	0.38**
	(0.87)	(0.43)		(0.59)	(0.00)	(0.09)	(0.00)
Chicken	-0.58**	-0.24*	0.06	1.00	-0.04	0.14	-0.04
	(0.00)	(0.03)	(0.59)		(0.74)	(0.19)	(0.75)
Lamb	-0.01	0.07	0.58**	-0.04	1.00	0.09	0.51**
	(0.95)	(0.54)	(0.00)	(0.74)		(0.44)	(0.00)
Fish	-0.18*	-0.10	0.19*	0.14	0.09	1.00	0.06
	(0.10)	(0.39)	(0.09)	(0.19)	(0.44)		(0.58)
Other Meat	0.07	0.14	0.38**	-0.04	0.51**	0.06*	1.00
	(0.55)	(0.21)	(0.00)	(0.75)	(0.00)	(0.058)	

Note: n=84, the numbers in parenthesis are probabilities, * and ** indicate the significance at 5% and 1%, respectively.

Table 6. Consumption preference and consumption frequency Spearman correlation coefficients

	Consumption Preference for:						
	Beef	Pork	Bison	Chicken	Lamb	Fish	Other Meat
Consumption Frequency for:							
Beef	0.608** (<.001)	-0.012 (0.916)	0.207* (0.062)	-0.235* (0.034)	-0.059 (0.600)	-0.314* (0.004)	-0.011 (0.920)
Pork	0.042 (0.706)	0.551** (<.001)	-0.131 (0.241)	-0.251* (0.023)	0.085 (0.448)	0.095 (0.398)	0.215* (0.052)
Bison	0.021 (0.853)	0.133 (0.232)	0.674** (<.001)	0.134 (0.230)	0.378* (0.001)	0.111 (0.321)	0.375* (<0.001)
Chicken	-0.203 (0.068)	-0.118 (0.292)	0.054 (0.632)	0.573** (<.001)	0.051 (0.651)	0.167 (0.134)	-0.094 (0.402)
Lamb	0.005 (0.962)	-0.023 (0.841)	0.407** (0.001)	0.057 (0.611)	0.679** (<.001)	0.145 (0.194)	0.450** (<.001)
Fish	-0.178 (0.110)	-0.023 (0.838)	0.126 (0.260)	0.145 (0.193)	-0.002 (0.987)	0.539* (<.001)	0.045 (0.692)
Other Meat	-0.048 (0.671)	-0.054 (0.629)	0.267* (0.015)	0.008 (0.945)	0.404** (<.001	0.176 (0.115)	0.855** (<.001)

Note: n=84, the numbers in parenthesis are probabilities, * and ** indicate the significance at 5% and 1%, respectively.

Table 7. Average rankings of different products by panelist after tasting color-coded samples (1=lowest, 10=Highest, n=84)

Product	Overall like	Like of Texture	Like of Juiciness	Like of Flavor
Average ranking by panelists:				
80% beef	7.26	6.68	7.00	7.04
93% bison	6.96	6.93	6.60	6.69
93% beef	7.92	7.80	7.74	7.57
Difference between Means[1]:				
93% bison - 80% beef	-0.30	0.25	-0.40	-0.35
P (T≤t) two-tail	(0.1521)	(0.2390)	(0.1315)	(0.1487)
93% beef - 80% beef	0.65**	1.12**	0.74**	0.54*
P (T≤t) two-tail	(0.0077)	(0.0001)	(0.0003)	(0.0278)
93% bison - 93% beef	-0.95**	-0.87**	-1.14**	-0.88**
P (T≤t) two-tail	(0.0007)	(0.0003)	(0.0001)	(0.0018)

[1]t-test, paired sample means, * and ** indicate difference significance at 5% and 1%, respectively.

Table 8. Average bids by round, and comparison of bids, by round (n=82)

Description	Round 1	Round 2	Round 3	Round4	Round 5	Average
Avg. bid, in $ per lb. for:						
80% beef	3.41	3.60	3.67	3.72	3.75	3.63
93% bison	3.68	4.02	4.10	4.12	4.12	4.01
93% beef	3.89	4.27	4.36	4.41	4.52	4.29

Description	Rounds 2&1	Rounds 3&2	Rounds 4&3	Rounds 5&4
Avg. difference between means[1] for:				
Bids, in $ per lb. for 80% beef	0.19*	0.07	0.05	0.04
P(T<=t) two-tail	(0.0119)	(0.2990)	(0.3145)	(0.5061)
Bids, in $ per lb. for 93% bison	0.34**	0.08	0.02	0.00
P(T<=t) two-tail	(0.0099)	(0.2365)	(0.7837)	(0.9633)
Bids, in $ per lb. for 93% beef	0.38**	0.09	0.05	0.11*
P(T<=t) two-tail	(0.0021)	(0.1765)	(0.4607)	(0.0188)
Avg. difference between means[1] for:				
Bid ranks for 80% beef	-0.43	0.60	0.28	0.11
P(T<=t) two-tail	(0.7354)	(0.6501)	(0.7856)	(0.9070)
Bid ranks for 93% bison	0.37	-0.02	0.12	-0.35
P(T<=t) two-tail	(0.8278)	(0.9837)	(0.9038)	(0.7120)
Bid ranks for 93% beef	0.22	0.29	-0.27	0.46
P(T<t) two-tailed	(0.9014)	(0.7976)	(0.8279)	(0.6490)

[1]t-test, paired sample means, * and ** indicate difference significance at 5% and 1%, respectively.

Table 9. Average bids for different products

Description	Average (All Panelists)	Average (With NIS)	Average (Without NIS)
No of Respondents	(n=82)	(n=40)	(n=42)
Average bids in $ per lb. for:			
80% beef	3.63	3.56	3.69
93% bison	4.01	4.64	3.41
93% beef	4.29	4.53	4.06
Difference between means[1]:			
93% bison-80% beef	0.38	1.08**	-0.28
P(T<=t) two-tail	(0.0565)	(0.0005)	(0.2369)
93% beef-80% beef	0.66**	0.96**	0.37
P(T<=t) two-tail	(0.0009)	(0.0004)	(0.1977)
93% bison-93% beef	-0.28	0.11	-0.65*
P(T≤t) two-tail	(0.1120)	(0.5924)	(0.0194)

[1]t-test, paired sample means, * and ** indicate difference significance at 5% and 1%, respectively.

Table 10. Comparison of bids for different products, with and without nutrition information

Description	80% beef	93% bison	93% beef
Average bid by panelists - with NIS, in $ per lb., (n=40)	$3.56	$4.64	$4.53
Average bid by panelists - without NIS, in $ per lb., (n=42)	$3.69	$3.41	$4.06
Difference between means[1], in $ per lb.	-0.13	1.23**	0.47*
P(T≤t) two-tail	(0.6697)	(0.0002)	(0.1008)

[1]t-test, paired sample means, * and ** indicate difference significance at 5% and 1%, difference significant at 5% and 1%, respectively.

Table 11. Summary statistics for dataset used in regression analysis (n=410)

Variables	Mean	Std Dev	Minimum	Maximum
Dependent Variables:				
PBISON	0.38	1.90	-5.60	7.50
PBEEF	0.66	1.85	-6.50	6.00
Independent Variables:				
Gender	0.50	0.50	0.00	1.00
Children	0.13	0.34	0.00	1.00
Income	0.46	0.50	0.00	1.00
Married	0.67	0.47	0.00	1.00
Age	0.76	0.43	0.00	1.00
Education	0.82	0.39	0.00	1.00
Purchased	0.35	0.48	0.00	1.00
NIS	0.49	0.50	0.00	1.00
Identified	0.39	0.49	0.00	1.00

Where:
PBISON = Premium for 93% bison over 80% beef, in $ per lb.
PBEEF = Premium for 93% beef over 80% beef, in $ per lb.
Gender = Gender (female=1, else=0)
Children = Children (7-18 yrs.) in household (yes=1, else=0)
Income = Income, $75,000 or more (yes=1, else=0)
Married = Marital status (married=1, else=0)
Age = Age (40 yrs. or over=1, else=0)
Education = Education (4 year college or more=1, else=0)
Purchased = Purchased bison last year (yes=1, else=0)
NIS = Nutrition information sheet provided (yes=1, else=0)
Identified = Identified 93% bison sample (yes=1, else=0)

Table 12. Regressions (OLS) explaining premiums for 93% bison and 93% beef

	93% bison	93% beef
Dependent Variable:	PBISON	PBEEF
R-Square	0.2359	0.1483
Adjusted R-Square	0.2187	0.1291
No. of Observations	410	410
df Residual	400	400
F-Ratio	13.72***	7.04***
Independent Variables:		
Intercept	-1.6918***	-0.8886***
	(0.33345)	(0.3245)
Gender, Gender (female=1, else=0)	0.3096*	0.3834**
	(0.1747)	(0.1812)
Children, Children (7-18 yrs.) in household (yes=1, else=0)	0.8135***	0.7465***
	(0.2788)	(0.2704)
Income, Income, $75,000 or more (yes=1, else=0)	-0.0971	-0.0123
	(0.2076)	(0.1876)
Married, Marital status (married=1, else=0)	0.1763	-0.5776***
	(0.1914)	(0.2186)
Age, Age (40 yrs. or over=1, else=0)	0.4152*	0.8647***
	(0.2334)	(0.2382)
Education, Education (4 year College or more=1, else=0)	0.4638*	0.3946*
	(0.2701)	(0.2468)
Purchased, Purchased bison last year (yes=1, else=0)	0.1718*	0.0732
	(0.1782)	(0.1617)
NIS, Nutrition information sheet provided (yes=1, else=0)	1.2889***	0.6524***
	(0.1700)	(0.2041)
Identified, Did identify 93% bison sample (yes=1, else=0)	0.7949***	0.8438***
	(0.1647)	(0.1803)

Notes: 1. Figures in parentheses are standard errors. The *, **, and ** indicate significance levels 10%, 5%, and 1%, respectively.

2. Regression diagnostics indicated no multicollinearity but presence of some heteroscedasticity. Accordingly, a correction procedure suggested by White (1989, p. 822) was implemented to generate heteroscedasticity-consistent standard errors.

APPENDIX

Informed Consent Document for Human Participation in Research

Departments of Economics Date: May 12, 2014

Project Director: Bashir A. Qasmi, PhD. **Phone:** 605-688-4870 **e-Mail:** bashir.qasmi@sdstate.edu

Please be aware of the following information:

1. This is an invitation for you to participate in a research project under the direction of Bashir A. Qasmi, Associate Professor at SDSU.
2. The project is entitled: **Identifying Consumer Preferences to Improve Bison Marketing**
3. The purpose of the project is to identify factors which influence bison meat purchase by consumers, and conduct a willingness to pay in conjunction with consumer sensory panel study for ground bison.
4. If you consent to participate, you will be involved in a four phase process: a) receiving background information about the project, b) participating in tasting and evaluating samples of fully cooked ground beef and ground bison, c) completing a survey questionnaire regarding your meat-purchasing behavior, eating preferences, and your socioeconomic and demographic information, and d) participating in a live auction of three types of ground meat products you sampled. The whole process will about two hours of your time.
5. There are no known risks to your participation in the study.
6. There are no direct benefits to you.
7. There is compensation for your participation in this study in the amount of $30.00. This amount will be paid after you have participated in phases a, b, and c listed above.
8. Your participation in this project is voluntary, and you have the right to withdraw any time (before or after receiving the amount of $30.00.
9. Your responses are strictly confidential. When the data are presented in the written report, you will not be linked to the data by your name, title or any other identifying item.

As a research subject, I have read the above, have my questions answered, and agree to participate in the research project. I may receive a copy of this form for my information, if I request a copy.

Participant's Signature _____ Date _____

Project Director's Signature _____ Date _____

If you have any questions regarding this study you may contact the Project Director. If you have questions regarding your rights as a participant, you can contact the SDSU Research Compliance Coordinator at (605) 688-6975 or SDSU.IRB@sdstate.edu.

This project has been approved by the SDSU Institutional Review Board, Approval No.: IRB-1404011-EXM, dated April 4, 2014.

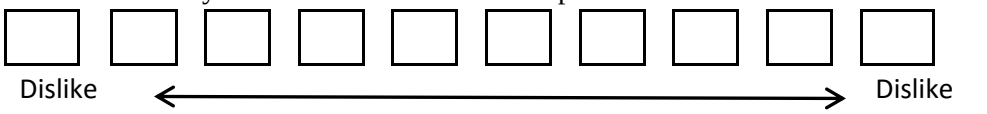
Sensory Rank Recording Form

ID _____

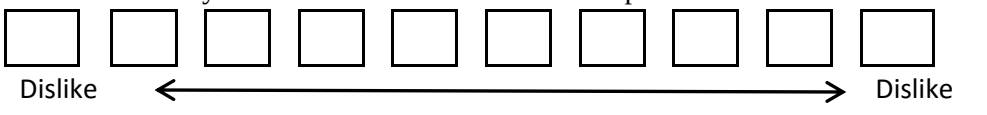
Sample _____

Take a bite of cracker and a drink of water.
Taste the meat sample.
Rate the sample for each question asked by making an 'X" in the box.

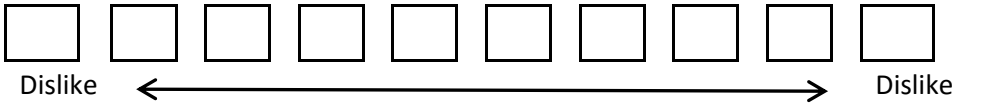
Please indicate your **Overall Like** of this sample.



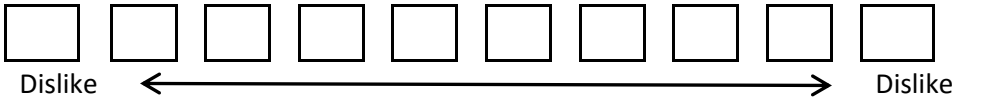
Please indicate your like of the **Texture** of this sample.



Please indicate your like of the **Juiciness** of this sample.



Please indicate your like of the **Flavor** of this sample.



Comments _____

_____

Identifying Consumer Preferences to Improve Bison Marketing
Demographic Questionnaire

1. Who purchases the Meat products (Beef, Pork, Bison, Chicken, Fish, etc.) for your family mostly? a. Myself _____ b. Spouse ____ c. Others _____

2. Which meat product do you prefer to consume? Please rank the preference for each product. Enter 1 (the highest rank) through 7 (the lowest rank), and 0 (if the product is not consumed).

3. a. Beef __ b. Pork __ c. Bison __ d. Chicken __ e. Lamb __ f. Fish __ g. Others___

4. Which meat product is consumed most often in your household? Please rank the preference for each product. Enter 1 (the highest rank) through 7 (the lowest rank), and 0 (if the product is not consumed).

5. a. Beef __ b. Pork __ c. Bison __ d. Chicken __ e. Lamb __ f. Fish __ g. Others ___

6. Which of the following factors has the most influence on your meat purchases? (Please check one)

   a. Price___ b. Quality ___ c. Budget ___ d. Health ___

7. What type of beef products do you purchase most often? (Please check one)

   a. Steak ___ b. Roast ___ c. Ground 93% ___ d. Ground 85% ___
   e. Ground 80% ___ f. Ground 73% ___ g. Others ____

8. Which type of beef product do you prefer most to consume? (Please check one)

   a. Steak ___ b. Roast ___ c. Ground 93% ___ d. Ground 85% ___
   e. Ground 80% ___ f. Ground 73% ___ g. Others ____

9. Have you ever purchased bison products during last one year? a. Yes ___ b. No ___

   9.1 If yes to 9, what type of bison product did you purchase? (Please check one or more)

      a. Steak ___ b. Roast ___ c. Ground bison ___ d. Other ____

   9.2 If yes to 9, which type of bison product do you prefer to consume? (Pl. check one)

      a. Steak ___ b. Roast ___ c. Ground bison ___ d. Other ____

(Continued on next page)

Demographic Questionnaire *(Continued)*

10. What is your level of education? (Please check one)

    a. Elementary school ___ b. Some High school ___ c. Completed High school ___

    d. Some College ___ e. Completed Junior college ___ f. Completed 4-year university ___

    g. Graduate school ___ h. Other ___

11. What is your marital status? (Please check one)

    a. Single ___ b. Married ___ c. Divorced ___ d. Widowed ___ e. Separated ___

    f. Domestic partnership ___

12. How many adults and children are in your house hold? (Please enter the applicable numbers)

    a. Adults ___ b. Children (7-18 years) ___ c. Children (0-7 year) ___

13. Who does the shopping, mostly, for your household? (Please check one)

    a. Myself ___ b. Spouse___ c. Others ___

14. What is your Gender? (Please check one) a. Male ___ b. Female ____

15. What is your age bracket? (Please check one)

    a. Under 15 years ___ b. 15 to 20 years ___ c. 20-30 years ___

    b. 30-40 years ___ e. 40-50 years ___ e. over 50 years ___

16. What is your Annual Household Income? (Please check one)

    a. $0 to $15,000 ___ b. $15,001 to 25,000 ___ c. $25,001 to 50,000 ___

    d. $50,001 to $75,000 ___ e. $75,001 to $100,000 ___ e. $100,000 or more ___

(Continued on next page)

Demographic Questionnaire *(Continued)*

17. To which racial or ethnic group(s) do you *most* identify your family? (Please check one)

    a. White Caucasian ____ b. Latino or Hispanic _____ c. African-American _____

    d. Native American ____ e. Asian/Pacific Islanders ____ f. Others _____

The three types of ground meat product you just finished sampling in the sensory panel are: a) 80% ground beef, b) 93% ground beef, and c) 93% ground bison. The percentages refer to the percentage of lean meat in the ground product. Please answer the follow three questions.

18. Please rank the order of your eating preference for each of these ground products. Use a rank of 1 to indicate most preferred, a rank of 3 for least preferred.

    80% ground beef _____ 93% ground beef _____ 93% ground bison _____

19. Please rank the order of your monthly eating pattern for each of these ground products. Use a rank of 1 to indicate most often, a rank of 3 for least often.

    80% ground beef _____ 93% ground beef _____ 93% ground bison _____

20. In the consumer sensory panel you just completed you sampled three color coded products (80% ground beef, 93% ground beef, and 93% ground bison). The identity of the each colored sample was not disclosed to you. Please make a guess for the identity of the samples, and draw a line to connect the colors below with the ground meat product you believed you were sampling associated with that color.

Yellow	80% ground beef
Orange	93% ground beef
Purple	93% ground bison

Thank you.

South Dakota State University

Bison/Beef Consumer Preference Study
Receipt

I acknowledge that I have received $30 (thirty dollars only) as compensation for my participation in the study titled "Identifying Consumer Preferences to Improve Bison Marketing" (Approval No. IRB 1404011=EXM, dated April 4, 2014). This study was funded through a grant by USDA/Agricultural Marketing Service, and Inter Tribal Buffalo Council.

After receiving the aforementioned amount, I have no further obligation, and my participation in the study is voluntary.

Signature: _____ Date: _____

Name:_____ Panelist ID:_____

Instructions for Candy Bar Auction (2nd Price Method)

Candy Bar Auction

1) Here at the front of the room we have three different candy bars: Milky Way, Butterfinger, and Hershey. We are interested in determining your preferences for each of these candy bars. For this purpose, we will conduct 2 rounds of sealed bid auction for each of the candy bars. The material provided to you includes 2 blank candy bar bid sheets. Through the bids on candy bar bid sheets, you will have the opportunity to indicate the ***most*** you are willing to pay, if anything, to purchase each of these candy bars in each rounds. **Your bids are private information and should not be shared with other participants.**

2) Please note that this method of auction (2nd Price Auction) is slightly different than common auction. In this case, we identify the 2nd highest price as the **winning price**, and the bid winners always pay the **winning price** (which is less that the price they bid).

3) Please also note that all bids need to be in 10 cents increment. **Any bid not in 10 cents increment will be rounded up to the next 10 cents increment.**

Auction Procedure

4) Starting with round 1, you will pick one candy bar bid sheet, write "Round 1" and then enter the ***most*** you are willing to pay for each of the candy bars.

5) When the bid entering process for round 1 is complete, a monitor will go around the room and collect the bid sheets for the round.

6) The bids will then be ranked from highest to lowest for each candy bar. In case of a tie, two or more bides may have the same highest price. After determining the **highest price**, the next lower bid (**winning price)**, will be determined for each candy bar for the round.

7) Bidders who bid equal or higher than the winning price for a candy bar in a round will be identified as the **potential winning bidders** for the candy bar in the round. Potential winning bidders for each candy bar for the round will be posted on the board. However, the winners for a particular candy bar in a particular round will be obligated to buy that particular candy bar at the **winning price** for that round only if the round turns out to be a **binding round for that candy bar**.

8) After each round, we will write the **winning price** and the **winning bidders** for each candy bar for the round on the board for all to see. After completing the round 1, we will re-conduct the auction for each additional round(s). In case of candy auction, there will be only two rounds.

9) At the completion of all rounds, we will randomly draw a number out of the rounds (from 1 & 2, in case of candy bar auction) to determine the binding round for each candy bar. For example, for Milky Way, if the number 2 is drawn, the **results of round 2 will be binding for Milky Way.** The probability of drawing each round is equal. Similarly, the binding rounds will be drawn for Butter Finger, and Hershey's.

(Continued on next page)

10) Once the binding rounds for different candy bars have been chosen, the winning bidders will come forward and pay the winning price amount and purchase their winning candy bar. All other participants, who are not winners for the binding round, pay nothing and will not receive that candy bar.

Important Notes

a) You will have only one opportunity to win the auction for *one* candy bar. Since we randomly draw the binding rounds, it is possible for you to win more than one variety of candy bars. **You will, at the most, take home one candy bar of each variety from this experiment.**

b) The winning bidders *will actually pay real money* for the candy bars they purchase. This ***is not*** a hypothetical auction.

c) In this auction the best strategy for winning is to bid ***exactly*** what the candy bar is worth ***to you.*** If you bid more than the candy bar is worth to you, you may end up paying more than the candy bar is worth to you. If you bid less than the candy bar is worth to you, you may not win the auction and not have the opportunity to buy the candy bar at a price you were actually willing to pay.

d) Bids of $0.00 are acceptable for any candy bar in any round if you think that that candy is worth $0.00 to you.

e) In case of meat product auction too, there will be three types of ground meat (labeled as **yellow, purple, and orange**). In case of meat products, there will be five rounds of auction. Accordingly, after completion of five rounds, we will randomly draw a number from 1 through 5 to determine a binding round for each meat (one by one).

An Example

Let us assume that there are 6 people involved in an auction. These individuals went through 2 rounds of bidding, and the 2nd round was randomly drawn as the binding round for the Milky Way bar. Suppose that in round 2 the bids were as follows: The #1 bid $0.70, #2 bid $0.70, #3 bid $0.40, #4 bid $0.20, #5 bid $0.50, and #6 bid $0.30. The highest price is $0.70 (a tie), so the winning price (the 2nd price) is $0.50.

Accordingly, participants #1, and #2 would win the auction, and each will pay $0.50 for a Milky Way bar. Participants #3, #4, #5, and #6 would pay nothing and will not win the right to buy a Milky Way bar.

These prices were used for illustrative purposes only and should not in any way reflect what the candy bars may be worth to you.

Are there any questions before we begin?

In order to get familiar with this auction method, we will have two practice rounds of Candy Bar Auction before we get to the ground beef and bison auction.

Now, we start the Candy Bar Auction for practice. First round begins. Please use the bid sheets marked "**Candy Bid Sheet",** and make sure to write your **ID** and **Round #** on each candy bid sheet, and then enter the bids for each candy**.**

Candy Bid Sheet
All Bids must be in ten cent increments

Panelist ID:_____ Round #_____

Candy Bar	**Amount bid**
Milky Way	$_____
Butterfinger	$_____
Hershey	$_____

If you choose not to bid, please explain why:

Candy Bid Recording Form (2nd Price Auction)

Group & Date: _____ Please check: Milky Way ___ Butter Finger ___ Hershey's ___

After completing each round, Pl. circle the winning price, and the winning bidders for the round.

	Round 1		Round 2	
Codes	Bid in $	Rank	Bid in $	Rank

Binding Round: _____

Winning Price for the Binding Round: _____

Winning Bidders (Code Numbers): _____

Recorder's Name and Date: _____

Instructions for Ground bison/beef Auction (2nd Price Auction Method)

Now that you know how the auction process works, we are interested in your preferences for the three different types of patties (Yellow, Orange, and Purple) that you had the opportunity to sample.

You will now have an opportunity to participate in an auction to purchase the type of patties you desire. In the front of the room there are patties of the same varieties that you have tasted. We would like you to use your consumption experiences to determine **how much per pound** you are willing to pay for each of the 3 different types of patties you sampled.

We will now conduct 5 rounds of sealed bid auction for each of the petties where you will have the opportunity to purchase ***one*** package of patties. You will be asked to indicate the ***most*** you would be willing to pay ***per pound*** for each of the patties by writing bids on the enclosed bid sheets. We will be following a 2nd price auction procedure, exactly the same as it was done for the candy bar auction. To make sure everyone is clear about the auction procedures, I will review them for you.

Auction Procedures Ground bison/beef Auction Bid Sheet

1) Each of you has been provided with the bid recording forms titled "Ground bison/beef Auction Bid" in your packet. On each bid sheet, there are 3 spaces for entering 3 bid prices, one for each of the three types of patties. On these sheets, you are expected to enter the ***most*** you are willing to pay for one pound of each of the three different patties (labeled Yellow, Orange, and Purple). **Your bids are private information, and should not be shared with other participants.**

2) Starting the Round 1, you will pick one bid recording form titled "Ground bison/beef Auction Bid", and write the Round # and then enter the most you are willing to pay for each of the meat patties (Yellow, Orange, and Purple).

3) After you have finished writing down your bids, the monitor will go around the room and collect the bid sheets for the round. The bids for the round for each color will be ranked from highest to lowest (in case of a tie, two or more bids may have the highest rank). After determining the **highest price**, the next lower bid (**winning price**) will be determined. Again, in case of a tie, two or more bids may have the 2nd highest rank.

4) Bidders who bid equal or higher than the round winning price for each color will be identified as the **potential winning bidders for that color in that round**. The **round winning price** and the **ID numbers of the potential bid winners** for each color will be posted on the board for all to see. However, the potential winners for a particular color in a particular round will be obligated to buy one lb. of patties of that color only if the round turns out to be a binding round for that color (to be determined after completing all 5 rounds).

5) After posting the round winning prices and winning bidder numbers on the board, we will repeat steps 2 through 4 (listed above) to conduct the auction for rounds 2 through 5.

(Continued on next page)

6) At the completion of the 5th round we will randomly draw one color (patty variety), and then draw a number from 1 through 5 to determine the binding round for that color (patty variety). All rounds have an equal probability of being selected as binding round for that color (patty variety).

7) Once the binding round for a patty variety is determined, the **round winning price** for that patty variety becomes the **auction purchasing price** for that patty variety, and the potential bid winners (for that color and that round) are declared as bid winners for that petty variety. Then, the bid winners will be asked (and obligated) to buy 1 lb. that patty variety at the auction winning price.

8) We will repeat the steps 6, and 7 for the other two colors (patty varieties).

Important Notes

You will have only one opportunity to win an auction for one package of one patty variety. Because we randomly draw a binding round and a binding patty variety, you cannot win more than one auction. **Under no bidding scenario will you take home more than one package of patties from this experiment.**

The winning bidders ***will pay with actual money*** for their patty package purchase. This process is not hypothetical.

In this auction the best strategy is to bid ***exactly*** what each patty variety is worth to you. If you bid more than the patty variety is worth to you, you may end up paying more than the actual value for the patty variety to you. If you bid too low, you may not win the auction and miss the opportunity to buy 1 lb. of ground meat patties (of a particular variety) at your true willingness to pay price. Thus, the best strategy is to bid ***exactly*** what you think the patty variety is worth to you.

$0.00 is an acceptable bid for any patty variety in any round.

Are there any questions before we begin?

Please use the bid sheets marked **"Bison and Beef Bid Sheet".** Please, make sure to write your ID, and round number on each bid sheet. Thank you.

Nutritional Information on selected ground meat products

Nutrient (units)	80% Lean Ground Beef per 100 grams	93% lean Ground Beef per 100 grams	93% lean Ground Bison per 100 grams
Water (g)	61.94	71.77	71.59
Energy (Kcal)	254	152	146
Protein (g)	17.17	20.85	20.23
Total lipid fat (g)	20	7	7.21
Calcium, Ca (mg)	18	10	11
Iron, Fe (mg)	1.94	2.33	2.78
Fatty acids, total saturated (g)	7.591	2.932	2.917
Fatty acids, total monounsaturated (g)	8.854	2.92	2.753
Fatty acids, total polyunsaturated (g)	0.521	0.292	0.336
Cholesterol (mg)	71	63	55

Source: USDA's National Nutrient Database, available at http://ndb.nal.usda.gov/

Bison and Beef Bid Sheet
All Bids must be in ten cent increments

Panelist ID:_____ Round#_____

Bid for Ground	**Amount bid in $/lb.**
Yellow	$_____
Purple	$_____
Orange	$_____

If you choose not to bid, please explain why:

Bid Recording Form for Ground bison/beef Auction (2nd Price Auction Method)

Group & Date: _____

Please Check the Ground Meat Product: Yellow _____ Purple_____ Orange _____

After completing each round, Please circle the winning price, and the winning bidders for the round.

	Round 1		Round 2		Round 3		Round 4		Round	
Code	Bid in $	Rank	Bid in $	Rank	Bid in $	Rank	Bid in $	Rank	Bid in $	Rank

Binding Round: _____

Winning Price for the Binding Round: _____

Winning Bidders (Code Numbers): _____

Recorder's Name and Date: _____