Factors influencing the purchase and consumers' willingness to pay for ground bison

Bashir Qasmi
Associate Professor of Economics at South Dakota State University, Brookings SD
Bashir.Qasmi@sdstate.edu

Scott Fausti
Professor of Economics at South Dakota State University, Brookings SD
Scott.Fausti@sdstate.edu

Keith Underwood
Assistant Professor of Animal Science at South Dakota State University, Brookings SD
Keith.Underwood@sdstate.edu

Selected Paper prepared for presentation at the Southern Agricultural Economics Association's 2015 Annual Meeting, Atlanta, Georgia, January 31-February 3, 2015.

Factors influencing the purchase and consumers' willingness to pay for ground bison

Abstract

A consumer preference study that included willingness to pay and consumer sensory experiments was conducted for ground bison versus ground beef. A total of 82 subjects completed the study. The initial statistical analysis suggest that there is consistent consumer behavior with respect to consumer preference and frequency of consumption within species consumption options, but consistent consumer behavior appears to weaken when across species consumption preferences is compared to across species frequency of consumption patterns.

Factors influencing the purchase and consumers' willingness to pay for ground bison[1]

Introduction

Bison production is gaining ground both in terms of production and marketing. Most recent Census of Agriculture, conducted in 2007, pegs the U.S. bison on private lands at 200,000 animals. With animals on public lands factored in, the actual size of the U.S. herd is now estimated at about 220,000 bison in the United States (National Bison Association 2012). According to USDA data with a bison herd of 38,701 head and an annual sale of over 11,000 head, South Dakota ranks number 1 in bison production and marketing. Other states important for bison production are Nebraska, North Dakota, and Montana. During the year 2007, 46.8% of the bison sold originated from these four states.

The bison industry is fairly small scale with approximately 20,000 heads of bison slaughtered per year compared to 125,000 cattle every 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 (Granger, 2001).

Given that bison meat is a niche market, and U.S. bison market supply chain is not integrated, very little research on bison demand has been done. Thus, very little is known about consumer preferences for bison meat. Bison production is 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 bison and identify factors which influence purchase of bison meat by consumers. Specifically, we are interested in revealing consumer preference and thereby consumers' willingness to pay (WTP) through experimental auctions for ground bison in conjunction with sensory panel evaluation of ground bison. The study focusses on consumers from the Sioux Falls area of South

[1] Preliminary analyses of WTP and sensor panel data are discussed in this working paper. The authors request that the results presented in this working paper are not cited unless the authors are first contacted.

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 in United States, in general.

Review of Literature

Compared to other commercial meats, consuming bison provides a number of health benefits i.e. low calories and cholesterol, but high 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, to restaurants, wholesale outlets, cooperatives, or via internet (Gegner, 2001). However, bison producers are under more pressure to develop marketing and merchandising plan (Yang and Woods, 2013).

Meat purchasing behavior can be highly related to socio-demographic characteristics of buyers. In the absence of many bison consumer studies, we can draw information on some possible premises from demand studies for 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, often with conflicting results (French et al. 2000, Mandell, Buchanan-Smith, and Cambell 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' willingness to pay (WTP) for 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 set al., 1996; Umberger et al., 2002, and Evans et al. 2011).

Yang and Wood (2013), assessed consumer willingness to pay for ground bison given nutrition information 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 specific health benefits associated with bison products, and were randomly distributed into two groups: one group was shown the nutrition comparison information and reference price for fresh ground bison and premium ground beef; and the other control group was only showed the reference price for fresh ground bison and premium ground

beef. They report that over 60% of consumers don't know about the benefits of bison nutrition. Respondents who know bison nutrition are willing to pay more about $2.68-$2.81 as compared to respondents who don't know bison nutrition at all. They further report that the respondents who were given bison nutrition information would like to pay about $0.40-$0.48 more for fresh ground bison compared to those who were not given nutrition information. They concluded that consumers show positive responses to bison nutrition information. They further concluded that younger male consumers with higher education and high income and families without kids 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 validly obtained via hypothetical research instruments. Evans et al., 2011 utilized a variant of Becker-DeGroot-Marschak peudo-auction mechanism to identify consumer perceptions of and WTP for Appalachian grass-fed beef.

In this study, we employed a 2nd highest price experimental auction approach to discover consumers' willingness to pay (WTP) for bison. We are trying to elicit consumers' preferences and true valuation of ground bison. The WTP mechanism identified by auction is less hypothetical valuation method as compared to other instruments. The adoption of 2nd highest price auction has the advantage of including an active market participation feature to engage off-margin bidders and reduce the incentive for strategic bidding in repeated auctions.

Our study is novel as we conduct a consumer sensory panel study in conjunction with consumers' WTP experiment in order to identify different product attributes important to consumers as well as the amount of premium 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 beef. After advertising in local newspaper(s), 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 9 taste panels each consisting of 3-16 consumers. After arriving at the research facility, consumers were asked to complete a survey describing their meat-purchasing behavior, eating preferences, knowledge about bison and beef, and their socioeconomic and demographic information. After completing the survey, panelists were asked to participate in sensory tasting of three cooked ground meat products (80% ground beef, 93% ground beef, and 93% ground bison).

Sensory tasting part of the study was conducted according to the standards set by 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 a 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, under red lights to limit observation of visual differences. Toothpicks, water, and saltines were made available to panelists.

Panelists were asked to taste and rate three color coded samples of cooked ground meat products (80% ground beef, 93% ground beef, and 93% ground bison) 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 (yellow, purple, and orange).

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 7-point hedonic scale (1=extremely dislike; 7=extremely like). Participants were also asked to state which sample they prefer, or if they have preference between the three samples. Panelists were allowed to make their own notes about their preferences to help deciding the bids for different meat products later at the meat auction.

Once the sensory panel was complete, panelists were asked to participate in practice round of WTP auction for three different candy bars displayed in front of them. They were given bid sheets and asked to simultaneously submit bids ($/candy bar) for each of three candies. Participants were encouraged to bid exactly the amount they believed a particular candy was worth to them. Participants were reminded that if they "won" a binding auction, they would be

obligated to purchase the candy bar at the auction market price except in case of the practice round. After the practice round, the first round of the candy auction was conducted. The panelists' bid sheets were collected and the auction monitor announced the round winning price (2^{nd} highest price) for each candy bar. All bids which were equal or higher than the round winning price were declared as potentially winning bids for that particular candy in that round. The highest bid was not disclosed, but the panelists with the highest bid were also listed as the potential winner for the round. Only two rounds of candy auction were held. After completing two rounds, for each candy, the winning round was randomly drawn, the panelists with the potential winning bids for the candy in the winning round were declared as bid winners, and the round winning price became the auction purchasing price. Following this, the bid winners were asked to buy their candy bars at the respective purchasing price.

After completing the practice auction for candy bars, the panelists were asked to participate in five rounds of WTP auction for three color-coded ground meat products (yellow, orange, and purple). Again, the identities of the ground meat products were not revealed and the panelists were asked to bid ($/pound, in an increments of 5 cents) for each of the yellow, orange, and purple ground meat products. For reference purpose, the current retail prices for 80% ground beef, and 93% ground beef in local grocery stores were posted on the board. Panelists in half sessions were also provided with a nutrition information sheet on bison from USDA source.

For round 1, panelists were given bid sheets, and asked to simultaneously bid for all three ground meat products. The participants were encouraged to bid exactly the amount they believed the product was worth to them, and were reminded that if they "won" a binding auction, they would be obligated to purchase the one-pound package of the product at auction market price. After the panelists entered their bids, the bid sheets were collected, and the auction monitor announced the round winning price (2^{nd} highest price) for each of the color. All bids equal or higher than the round winning price were potentially winning bids for that particular color in that round. The highest bid was not disclosed, but panelists with the highest bid were listed as the round potential winners for that color in that round. There were five rounds of meat auction. After completing five rounds, for each color, the winning round was randomly drawn, the panelists with the potential winning bids for the color in the winning round were declared as bid winners, and the round winning price became the auction purchasing price for that color. Following that, the bid winners were asked to buy one pound packet of their color-coded ground

meat at the auction purchasing price. Subject to the availability, other participants were also given a chance to buy packets of ground meat of different colors at the respective auction purchasing prices of the session.

Data and Summary Statistics

Data used in the analysis includes a total of 82 participants from the nine groups that participated in the dual experiment. On average the participants had completed at least an associate's degree, married at least once, and the average household size was slightly over 2. Half of the survey 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 overall gender profile for the 82 participants was 41 males and 41females.

Results:

Preliminary statistical results are presented to provide the reader an overview of basic relationships between consumer preferences for alternative protein sources and frequency of consumption. In Table 1 the average rankings for consumption preference and frequency of consumption are provided. In Tables 2, 3, and 4; the Spearman Correlation Coefficients consumption preferences, frequency of consumption, and the cross correlations for these two consumer response categories are provided, respectively for the 82 study participants are provided.

Eating preferences and frequency of consumption questions were designed so that participants make an ordinal relative ranking for each of the seven protein sources with respect to preference to consume and frequency of consumption (Table 1). The rankings range from one to seven. The highest ranking is one and seven the lowest ranking. Eating preferences and frequency of consumption questions ranked beef as number 1 and chicken number 2 in both categories. Pork and other meats switched rankings for third and fourth.

Table 1 Eating Preference (Q3) and Eating Frequency (Q5) Rankings

	Beef	Pork	Bison	Chicken	Lamb	Fish	Other Meat
Preferences Q3	1	4	6	2	5	7	3
Frequency Q5	1	3	6	2	5	7	4

Table 2 provides Spearman Correlation Coefficient estimates for the seven protein types with respect to preference to consume. Beef preference is negatively related to chicken and fish consumption preferences. Pork consumption preference has no linear relation with any of the other six protein sources. Chicken consumption is inversely related to beef consumption preferences. Bison, Lamb, and other meats are all positively correlated. Fish consumption preference is positively related to other meats and negatively related to beef.

Table 2 Eating Preference (Q3) Spearman Correlations

	Beef Q3A	**Pork Q3B**	**Bison Q3C**	**Chicken Q3D**	**Lamb Q3E**	**Fish Q3F**	**Other meats Q3G**
Q3A	**1.00**	**-0.02**	**0.09**	**-0.21**	**-0.01**	**-0.39**	**-0.12**
Q3A		**0.84**	**0.44**	**0.05**	**0.92**	**0.00**	**0.29**
Q3B	**-0.02**	**1.00**	**-0.05**	**-0.10**	**0.01**	**-0.07**	**0.03**
Q3B	**0.84**		**0.69**	**0.36**	**0.91**	**0.56**	**0.79**
Q3C	**0.09**	**-0.05**	**1.00**	**0.03**	**0.43**	**0.04**	**0.26**
Q3C	**0.44**	**0.69**		**0.76**	**0.00**	**0.74**	**0.02**
Q3D	**-0.21**	**-0.10**	**0.03**	**1.00**	**0.08**	**0.00**	**-0.05**
Q3D	**0.05**	**0.36**	**0.76**		**0.48**	**0.99**	**0.62**
Q3E	**-0.01**	**0.01**	**0.43**	**0.08**	**1.00**	**0.16**	**0.39**
Q3E	**0.92**	**0.91**	**0.00**	**0.48**		**0.15**	**0.00**
Q3F	**-0.39**	**-0.07**	**0.04**	**0.00**	**0.16**	**1.00**	**0.24**
Q3F	**0.00**	**0.56**	**0.74**	**0.99**	**0.15**		**0.03**
Q3G	**-0.12**	**0.03**	**0.26**	**-0.05**	**0.39**	**0.24**	**1.00**
Q3G	**0.29**	**0.79**	**0.02**	**0.62**	**0.00**	**0.03**	

Table 3 provides Spearman Correlation Coefficient estimates for the seven protein types with respect to frequency of consumption. Beef consumption frequency preference is negatively related to chicken and fish consumption frequency. Pork consumption frequency is negativell related to chicken consumption frequency. Chicken consumption frequency is inversely related to beef and pork. Bison consumption frequency is positively related to fish, Lamb, and other meats. Lamb consumption frequency is positively related to other meats and bison. Fish consumption frequency is negatively related to beef but positively related to bison. Frequency of consumption of other meats is positively relative to bison and lamb.

Table 3 Eating Frequency (Q5) Spearman Correlations

	Beef Q5A	Pork Q5B	Bison Q5C	Chicken Q5D	Lamb Q5E	Fish Q5F	Other Meats Q5G
Q5A	1.00	0.00	0.02	-0.58	-0.01	-0.18	0.07
Q5A		0.97	0.87	0.00	0.95	0.10	0.55
Q5B	0.00	1.00	-0.09	-0.24	0.07	-0.10	0.14
Q5B	0.97		0.43	0.03	0.54	0.39	0.21
Q5C	0.02	-0.09	1.00	0.06	0.58	0.19	0.38
Q5C	0.87	0.43		0.59	0.00	0.09	0.00
Q5D	-0.58	-0.24	0.06	1.00	-0.04	0.14	-0.04
Q5D	0.00	0.03	0.59		0.74	0.19	0.75
Q5E	-0.01	0.07	0.58	-0.04	1.00	0.09	0.51
Q5E	0.95	0.54	0.00	0.74		0.44	0.00
Q5F	-0.18	-0.10	0.19	0.14	0.09	1.00	0.06
Q5F	0.10	0.39	0.09	0.19	0.44		0.58
Q5G	0.07	0.14	0.38	-0.04	0.51	0.06	1.00
Q5G	0.55	0.21	0.00	0.75	0.00	0.58	

Table 4 provides Spearman Cross Correlation estimates for the seven protein types with respect to preference to consume and frequency of consumption. All seven protein categories are positively correlated within protein category. This indicates consistent behavior with respect to consumption preferences and consumption behavior with respect to a specific protein source.

Table 4 Eating Preference (Q3) and Eating Frequency (Q5) Spearman Correlations

Prefer Freq	Beef Q3A	Pork Q3B	Bison Q3C	Chicken Q3D	Lamb Q3E	Fish Q3F	Other Meat Q3G
Q5A Q5A	0.60813 <.0001	-0.01177 0.9164	0.20718 0.0618	-0.23502 0.0336	-0.05876 0.6000	-0.31356 0.0041	-0.01123 0.9202
Q5B Q5B	0.04234 0.7057	0.55087 <.0001	-0.13105 0.2406	-0.25138 0.0227	0.08490 0.4482	0.09468 0.3975	0.21498 0.0524
Q5C Q5C	0.02075 0.8532	0.13336 0.2323	0.67389 <.0001	0.13397 0.2302	0.37818 0.0005	0.11098 0.3209	0.37512 0.0005
Q5D Q5D	-0.20246 0.0681	-0.11779 0.2919	0.05373 0.6316	0.57341 <.0001	0.05068 0.6512	0.16696 0.1338	-0.09376 0.4021
Q5E Q5E	0.00535 0.9619	-0.02248 0.8411	0.40703 0.0001	0.05704 0.6108	0.67904 <.0001	0.14477 0.1944	0.44938 <.0001
Q5F Q5F	-0.17783 0.1100	-0.02292 0.8380	0.12595 0.2595	0.14514 0.1932	-0.00179 0.9873	0.53902 <.0001	0.04446 0.6916
Q5G Q5G	-0.04767 0.6706	-0.05422 0.6285	0.26697 0.0153	0.00781 0.9445	0.40416 0.0002	0.17554 0.1147	0.85472 <.0001

However, cross correlations between preferences and eating behavior tell a very interesting story. Cross correlations between preferences and frequency for an individual protein relative to the other six protein sources are not symmetric. This suggests frequency of consumption is affected by other factors besides preference. This suggests consumers are facing constraints in their purchasing decisions. Each protein source will be discussed in turn.

a) Beef consumption preference is negatively correlated with chicken frequency of consumption. However, beef frequency is positively correlated with bison preference and negatively correlated with chicken and fish consumption preference.

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

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

d) Chicken preference is negatively correlated with frequency of consumption of beef and pork. However, frequency of consumption of chicken is only negatively correlated with preference for beef.

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

f) Fish consumption preference is negatively correlated with frequency of consumption of beef. However, frequency of fish consumption is not correlated with any other protein source consumption preference.

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

Summary

The initial statistical analysis suggest that there is consistent consumer behavior with respect to consumer preference and frequency of consumption within species consumption options, but consistent consumer behavior appears to weaken when across species consumption preferences is compared to across species frequency of consumption patterns.

Data analysis is ongoing and we expect to uncover additional interest insights on consumer behavior as the WTP analysis unfolds.

References

Bidner, T., A. Schupp, R. Montgomery, and Carpenter, Jr. 1981, "Acceptability of Beef Finished on all Forage, Forage Plus Grain, or High Energy Diets," *Journal of Animal Science* 53(5): 1181-1187.

Evans, Jason R., Gerald E. D'Souza, Alan Collins, Cheryl Brown, and Mark Sperow, 2011, "Determining Consumer Perceptions of and Willingness to Pay for Appalachian Grass-Fed Beef: An Experimental Economics Approach," *Agricultural and Resource Economics Review* 40(2): 233-250.

French, P., E. O'Riordan, F. Monaha P. Caffrey, M. Vidal, and M. Moony, 2000, "Meat Quality of Steers Finished on Autum Grass, Grass Silage, or Concentrate-Based Diets." *Meat Science* 56(2): 173-180.

Gegner, L.E, 2001, "Bison Production." Livestock Production Guide, Appropriate Technology Transfer for Rural Areas, University of Arkansas. Fayetteville, AR.

Lusk, J. L., J. A. Fox, T. C. Schroeder, j. Mintert, and M. Koohmaraie, 2001, "In-Store Valuation of Steak Tenderness," *American Journal of Agricultural Economics* 83(August): 539-550.

USDA/Food Safety and Inspection Service, 2011, Bison from farm to Table, retrieved on 1/13/2015 from: http://www.fsis.usda.gov/PDF/Bison_from_Farm_to_Table.pdf

Yang, Shang-Ho, Timothy A. Woods, 2013, "Assessing Consumer Willingness to Pay for Ground Bison Given Nutritional Information", Selected Paper, Southern Agricultural Economics Association Annual Meeting, Orlando, FL February 2-5, 2013.

Mandell, I., J. Buchanan-Smith, and C. Campbell, 1998, "Effects of Forage vs. Grain Feeding on Carcass Characteristics, Fatty Acid Composition, and Beef Quality in Limousin-Cross Steers when Time on Feed is Controlled." *Journal of Animal Science* 76(10): 2619-2630.

May, S., H. Dolezal, D. Gill, F. Ray, and D. Buchanan. 1992. "Effects of Days of Fed, Carcass Grade Traits, and Subcutaneous Fat Removal on Postmortem Muscle Characteristics and Beef Palatability." *Journal of Animal Science* 70(2): 444-453.

Melton, B.E., W. E. Huffman, J. Shogren, and J. A. Fox, 1996, "Consumer Preferences for Fresh Food Items with Multiple Quality Attributes: Evidence from an Experimental Auction of Pork Chops," *American Journal of Agricultural Economics* 78(November): 916-923.

National Bison Association, 2012, Denver, Co. Available at http://www.bisoncentral.com/about-bison/current-status

Schaake, S., G. Skelly, E. Halpin, L. Grimes, R. Brown, D. Cross, and C. Thompson. 1993. "Carcass and Meat Sensory Traits of Steers Finished on Fescue and Clover, Summer Forage, or Different periods of Drylot." *Journal of Animal Science* 71(12): 3199-3205.

Schroder, J., D. Cramer, R. Bowling, and C. Cook. 1980. "Palatability, Shelf Life, and Chemical Differences Between Forage and Grain –Finished Beef." *Journal of Animal Science* 50(5): 852-859.

Spiselman, A. 2006. “Is Grass-Fed Greener?” *Meetingplace: In the Aisles section*. September issue: 74-77.

Umberger, W. J., D. Feuz, C. Calkins, and K. Killinger-Mann, 2002, “U.S. Consumer Preferences and Willingness-to-Pay for Domestic Corn-Fed Beef versus International Grass-Fed Beef Measured Through an Experimental Auction.” *Agribusiness: An International Journal* 18(4): 491-504.