

CONSUMER PREFERENCES FOR FINELY
TEXTURED BEEF (FTB) IN GROUND BEEF
FORMULATIONS

By

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FORMULATIONS

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Abstract:

Inclusion of finely textured beef (FTB) in ground beef increases efficiency of the beef industry and decreases costs for consumers. However, following the "pink slime" media storm of 2012, consumers expressed severe misunderstanding of the safety of FTB as a food product. Since 2012, there has been evidence that FTB could increase the palatability of ground beef, potentially to the point that consumers might be willing to pay more for ground beef containing FTB. This study tested this hypothesis through a blind taste test by having participants eat sliders containing 0%, 15%, and the maximum inclusion of FTB, using their favorite condiments and toppings. Conditional logit modeling utilizing data from subsequent hypothetical choice questions and demographic information revealed that participants have no significant differences in taste preferences amongst the three ground beef types, even when taking gender, frequency of ground beef purchases, and status as an Oklahoma State University undergraduate student into account. Thus, inclusion of FTB does not seem to significantly alter the taste of ground beef when it is consumed in the typical hamburger scenario.

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CHAPTER I. INTRODUCTION

I.1 PROBLEM STATEMENT

Ground beef products, such as hamburger, comprise nearly half of United States total beef consumption (National Cattlemen's Beef Association 2012), but recently, ground beef prices have reached record-breaking heights (Bureau of Labor Statistics 2015). Certain processes currently implemented within the beef industry are already in place to help reduce these costs to consumers, as well as prevent substitution towards other lower-priced meat commodities. The production of finely textured beef (FTB), also known as lean finely textured beef (LFTB), for example, retrieves enough lean protein from carcass trimmings to allow the beef industry to slaughter 1.5 million fewer cattle per year, which translates into more efficient use of resources for the beef industry (Rabobank 2012). Beef Products, Inc. (2012) reports that nearly 97 million bushels of corn, 375 billion gallons of water, and 600 thousand acres of farmland are saved on an annual basis through LFTB production, which translates into ground beef price reductions in the retail case.

Nevertheless, the industry has encountered resistance to the incorporation of FTB into ground beef formulations. Following the 2012 ABC News controversy regarding "pink slime," LFTB production in the U.S. decreased significantly, culminating in plant closures (Keefe 2012) but has since begun a slow comeback (Huffstutter 2014). An opportunity exists to increase sales of LFTB products once more, especially given evidence in the beef industry that patties containing LFTB may provide a more desirable eating experience (Moon et al. 2012). However,

there is still little objective published research available regarding consumer taste preferences for ground beef formulations that contain FTB, much less how these preferences translate into purchasing behaviors. The purpose of this study, therefore, is to determine consumer preferences for ground beef products made with and without FTB.

I.2 OBJECTIVES

The purpose of this study is to investigate consumer taste preferences for ground beef formulated with different levels of finely textured beef (FTB). Specifically, the first objective of this research is to determine differences in overall eating experience between traditional ground beef patties (0% FTB inclusion), patties containing 15% FTB, and patties containing maximum FTB, where the actual percentage corresponding to maximum FTB is higher than 15% but is proprietary information. Additionally, this study will determine if certain demographic characteristics of consumers, especially gender and frequency of ground beef consumption, has any effect on choice differences.

CHAPTER II. REVIEW OF LITERATURE

II.1 GROUND BEEF AND THE ROLE OF FTB

Sensory factors are important in consumer evaluations of beef products (McIlveen and Buchanan 2001), as are perceptions of extrinsic quality cues and knowledge of beef processing technologies (de Barcellos et al. 2010; Van Wezemael et al. 2010). Providing consumers factual information about such processing technologies does not seem to detract from the sensory components of the eating experience of these products (Van Wezemael et al. 2012), but if US consumers express even a modicum of food safety concern with invasive processing techniques (e.g. injected marination, nutritional enhancement, infrared radiation, and shock wave treatments) as do European consumers (de Barcellos et al. 2010), does there exist potential for these external factors to overshadow product palatability when it comes to consumer purchasing decisions?

In the case of finely textured beef (FTB) inclusion in ground beef, consumers have exhibited misunderstandings regarding the content, safety, and function of LFTB (Lusk and Murray 2013). This begs the difficult question if these concerns have translated into changed purchasing behaviors. Due to the USDA ruling that FTB labeling will be voluntary rather than mandatory (Greene 2012), most consumers are not typically made aware of FTB incorporation into ground beef mixtures at any time during the purchasing decision. Indeed, this lack of awareness and industry transparency may be partially responsible for the media storm and public backlash that occurred in 2012 following the ABC News coverage of "pink slime" (Adams 2014; Greene 2012). However, even after all of the 2012 media attention, only 33% of surveyed

consumers answered that they had ever heard of LFTB, compared to 63% who had heard of its unscientific moniker “pink slime” (McKendree, Widmar, and Widmar 2014). In this same survey, an overwhelming majority of respondents (89%) indicated they would not purchase LFTB in the next six months, revealing a general negative perception of LFTB that was pervasive through the sampled consumers (McKendree, Widmar, and Widmar 2014).

There was conflicting evidence concerning the economic effects of the 2012 LFTB media storm. Despite the announcements of several restaurant and grocery chains that they would no longer carry LFTB, market shares in the agribusiness sector demonstrated no significant abnormal returns in the short-term (Detre and Gunderson 2012). Immediately following the 2012 media storm surrounding LFTB, preliminary findings in one study indicated lean trim value and prices fell by as much as 10% (Herrington, Fox, and Tonsor 2013). Initial projections through IMPLAN modeling predicted that \$273 million of the U.S. economy, in addition to \$300 million more from indirect economic effects, would be lost due to the LFTB hysteria, and retail prices for ground beef could increase by as much as \$0.06/lb (Hayes and Otto 2012). Recent investigation through Central Bureau of Statistics modeling, however, shows that consumer responses to the 2012 controversy have been temporary (Yadavalli and Jones 2014). This research may indicate that consumer perception of FTB content in ground beef no longer plays as large a role in consumer purchasing behavior of ground beef as other factors.

A study by Moon et al. (2012) examined whether LFTB incorporation in ground beef mixtures, in addition to increasing industry efficiency (Beef Products, Inc. 2012), had any impacts on the resulting cooked quality of ground beef patties. Results of this study found that increasing the percentage of incorporated LFTB up to 20% was significantly correlated with improved pH, raw color, lipid oxidation, and Lee Kramer shear force values (Moon et al. 2012). This evidence suggests it likely that ground beef containing LFTB has higher potential palatability to the consumer over ground beef not containing LFTB, especially regarding tenderness (Moon et al. 2012).

II.2 CHOICE EXPERIMENTATION AND UTILITY

This improvement in taste attributes, if substantial, might increase the utility for ground beef products. Here, utility is an economic term referring to an index of consumer desire for the product. The more consumers desire the product, the higher their utility, and the more they are willing to pay. A previous experiment by Lusk et al. (2001) examined beef steaks and found that, in a blind taste test, consumers were not only able to detect increased palatability characteristics such as tenderness, but they also exhibited higher willingness-to-pay for more tender steaks. Other previous studies (Lusk, Roosen, and Fox 2003; Chang, Norwood, and Lusk 2009) have established the effectiveness of the random utility model (1), where the utility for a specific good U is set equal to an observable, quantitative component V and a random component e . The observable component V can be further separated into two distinct portions (2): a direct contribution to utility α , and an indirect component P that refers to the loss of utility from having to pay a monetary price for the good.

$$(1) \quad U = V + e$$

$$(2) \quad V = \alpha - \beta P$$

$$(3) \quad U = \alpha - \beta P + e$$

Conjoint analysis and choice experiments (CE) have already been established as tools to measure utility with regards to beef products, in both hypothetical and non-hypothetical situations (Chang, Lusk, and Norwood 2009; Lusk, Roosen, and Fox 2003). Specifically, CE can be utilized in this case to infer the values of parameters α and β in the random utility model. This study seeks to determine if consumer utility for ground beef products is improved with the inclusion of FTB and if it is influenced by certain individual demographics, all of which is lacking in current literature with regards to this specific beef product.

CHAPTER III. METHODOLOGY

III.1 CONCEPTUAL FRAMEWORK AND HYPOTHESES

It is well-established that tenderness is a desired aspect of beef palatability to consumers (Boleman et al. 1997; Lusk et al. 2001). While ground beef does not fall under the same market behaviors as other whole-muscle products such as steaks (Brester and Wohlgenant 1991), tenderness is still considered an important aspect of ground beef sensory analysis, especially in cooked patties (Andersson and Lundgren 1981; Kundu and Holley 2013; Lorenzen and Heymann 2003; Luchsinger et al. 1997). Therefore, due to the evidence of increased tenderness of ground beef containing finely textured beef (FTB) (Moon et al. 2012) and the findings of previous research regarding other beef products (Boleman et al. 1997; Lusk et al. 2001), the following hypotheses are proposed with regards to ground beef made with 0%, 15%, and more than 15% inclusion of FTB:

H₁ Null: Subjects, on average, do not prefer one ground beef product to another.

Alternative: At least one ground beef product is preferred. If so, analyses will identify the preferred FTB inclusion.

H₂ Null: Gender, on average, has no effect on subjects' preferences for one ground beef product to another.

Alternative: Male and female subjects exhibit different preferences for FTB inclusion in ground beef.

H₃ Null: On average, students and adults will not exhibit different preferences for one ground beef product to another.

Alternative: Students and adult subjects will exhibit different preferences for FTB inclusion in ground beef.

III.2 MATERIALS AND SAMPLING

To determine if differences exist in the eating experience between ground beef patties that contain finely textured beef (FTB) and patties that do not contain FTB, a blind taste test of these products was conducted. The ground beef patties for the study were supplied by the company Cargill in three different formulations: ground beef not containing FTB, ground beef with 15% FTB inclusion, and ground beef with maximum FTB inclusion. Each of these formulations was identified by lot number, but was not labeled by their formulations to prevent any accidental revelations to participants or the researchers. All three formulations contained the exact same lean percentage of 80% so that any differences participants perceived in flavor could not be attributed to differing fat contents. Furthermore, all patties were thawed from frozen and cooked to the same internal temperature of 165°F for uniformity, as shown in **Figure 1**.



Figure 1. Thawed ground beef patties being cooked for the taste experiment, identified by colored cards with lot numbers and shapes.

Table 1. Variable definitions and summary statistics of all test subjects ($N = 232$)

Variable	Definition	Percentage
Gender	Male	39.1%
	Female	60.4%
Student	Student	60.4%
	Adults	38.7%
Income	Less than \$10,000	10.0%
	\$10,000-\$19,999	13.0%
	\$20,000-\$29,999	7.0%
	\$30,000-\$39,999	4.8%
	\$40,000-\$49,999	8.2%
	\$50,000-\$59,000	4.8%
	\$60,000-\$69,999	6.1%
	\$70,000-\$79,999	7.8%
	\$80,000-\$89,000	10.0%
	\$90,000-\$99,999	4.8%
	\$100,000 or more	21.7%
Consumption	Frequency of ground beef consumption	
	Frequently	84.3%
	Rarely	15.2%
Hamburger	Never	—
	Frequency of hamburger consumption	
	Frequently	76.1%
	Rarely	22.6%
	Never	1.3%
Purchase	Frequency of ground beef purchases	
	At least once a week	36.5%
	At least once every two weeks	28.3%
	At least once a month	14.8%
	At least once every two months	4.3%
	Less than once every two months	8.3%
	Never	7.0%

Two main groups were utilized as participants in this study: undergraduate college students and non-student adults. For the first group, students currently attending Oklahoma State University's Freshman-in-Transition (FIT) program were asked to attend a research session for \$10.00 cash compensation. For the second group, adults in Stillwater, OK, were recruited via word of mouth and emailed invitations to attend for a \$10.00 Walmart gift card compensation.

Many of these adults were staff and faculty of Oklahoma State University. A total of 8 experimental sessions were conducted, four for the student group and four for the adult group. All sessions were conducted in the Oklahoma State University Food and Agricultural Products Center. **Table 1** shows the overall demographics of all test subjects who attended these experimental sessions.

III.3 BLIND TASTE TEST

The objective of this study is to measure consumer preferences for ground beef with different levels of finely textured beef (FTB), but asking consumers directly about these preferences is problematic because even if they are aware of the product outside of its dysphemism "pink slime," they may not be able to effectively recall the taste of FTB. Subjects must be allowed to taste ground beef with varying levels of FTB, without being told that FTB is included in the formulation, and then allowed to express their choice of beef in order for their preferences to have greater, unbiased validity.

Participants were given three bite-sized samples of the ground beef patties labeled *square*, *circle*, and *triangle* (**Figure 2**), corresponding to each of the three ground beef blends, respectively. Before and between each taste, participants were asked to take a bite of unsalted cracker and a drink of water to cleanse their palettes. Participants were asked to record their eating experiences on a nine-point scale, from "like extremely" to "dislike extremely," for each sample on a paper survey (see **Appendix B**). To prevent any potential order effects, participants were directed which shape to consume first, and the order of those shapes was randomized across participants. For example, a participant with survey version A consumed the *square* sample first, while the next participant with survey B consumed the *circle* sample first.



Figure 2. Ground beef samples labeled from left to right *triangle*, *square*, and *circle*.

Following completion of this part of the experiment, participants were asked to enter a buffet line (**Figure 3**) and construct three sliders from three cooked patties labeled with a *red*, *white*, or *blue* toothpick (**Figure 4**), each corresponding to the three ground beef blends being tested. Participants were instructed to place whichever condiments and toppings they preferred on their sliders, so long as all three sliders were constructed to be identical (**Figure 5**). Provided options for toppings and condiments consisted of slider buns, cheese slices, ketchup, mustard, mayonnaise, barbecue sauce, sliced tomatoes, lettuce, pickles, and sliced onions. Participants were also given the options of cookies or chips for a side dish. Bottled water was the only beverage provided.



Figure 3. Buffet line for subjects featuring choices of condiments provided to subjects.



Figure 4. Three sliders, as presented to subjects with distinguishing red, white, and blue toothpicks.



Figure 5. Subject placing identical condiments on each of the three sliders.

Once they were ready to eat their meal, participants were asked to take one bite of each slider and record their initial perceived eating experience on their survey (**Figure 6**). As before, participants were instructed to cleanse their palettes with unsalted cracker and water before and between each bite. Also, the order of the color-coded slider questions were rotated on each version of the survey to prevent any order effects. For example, a participant with survey *A* was asked to taste the *red* slider first, while a participant with survey *B* was asked about the *white* slider first.

Once they recorded their responses about the first bite, participants were permitted to eat the rest of their meal with no further restrictions. They were permitted to talk amongst themselves

if they wished to mimic a typical social event where this type of meal might be eaten, but they were instructed not to discuss the food itself or their perceptions of the eating experience. Once they were finished, participants were asked to rate their overall perceived eating experiences of the *red*, *white*, and *blue* sliders.



Figure 6. Subjects tasting sliders and filling out questionnaires.

A separate research team has been charged with analyzing these data from the beef samples, and they have found no significant statistical differences in the ratings of these three meats in terms of flavor, juiciness, and overall satisfaction. Although the meats containing no FTB and 15% FTB inclusion received the same ratings for tenderness, the ground beef containing maximum FTB was rated as more tender, though numerically the difference was minor (Neilson et al. 2015). This team is also charged with the evaluation of the three custom-built sliders, but this portion is currently incomplete.

III.4 ELICITING CONSUMER PREFERENCE

In the case that participants detected differences between the ground beef types in the blind taste test, it was necessary to determine if some of these differences would be equally detectable in the form of sliders (small hamburgers), and whether those differences might be

manifested in beef purchases. Therefore, following the end of the participants' meals, they were each asked a series of four hypothetical choice set questions that mimicked potential shopping scenarios, the responses of which subsequently being used to calculate utility through conjoint analysis.

Each choice set contained four options, consisting of the three color-coded sliders (*red*, *white*, and *blue*) and a "none" option. Two price levels of \$3.50/lb and \$4.25/lb were assigned across the choice options in an orthogonal fractional factorial design. For example, in one scenario, all slider ground beef types had the same price of \$4.25, while in the other three scenarios, one of the ground beef types was priced at \$4.25 against the others, which were priced at \$3.50. The order in which each color appeared in the choice set was randomized to prevent ordering effects. For example, the blue slider appeared in the left-most column for some subjects, while for others it was the middle or right-most column. **Figure 7** shows the exact four questions that were presented. Because this mimics an actual shopping scenario, their answers formed the ideal mechanism for determining whether consumers truly value ground beef differently as the included level of FTB varied. Thus, answers to these hypothetical choice experiments were used to estimate a random utility function (4) for sliders, where the deterministic component of utility was allowed to differ for the sliders containing no FTB, 15% FTB, and the maximum inclusion of FTB. Preferences can be studied by observing how α_1 , α_2 , and α_3 change in relationship to the price coefficient β . This equation can also be further expanded to test the effects of age, gender, and other demographic variables on consumer preferences for the different ground beef formulations.

$$(4) \quad V = \alpha_1(NOFTB) + \alpha_2(15FTB) + \alpha_3(MAXFTB) + \beta(PRICE)$$

It should be noted that these choice sets only involved the sliders, not the ground beef samples that participants tasted at the beginning of the experiment. Participants were also asked a free-response question where they could speculate as to what might have been different between

the patties, followed by a series of basic demographic questions concerning age, gender, income level, frequency of ground beef consumption, and frequency of ground beef purchases.

Which of the following would you purchase?

<i>Choice #1</i>	Red \$4.25/lb	White \$4.25/lb	Blue \$4.25/lb	If these were the only options, I would buy something else.
I would choose...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Choice #2</i>	Red \$3.50/lb	White \$3.50/lb	Blue \$4.25/lb	If these were the only options, I would buy something else.
I would choose...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Choice #3</i>	Red \$3.50/lb	White \$4.25/lb	Blue \$3.50/lb	If these were the only options, I would buy something else.
I would choose...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<i>Choice #4</i>	Red \$4.25/lb	White \$3.50/lb	Blue \$3.50/lb	If these were the only options, I would buy something else.
I would choose...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 7. Hypothetical choice questions from the participant survey.

CHAPTER IV: FINDINGS

IV.1 CLEANING OF DATA SET

A total of 232 individuals (previously described in **Table 1**) participated in the experiment, thereby producing 838 choice observations, but some of these observations were discarded prior to data analysis. Individuals who answered in an incorrect format, such as selecting two ground beef products instead of one in the hypothetical choice sets, were excluded from the final sample. Additionally, individuals who failed to indicate important demographic information such as their gender or frequency of ground beef purchases were also removed. Responses from graduate students were likewise excluded because they may have their own distinct preference patterns, but were too few in number to be given their own category.

Following this filtration of incomplete responses, a total of 155 individuals remained. Most, but not all, of these respondents answered all four choice set questions in an appropriate manner; thus there were 605 total choice set observations. **Table 2** describes the characteristics of this final subset of participants. These data were then imported into the *LIMDEP* econometric software package for analysis, and the code utilized is provided in **Appendix C**.

Table 2. Variable definitions and summary statistics of 155 subjects included in the analysis.

Variable	Definition	Percentage
Gender	Male	38.1%
	Female	61.9%
Student	Student	56.8%
	Adults	43.2%
Income	Less than \$10,000	10.5%
	\$10,000-\$19,999	4.6%
	\$20,000-\$29,999	5.9%
	\$30,000-\$39,999	3.9%
	\$40,000-\$49,999	5.9%
	\$50,000-\$59,000	5.9%
	\$60,000-\$69,999	5.2%
	\$70,000-\$79,999	11.7%
	\$80,000-\$89,000	11.1%
	\$90,000-\$99,999	5.9%
Consumption	\$100,000 or more	29.4%
	Frequency of ground beef consumption	
	Frequently	84.5%
	Rarely	15.5%
Hamburger	Never	—
	Frequency of hamburger consumption	
	Frequently	76.8%
	Rarely	21.9%
Purchase	Never	1.3%
	Frequency of ground beef purchases	
	1=At least once a week	38.7%
	2=At least once every two weeks	29.7%
	3=At least once a month	11.6%
	4=At least once every two months	4.5%
	5=Less than once every two months	7.7%
6=Never	7.7%	

IV.2 HYPOTHETICAL PURCHASES

Although the choice experiments were strictly hypothetical, the fact that participants are considering a simulated shopping experience may give important clues as to how the taste of ground beef might influence their choices. Consider the choices outlined in **Table 3**, below. The first row indicates which product participants would have purchased when all ground beef types were priced equally at \$4.25/lb. The percentages of people choosing each product were nearly

identical, suggesting that the amount of FTB inclusion in the sliders did not alter their culinary appeal.

The next three rows describe simulated, hypothetical purchases when one ground beef product was labeled with a higher price of \$4.25/lb while the other two products were labeled with a lower price of \$3.50/lb. The division of lower-priced and higher-priced products increased the percentages for some of the ground beef types versus the “none” option, and predictably, participants shunned the higher-priced products for their cheaper counterparts. Overall, the subjects seemed indifferent to the three ground beef types, but a certain percentage of participants still selected the higher-priced sliders, indicating that they were not indifferent and believed these products to be of higher quality.

Table 3. Numbers and percentages of respondents who chose each type of ground beef in the choice sets. Within rows, percentages sum to 100%^a.

	No FTB		15% FTB		max FTB		None	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Equal High Prices^b	41	27% ^β	45	29% ^β	47	31% ^β	21	14% ^β
One Price High^c								
<i>No FTB priced high</i>	13	9% ^β	67	45% ^α	61	41% ^α	8	5% ^β
<i>15% FTB priced high</i>	60	40% ^β	19	13% ^α	60	40% ^β	12	8% ^α
<i>max FTB priced high</i>	67	44% ^β	59	39% ^{β,α}	18	12% ^γ	7	5% ^{α,γ}

Notes: Percentages with the same Greek letter in each row are not statistically different from one another at the 5% level, as determined by t-tests.

^aWithin rows, *n* totals are not equal due to participant lack of response on some questions.

^bAll ground beef types were presented at \$4.25/lb.

^cSpecified ground beef type in row was presented in choice set at \$4.25/lb while others were presented at \$3.50/lb.

IV.3 EMPIRICAL UTILITY FUNCTIONS

The tabulated results in **Table 3** are enlightening, and if all subjects were the same, there would be no need for further analysis. However, the subjects in this experiment reflect diverse demographics, and factors like gender have previously been shown to influence preferences for

meat (Lusk et al. 2001). To better study the impact of FTB inclusion on the desirability of ground beef, utility functions are estimated to account for any potential demographic effects.

Data from these final 605 choice set observations were analyzed via multinomial logit regression in the program *LIMDEP*. The random utility model (5) was the primary econometric model employed, based on its effectiveness in prior studies (Lusk, Roosen, and Fox 2003; Chang, Norwood, and Lusk 2009), where U_{ij} represents the utility a consumer i receives from choice j and V_{ij} represents the deterministic portion. For this study, j denotes an item of interest from the choice set of four alternatives: *red* ground beef (maximum FTB inclusion), *white* ground beef (no FTB inclusion), *blue* ground beef (15% FTB inclusion), or none of these. In this model, V_{ij} in (6) is dependent on an alternative specific constant (α_j), the utility alternative j offers compared to "none;" the marginal utility of money (β); and the price of alternative j that consumer i encounters in the choice set (P_{ij}), which in this case is either \$3.50/lb or \$4.25/lb. For the none option, the intercept α_j and the price P_{ij} equal zero, thus making V_{ij} also zero. Out of 4 total options, then, and assuming that stochastic portion ε_{ij} is independently distributed amongst all participants in the study sample according to the Type I Extreme Value distribution, the probability of a consumer i making choice j can be calculated by the following equation (7).

$$(5) \quad U_{ij} = V_{ij} + \varepsilon_{ij}$$

$$(6) \quad V_{ij} = \alpha_j + \beta P_{ij}$$

$$(7) \quad \text{Prob}\{j \text{ is chosen}\} = \frac{e^{V_{ij}}}{\sum_{k=1}^4 e^{V_{ik}}} = \frac{e^{\alpha_j + \beta P_{ij}}}{\sum_{k=1}^4 e^{\alpha_k + \beta P_{ik}}}$$

Applied specifically to the three different utilities that consumers may receive from each type of ground beef, the unrestricted model (8) can be used to calculate discrete choice estimates based on participant choices. In this model, *NOFTB*, *MXFTB*, and *15FTB* are the coded dummy variable names for consumer choices of ground beef containing no FTB (*blue*), ground beef with

maximum FTB inclusion (*red*), and ground beef containing 15% FTB (*white*), respectively, dependent on the prices that were assigned within the choice set. Referred to as **Model 1, Table 4** shows the parameter estimates when there are no parameter restrictions.

(8) **Model 1 (unrestricted):**

$$V_{ij} = \alpha_1(NOFTB_{ij}) + \alpha_2(MXFTB_{ij}) + \alpha_3(15FTB_{ij}) + \beta(PRICE_{ij})$$

To determine if there are significant differences between the likelihoods of a consumer choosing one of these ground beef types over another, however, this unrestricted model must be compared to the restricted model (9). Here the variables *NOFTB*, *MXFTB*, and *15FTB* have been collapsed to a single dummy variable *ANYMEAT*, and the coefficients for these variables are likewise condensed to a single α estimate. If *ANYMEAT* equals 1, it refers to one of the three ground beef types without indicating a specific product. **Table 5** shows results from conditional logit regression using this restricted model.

(9) **Model 1 (restricted):**

$$V_{ij} = \alpha(ANYMEAT_{ij}) + \beta(PRICE_{ij})$$

$$\alpha = \alpha_1 + \alpha_2 + \alpha_3$$

Coefficients for these models were chosen to maximize the resulting log likelihood functions in (10), where the subscript t accounts for the fact that any one subject may make multiple choices. The variable $PRICE_{i=99,j=2,t=3}$ then, refers to subject 99 evaluating the second ground beef product in their third choice set. Utilizing log likelihood function values from both models, a likelihood ratio test (11) may be performed to generate a chi-squared statistic, which can in turn be used to test the null hypothesis $\alpha = \alpha_1 + \alpha_2 + \alpha_3$, versus the alternative hypothesis that these three parameters are not equal. Because **Model 1** contains two fewer coefficients to estimate in the restricted model, compared to its unrestricted counterpart, the chi-squared statistic has two degrees of freedom.

$$(10) \quad \alpha_j, \beta = \max_{\alpha_j, \beta} LLF_R = \sum_i \sum_j \sum_t Y_{ijt} \ln \left(\frac{e^{\alpha_j + \beta P_{ij}}}{\sum_{k=1}^J e^{\alpha_k + \beta P_k}} \right)$$

$$\alpha, \beta = \max_{\alpha, \beta} LLF_U = \sum_i \sum_j \sum_t Y_{ijt} \ln \left(\frac{e^{\alpha + \beta P_{ij}}}{\sum_{k=1}^J e^{\alpha + \beta P_k}} \right)$$

$$(11) \quad \ln(\lambda) = 2(LLF_U - LLF_R)$$

Comparing the restricted and unrestricted versions of **Model 1**, the $\ln(\lambda)$ statistic equals $2(722.780 - 722.645) = 0.27$. Evaluating the cumulative chi-square distribution with two degrees of freedom, the probability of a Type I Error (the probability of observing a statistic equal to or greater than 0.27 when the null hypothesis is true) is 87%. Referred to as a p -value, the null hypothesis would typically be rejected whenever it is less than some threshold, usually 5% if a 95% confidence interval is utilized. In the presence of multiple tests, however, this threshold must be modified, as the p -value only represents the probability if a single test is conducted. This study adopts the Bonferroni Correction, where the null hypothesis is rejected whenever the p -value is less than 0.05 divided by the number of tests conducted. This study conducts a total of eight tests (three shown in **Table 4**, one in **Table 6**, one in **Table 9**, and three in **Table 11**), so the p -value must be less than $0.05/8 = 0.00625$ before the null hypothesis is rejected.

The unrestricted estimates of **Model 1** are shown in **Table 4** while the restricted estimates are shown in **Table 5**. Both tables also estimate interaction coefficients for **Models 2 and 3**, which are discussed in a subsequent session. After comparing the estimate values of the restricted and unrestricted versions of **Model 1**, and accounting for the fact that the restricted model estimates two fewer coefficients, the correlating p -value is 0.8735. Thus, the null hypothesis that $NOFTB = MXFTB = 15FTB$ is not rejected, implying that consumers are indifferent between

ground beef products containing differing levels of FTB, so long as they are sold at the same price.

Table 4. Estimates of unrestricted conditional logit model and log likelihood function. *P*-values are in parentheses below estimate values.

Attribute	Variable	Estimates		
		Model 1	Model 2	Model 3
Price	Ground beef price per pound (<i>PRICE</i>)	-1.728 (0.00)	-1.535 (0.00)	-2.065 (0.000)
Ground Beef	<i>Blue</i> slider (<i>NOFTB</i>)	7.999 (0.00)	6.731 (0.00)	9.020 (0.00)
	<i>Red</i> slider (<i>MXFTB</i>)	8.032 (0.00)	6.725 (0.00)	9.080 (0.00)
	<i>White</i> slider (<i>15FTB</i>)	8.055 (0.00)	6.641 (0.00)	9.223 (0.000)
Interactions	<i>PRICE</i> * <i>STUDENT</i> ^a	—	-0.376 (0.309)	—
	<i>NOFTB</i> * <i>STUDENT</i>	—	2.665 (0.071)	—
	<i>MXFTB</i> * <i>STUDENT</i>	—	2.732 (0.065)	—
	<i>15FTB</i> * <i>STUDENT</i>	—	2.908 (0.049)	—
	<i>PRICE</i> * <i>GENDER</i> ^b	—	—	0.518 (0.183)
	<i>NOFTB</i> * <i>GENDER</i>	—	—	-1.532 (0.321)
	<i>MXFTB</i> * <i>GENDER</i>	—	—	-1.568 (0.310)
	<i>15FTB</i> * <i>GENDER</i>	—	—	-1.764 (0.255)
	Log Likelihood Function (LLF _v)	-722.645	-712.817	-720.353
	<i>p</i> -value for null hypothesis that <i>NOFTB</i> = <i>MXFTB</i> = <i>15FTB</i>	0.8735 <i>Do Not Reject Null</i>	0.8147 <i>Do Not Reject Null</i>	0.8245 <i>Do Not Reject Null</i>

^aVariable *STUDENT* includes all respondents who were undergraduate university students under the age of 26 and excludes all non-student adults.

^bVariable *GENDER* includes all respondents who were female and excludes all male respondents.

Table 5. Estimates of restricted conditional logit model and log likelihood function. *P*-values are in parentheses below estimate values.

Attribute	Variable	Estimates		
		Model 1	Model 2	Model 3
Price	Ground beef price per pound (<i>PRICE</i>)	-1.728 (0.00)	-1.535 (0.00)	-2.059 (0.00)
Ground Beef	<i>Blue, Red, and White</i> together (<i>ANYMEAT</i>)	8.027 (0.00)	6.701 (0.00)	9.085 (0.00)
Interactions	<i>PRICE*STUDENT</i> ^a	— —	-0.374 (0.312)	— —
	<i>ANYMEAT*STUDENT</i>	— —	2.761 (0.061)	— —
	<i>PRICE*GENDER</i> ^b	— —	— —	0.512 (0.188)
	<i>ANYMEAT*GENDER</i>	— —	— —	-1.601 (0.298)
	Log Likelihood Function (LLF _R)	-722.780	-713.600	-721.109

^aVariable *STUDENT* includes all respondents who were currently university students and excludes all non-student adults.

^bVariable *GENDER* includes all respondents who were female and excludes all male respondents.

IV.4 EFFECT OF DEMOGRAPHICS

While there may be no overall significant differences in how participants perceived the ground beef formulations, it is still possible for certain subgroups of participants to have distinguishable preferences for certain ground beef types that are correlated to or influenced by their characterizable differences. For example, one can imagine a scenario where individuals of a certain demographic category prefer less inclusion of FTB in ground beef, while individuals of another demographic category prefer more. However, without separating these categories, the subjects collectively might appear to be indifferent between the products. For the purposes of this study, the demographical characteristics of gender, frequency of ground beef purchases, and

whether they are an OSU undergraduate student were specifically considered as potential variables of interest.

To determine if any significant differences exist between how undergraduate university students 25 years of age or younger perceived and evaluated the three ground beef types versus that of non-student adults, additional variables can be added to the models such that preferences for each group are described by two different sets of parameters. First, consider a model where students (designated by the *STUDENT* dummy variable) have different preference parameters than their counterparts (12 and 13). Referred to as **Model 2**, **Table 4** and **Table 5** report results from these unrestricted and restricted interaction models, respectively.

(12) **Model 2 (unrestricted):**

$$V_{ij} = \alpha_1(NOFTB_{ij}) + \alpha_2(MXFTB_{ij}) + \alpha_3(15FTB_{ij}) + \alpha_4(NOFTB_{ij} * STUDENT_{ij}) \\ + \alpha_5(MXFTB_{ij} * STUDENT_{ij}) + \alpha_6(15FTB_{ij} * STUDENT_{ij}) + \beta_1(PRICE_{ij}) \\ + \beta_2(PRICE_{ij} * STUDENT_{ij})$$

When *STUDENT* = 1 (student participant),

$$V_{ij} = (\alpha_1 + \alpha_4)(NOFTB_{ij}) + (\alpha_2 + \alpha_5)(MXFTB_{ij}) + (\alpha_3 + \alpha_6)(15FTB_{ij}) \\ + (\beta_1 + \beta_2)(PRICE_{ij})$$

When *STUDENT* = 0 (adult participant),

$$V_{ij} = \alpha_1(NOFTB_{ij}) + \alpha_2(MXFTB_{ij}) + \alpha_3(15FTB_{ij}) + \beta_1(PRICE_{ij})$$

(13) **Model 2 (restricted):**

$$V_{ij} = \alpha_1(ANYMEAT_{ij}) + \alpha_4(ANYMEAT_{ij} * STUDENT_{ij}) + \beta_1(PRICE_{ij}) + \\ \beta_2(PRICE_{ij} * STUDENT_{ij})$$

When *STUDENT* = 1 (student participant),

$$V_{ij} = (\alpha_1 + \alpha_4)(ANYMEAT_{ij}) + (\beta_1 + \beta_2)(PRICE_{ij})$$

When *STUDENT* = 0 (adult participant),

$$V_{ij} = \alpha_1(ANYMEAT_{ij}) + \beta_1(PRICE_{ij})$$

A similar likelihood ratio test is performed to test the null hypotheses that $\alpha_1 = \alpha_2 = \alpha_3$ and $\alpha_4 = \alpha_5 = \alpha_6$. The restricted version of **Model 2** requires estimating four fewer parameters,

indicating four degrees of freedom, and the p -value of the test is 0.815. Much larger than the threshold of 0.007143, the null hypothesis is not rejected, indicating both groups are indifferent between the three beef types.

An identical test was used to determine the effect of gender on participant choices, where the *STUDENT* variable was replaced with the dummy variable *FEMALE* (see **Model 3** in **Tables 4 and 5**). The resulting p -value of 0.824 likewise indicates that both females and males are indifferent between the three ground beef types.

Thus far, it appears that participants were indifferent between the three beef products. Perhaps subjects have difficulty discerning between the three ground beef types due to a lack of experience with ground beef purchases. Assigning more weight to the responses from individuals who purchase more ground beef may show that some people do prefer one beef product over another. To see if this is the case, an additional weighted model was also calculated. Referred to as **Model 4**, this weighted model is the same as **Model 1**, except that it places greater weights on those individuals who more frequently purchased ground beef at the grocery store. Using the *PURCHASE* variable in **Table 2**, observations were weighted such that respondents with lower coded values were given heavier weights. This was accomplished by creating a variable W_{jit} that equals $7 - PURCHASE$. For example, a respondent with a Purchase score of 1, who purchases ground beef "at least once a week," carried twice as much weight as a respondent with a Purchase score of 4, who purchases ground beef "at least once every two months." **Table 6** and **Table 7** report the results of these weighted models, estimated using an altered log likelihood function equation (14), where W_i represents the weights applied.

$$(14) \quad LLF = \sum_i \sum_j \sum_t W_i Y_{itj} \ln \left(\frac{e^{V_{ij}}}{\sum e^{V_{ik}}} \right)$$

The resulting p -value of 0.20 from the likelihood ratio test indicates failure to reject the null hypothesis. Respondents are indifferent between the three beef types, even when special emphasis is placed on those who purchase ground beef regularly.

Table 6. Estimates of weighted unrestricted conditional logit model and log likelihood function. *P*-values are in parentheses below estimate values.

Attribute	Variable	Model 4 Estimates
Price	Ground beef price per pound (<i>PRICE</i>)	-1.717 (0.00)
Ground Beef	<i>Blue</i> slider (<i>NOFTB</i>)	8.143 (0.00)
	<i>Red</i> slider (<i>MXFTB</i>)	8.192 (0.00)
	<i>White</i> slider (<i>15FTB</i>)	8.232 (0.00)
	Log Likelihood Function (LLF_U)	-3298.247
	<i>p</i> -value for null hypothesis that <i>NOFTB=MXFTB=15FTB</i>	0.2005 <i>Do Not Reject Null</i>

Table 7. Estimates of weighted restricted conditional logit model and log likelihood function. *P*-values are in parentheses below estimate values.

Attribute	Variable	Model 4 Estimates
Price	Ground beef price per pound (<i>PRICE</i>)	-1.716 (0.00)
Ground Beef	<i>Blue, Red, and White</i> together (<i>ANYMEAT</i>)	8.185 (0.00)
	Log Likelihood Function (LLF_R)	-3299.854

IV.5 LATENT CLASS MODELING

Sometimes different groups exhibit distinct eating habits and food preferences, but for reasons that are difficult to identify. For example, if a group of individuals are asked for their preference of two different foods, half may strongly pick the first while the other half may prefer the second with equal intensity. Both of these groups may have roughly the same demographics, so therefore the differences in food preference cannot be attributed to clear variables such as gender or ethnicity. These two groups of individuals could be said to belong to distinct latent

classes, meaning their food preferences differ, but one can only determine this after the fact by observing their choices. In other words, their choices cannot be anticipated solely based on clear, definable characteristics such as demographics.

The previous models indicated that individuals do not prefer one ground beef formulation over another, even when different preferences are assigned to students versus non-student adults, females versus males, and individuals with different ground beef purchasing habits. Subjects may still exhibit different preferences for ground beef, though, and in ways difficult to capture due to such "latent" or unobserved explanatory variables. After separating individuals according to these latent preferences, we might then find that some individuals do prefer one ground beef product over another.

To assess this possibility, three latent class models were calculated: a 2-class model, a 3-class model, and a 4-class model. A class refers to a group within the sample that share the same preference parameters. For example, in a two-class model, the first class has the preference parameters $\alpha_1^{(L1)}, \alpha_2^{(L1)}, \alpha_3^{(L1)}$, and $\beta^{(L1)}$, while the second class has the parameters $\alpha_1^{(L2)}, \alpha_2^{(L2)}, \alpha_3^{(L2)}$, and $\beta^{(L2)}$. **Models 1-3** account for heterogeneous preferences by estimating different parameters for different groups of subjects. Latent class models operate by a similar mechanism, except that it is impossible to know which group any given individual belongs. With an L -class model, any individual has a certain probability of belonging in one class or another, and this probability is estimated along with the parameter coefficients for each class. If L groups of subjects exhibit significantly different preferences for ground beef in their surveys, their choices will be reflected in the parameter estimates. As with the weighted model, another log likelihood function equation (15) was utilized for this latent class model, where P_L represents the probability of any respondent being in class L . In this instance, $L = 1, 2, 3$ to match the three classes in the final model.

$$(15) L\text{-classes LLF} = \sum_i \sum_j \sum_t Y_{ijt} \ln \left(\sum_{c=1}^L P_c \frac{e^{v_{ijt}^{(Lc)}}}{\sum e^{v_{jt}^{(Lc)}}} \right)$$

It is impossible to determine whether a 2, 3, or 4 class model is best, but the use of the Akaike information criterion (AIC) and Bayesian information criterion (BIC) can assist in model comparison and selection. After estimating coefficients for each of the three latent class models, AIC and BIC values were calculated. For both criterion, a lower numeric value indicates a more preferable model, but as shown in **Table 8**, the results are inconclusive. Comparison of AIC values suggests a latent class model with four or more classes should be selected, while comparison of BIC values indicates that only one class is warranted. A three-class model is considered here as a compromise between the AIC and the BIC values. Furthermore, a two-class model does not converge well in its restricted form. **Table 9** and **Table 10** report estimates from unrestricted and restricted latent class modeling with three classes.

Table 8. AIC and BIC values for 1, 2, 3, and 4 class latent class models.

Number of Classes	LLF	Number of Parameters Estimated	AIC	BIC
1	-722.645	4	1453.289	1476.455
2	-708.745	10	1437.49	1495.405
3	-687.117	15	1404.234	1495.849
4	-680.076	20	1400.152	1522.307

The resulting *p*-value of 0.000002 from the likelihood ratio test between the unrestricted and restricted latent class models indicates that there are significant differences between how these three classes evaluated the three ground beef products. For the first time, subjects were not indifferent between the three ground beef types. Due to the positive coefficients on price in Class 3 and the negative coefficients on the ground beef types, subjects in this class demonstrate a

strange positive correlation between increased price of ground beef and increased likelihood of ground beef purchases. This manner of behavior is irrational compared to the other two classes, suggesting that this small group may have answered questions haphazardly, giving little consideration to their answers. However, because the p -value is lower than the established threshold, the null hypothesis is rejected. At least one class in this model exhibits a significant preference for one ground beef formulation over the others, but as previously stated, it is impossible to know what characteristics may be correlated to these preferences, nor is it clear which ground beef type is preferred. Observing **Table 9**, Class 1 seems to rank the ground beef labeled "white" as most preferable and the ground beef labeled "blue" as least preferable, while the opposite is true for Class 2. Thus, these results are ambiguous as to which ground beef type is truly preferred.

Table 9. Estimates of latent class unrestricted conditional logit modeling with three classes. P -values are in parentheses below estimate values.

Attribute	Variable	Estimates		
		Class 1	Class 2	Class 3
Price	Ground beef price per pound (<i>PRICE</i>)	-2.135 (0.00)	-2.898 (0.00)	38.985 (0.15)
Ground Beef	<i>Blue</i> slider (<i>NOFTB</i>)	9.452 (0.00)	13.670 (0.00)	-165.655 (0.99)
	<i>Red</i> slider (<i>MXFTB</i>)	9.978 (0.00)	12.877 (0.00)	-165.462 (0.99)
	<i>White</i> slider (<i>15FTB</i>)	10.364 (0.00)	11.806 (0.00)	-166.206 (0.99)
	Latent Class Probabilities	61.93% (0.00)	32.44% (0.00)	5.63% (0.028)
	Log Likelihood Function (LLF _{<i>U</i>})		-687.117	
	p -value for null hypothesis that <i>NOFTB=MXFTB=15FTB</i> for all three classes		0.0000 <i>Reject Null</i>	

Table 10. Estimates of latent class restricted conditional logit modeling with three classes. *P*-values are in parentheses below estimate values.

Attribute	Variable	Estimates		
		Class 1	Class 2	Class 3
Price	Ground beef price per pound (<i>PRICE</i>)	-2.214 (0.00)	39.283 (1.000)	99.180 (1.00)
Ground Beef	<i>Blue, Red, and White</i> together (<i>ANYMEAT</i>)	10.305 (0.00)	-104.839 (1.000)	-422.028 (1.00)
	Latent Class Probabilities	94.35% (0.00)	1.10% (0.234)	4.55% (0.009)
	Log Likelihood Function (LLF_R)		-838.708	

To eliminate a portion of this ambiguity, the coefficients for each ground beef type and each class were multiplied by the latent class probabilities. This placed more weight on coefficients from classes with more members. For example, the coefficient in the first class for *15FTB* of 10.364 was multiplied by the latent class probability of Class 1 (0.6193), resulting in a weighted coefficient of 6.418. This value was higher than that of any other meat-class combination, suggesting that the ground beef type containing 15% FTB inclusion was slightly more preferred by test subjects than other ground beef formulations presented.

Thus, to determine if differences truly existed between consumer preferences of ground beef types, as suggested by the latent class model, hypothesis testing was performed where two ground beef types were restricted, set equal to each other, and thereby compared to the unrestricted third ground beef option. For example, *MXFTB* was set equal to *NOFTB* and then compared to *15FTB* via the previously established latent class model, and this was repeated for the remaining two combinations. **Table 11** shows the resulting likelihood functions and likelihood ratio tests from the testing of these hypotheses. The resulting *p*-values indicate that

there are no significant differences between the ground beef types labeled *MXFTB* and *NOFTB*, nor between the ground beef types labeled *MXFTB* and *15FTB*. However, the p -value of 0.001 confirms the above comparison between weighted latent class coefficients, indicating that there may be differences in participants' preferences between the ground beef types labeled *NOFTB* and *15FTB*. Thus, there is slight evidence that participants in this study may exhibit preferences for the ground beef containing 15% inclusion of FTB, but given the results of the previous hypothesis tests, the evidence is far from compelling.

Table 11. Likelihood-ratio tests in latent class model with three classes.

	Null Hypotheses		
	<i>MXFTB=NOFTB</i> across all classes	<i>NOFTB=15FTB</i> across all classes	<i>MXFTB=15FTB</i> across all classes
Unrestricted likelihood function (LLF_U)	-687.1168	-687.1168	-687.1168
Restricted likelihood function (LLF_R)	-688.4142	-694.9741	-690.4627
Likelihood-ratio test statistic	2.5948	15.7146	6.6918
p -value of null hypothesis	0.458 <i>Do Not Reject Null</i>	0.001 <i>Reject Null</i>	0.0824 <i>Do Not Reject Null</i>

CHAPTER V: CONCLUSIONS

V.1 SUMMARY OF RESULTS

Varying degrees of inclusion of finely textured beef (FTB) in ground beef formulations, in the context that most individuals consume this product, has no significant overall effect on participants' perceived palatability and subsequent utility. Even subgroups based on gender, education status, and frequency of ground beef purchases show no significant differences in their choice observations. Although latent class modeling provided some indication that consumers could tell the difference between products, the evidence was too contradictory to draw any conclusions regarding their purchasing preferences.

V.2 LIMITATIONS OF THE STUDY

Due to the focus of this study's objectives and certain limitations to the data, no analysis was performed regarding the effect of the condiments on participants' choice selections. While it would be interesting to see if certain condiments do influence a participants' ability to perceive taste and textural differences in ground beef, there were not enough data points for all of the possible toppings to perform a fair analysis. For example, cheese and ketchup were commonly chosen condiments, while barbecue sauce was far less popular and was not chosen frequently enough to statistically show any differences in the effect on taste perception.

Furthermore, to have performed such an analysis regarding the toppings would have gone beyond the scope of the original objectives of this experiment. Participants were asked to choose condiments they usually consumed when they ate hamburgers so as to increase the validity of their experimental eating experience. It is possible that certain participants might have disobeyed these instructions, chosen toppings they don't usually use, and thus had their eating experiences negatively affected during the experiment, but subjects were observed carefully as they prepared their sliders and this didn't seem to be the case.

Additionally, participants were only asked hypothetical choice questions after the consumption of the sliders, not after the initial bites previously labeled *square*, *circle*, and *triangle*. Asking the choice questions after participants tasted the meat samples might have provided us more information regarding the specific taste of the ground beef, but it would not have appropriately mimicked the true eating experience that most consumers have with ground beef, as previously stated with regards to the toppings.

V.3 IMPLICATIONS AND AREAS FOR FUTURE RESEARCH

The slider blind taste test and hypothetical choice methodologies utilized in this experiment were advantageous in that they closely mimicked real-world scenarios for the consumption of ground beef. Consumers who purchase ground beef in a store most likely do not know whether or not it contains FTB, and they are unlikely to eat it plainly cooked without the use of condiments to enhance the eating experience. Thus, our results have high generalizability to ground beef consumers in the United States. However, the primary concerns regarding FTB that led to the media storm of 2012 were related to consumer misunderstandings of the safety of FTB. The results of this experiment can only extend to consumer perceptions of taste, not those of food safety perceptions.

This being said, it raises an important question regarding whether or not participant taste preferences might have changed had they been informed as to which ground beef formulations they were tasting contained FTB. Future research that examines hypothetical consumer purchasing behavior in a non-blind taste experiment would show insight into this question, as would an experiment that misidentifies each ground beef formulation and asks subsequent questions to investigate if participants' taste experiences are biased by incorrect knowledge of the product. Non-hypothetical choice experiments may also be a potential route of exploration to explore actual consumer purchases based on knowledge provided.

In addition, this study was far from exhaustive with regards to all of the forms in which ground beef is consumed in the United States. As previously explained, sliders were chosen as they are the most common form of ground beef consumption, but other food types such as tacos or meatballs might yield different results due to the differences in cooking styles.

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APPENDICES

APPENDIX A

IRB Approval Letter

Oklahoma State University Institutional Review Board

Date: Thursday, September 04, 2014

IRB Application No AG1441

Proposal Title: Preferences for Ground Beef

Reviewed and Processed as: Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 9/3/2017

Principal Investigator(s):

F. Bailey Norwood
426 Ag Hall
Stillwater, OK 74078

Jayson Lusk
411 Ag Hall
Stillwater, OK 74078

Deborah VanOverbeke
104D An. Sci.
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

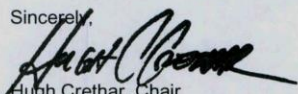
The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval. Protocol modifications requiring approval may include changes to the title, PI advisor, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms
2. Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of the research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Dawnett Watkins 219 Cordell North (phone: 405-744-5700, dawnett.watkins@okstate.edu).

Sincerely,



Hugh Crethar, Chair
Institutional Review Board

APPENDIX B

Experiment Questionnaire

There were three versions of this questionnaire. All three contained identical questions, but had different orders of questions in Sections A, B, C, and D.

PARTICIPANT INFORMATION

OKLAHOMA STATE UNIVERSITY

Project Title: Preferences for ground beef

Investigator(s):

Jayson Lusk, Department of Agricultural Economics.

Bailey Norwood, Department of Agricultural Economics.

Deb VanOverbeke, Department of Animal Science.

Purpose: The objective of the research is to study people's preferences for ground beef. You must be 18 or older to participate.

What to Expect: To participate in this study you must be willing to taste ground beef and hamburgers and provide feedback on your eating experience. First you will be asked to taste three pieces of ground beef and report your preference. Then you will be given three sliders (small hamburgers) and asked to make three nearly-identical hamburgers, including whatever toppings and condiments you wish. You will then report your preference for the burgers. All food has been prepared by a meat scientist and so will be as safe as a normal meal.

When you are done eating you will be given \$10 for your participation.

Risks: There are no risks associated with this project which are expected to be greater than those ordinarily encountered in daily life. At no point do we ask your contact information, so your identity cannot be matched with your responses.

Benefits: A chance to help researchers understand your preferences for ground beef.

Compensation: A free meal and \$10 in cash.

Your Rights and Confidentiality: Your participation in this research is voluntary. There is no penalty for refusal to participate, and you are free to withdraw your consent and participation in this project at any time. If you feel you may have an allergy to any of the foods, please let the researchers know promptly, and you may cease participating with no penalty.

Confidentiality: You will be given an identification number and at no time will you be asked for your contact information. Thus, it would be impossible for anyone to match your responses to your identity.

Contact: You may contact any of the researchers at the following addresses and phone numbers, should you desire to discuss your participation in the study and/or request information about the results of the study:

Bailey Norwood. 426 Ag Hall. Department of Agricultural Economics. Oklahoma State University. 405-334-0010. bailey.norwood@okstate.edu. fbaileynorwood.com.





If you have questions about your rights as a research volunteer, you may contact the IRB Office at 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu

CONSENT DOCUMENTATION:

I have been fully informed about the procedures listed here. I am aware of what I will be asked to do and of the benefits of my participation. I also understand the following statements:

I affirm that I am 18 years of age or older.

Preface the signature lines with the following statement (expand if appropriate):
I have read and fully understand this consent form. I sign it freely and voluntarily. A copy of this form will be given to me. I hereby give permission for my participation in this study.

	
Signature of Participant	Date
I certify that I have personally explained this document before requesting that the participant sign it.	
	
Signature of Researcher	Date

Instructions for subjects

- Please sit anywhere you like. This session will proceed as follows.
- **Part A:** First we will bring you each three pieces of ground beef. After taking each bite, please cleanse your palate by eating a cracker and taking a sip of water. You will taste each piece and answer a few questions about your eating experience.
- **Part B:** Then you will be given three sliders (small hamburgers) and will be asked to build identical hamburgers using whatever toppings you wish. You may also take whatever side dishes and drinks you wish. You will take one bite from each slider and report your eating experience. Between each bite, please cleanse your palate by eating a cracker and taking a sip of water. As you eat, please do not talk amongst each other about the burgers or the beef. After taking one bite of each burger and reporting your experience, you are free to continue eating and socializing, and you may talk about anything except the beef and burgers.
- **Part C:** After you have finished eating you will indicate once again your eating experience.
- **Part D:** You will indicate which ground beef products you would purchase at various prices.
- **Part E:** You will comment on whether you believe the burgers are identical or different from each other.
- **Part F:** You will answer a few questions about yourself.

(A) Meats labeled square, triangle, and circle

Please indicate the extent to which you like or dislike the tenderness, flavor, juiciness, and overall satisfaction of the beef labeled <i>square</i> .										
SQUARE	Tenderness	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
	Flavor	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
	Juiciness	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
	Satisfaction with overall eating quality	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>

(Remember to cleanse your palate by eating a cracker and taking a sip of water.)

Please indicate the extent to which you like or dislike the tenderness, flavor, juiciness, and overall satisfaction of the beef labeled <i>triangle</i> .										
TRIANGLE	Tenderness	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
	Flavor	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
	Juiciness	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
	Satisfaction with overall eating quality	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>

(Remember to cleanse your palate by eating a cracker and taking a sip of water.)

Please indicate the extent to which you like or dislike the tenderness, flavor, juiciness, and overall satisfaction of the beef labeled <i>circle</i> .										
CIRCLE	Tenderness	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
	Flavor	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
	Juiciness	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
	Satisfaction with overall eating quality	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>

When you have finished Part A you may then build three identical sliders (small hamburgers) and take whatever side-dishes and drinks you like.

(B) Burgers labeled red, white, and blue (first bites)

Using the sliders labeled red, white, and blue, make identical burgers using the same toppings and in the same amount. Take one bite from each slider and then indicate below the extent to which you like the overall eating experience.

(Remember to cleanse your palate by eating a cracker and taking a sip of water between each bite.)

Red	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
White	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
Blue	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>

After you have finished your meal please complete all remaining questions.

(C) Burgers labeled red, white, and blue (after you are finished)

Now that you have finished eating, please indicate below the extent to which you like the overall eating experience.									
Red	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
White	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>
Blue	Like Extremely <input type="radio"/>	Like Very Much <input type="radio"/>	Like Moderately <input type="radio"/>	Like Slightly <input type="radio"/>	Neither Like nor Dislike <input type="radio"/>	Dislike Slightly <input type="radio"/>	Dislike Moderately <input type="radio"/>	Dislike Very Much <input type="radio"/>	Dislike Extremely <input type="radio"/>

(D) Food purchasing decisions

Imagine you are in the grocery store buying a package of ground beef. There are three ground beef options exactly the same as the options you tried today: red, white, and blue. For each of the following four questions that follow, please indicate which option you would be most likely to buy.

Which of the following would you purchase?

<i>Choice #1</i>	Red \$4.25/lb	White \$4.25/lb	Blue \$4.25/lb	If these were the only options, I would buy something else.
I would choose...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<i>Choice #2</i>	Red \$3.50/lb	White \$3.50/lb	Blue \$4.25/lb	If these were the only options, I would buy something else.
I would choose...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<i>Choice #3</i>	Red \$3.50/lb	White \$4.25/lb	Blue \$3.50/lb	If these were the only options, I would buy something else.
I would choose...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

<i>Choice #4</i>	Red \$4.25/lb	White \$3.50/lb	Blue \$3.50/lb	If these were the only options, I would buy something else.
I would choose...	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(E) What were these three products?

The three ground beef products may be different or they may be identical. If you believe they are different, can you speculate on how they are different?

_____ I think the red, white, and blue products are identical

_____ I think at least two of the products are different (*Please speculate in the box below how you think they are different. Are they cooked differently? Made from different types of meat? Any thoughts you have are welcome.*)

(F) A few more questions

(F.1) Please check all toppings and condiments you placed on your burgers. *Please check all that apply.*

 ketchup pickles mustard cheddar cheese BBQ sauce mayonnaise lettuce bun tomatoes white onions

(F.2) What is your gender? *Please check one.*

 male female other

(F.3) What is your age? _____ years

(F.4) How often do you eat hamburgers? *Please check one.*

 Frequently Rarely Never

(F.5) How often do you eat ground beef in the form of any food (for example, hamburgers, tacos)?
Please check one.

 Frequently Rarely Never

Section F

(F.6) How often do you or your household purchase ground beef? *Please check one.*

- At least once a week
- At least once every two weeks
- At least once a month
- At least once every two months
- Less than once every two months
- Never

(F.7) What is your pre-tax, annual household income level? *Please check one.*

- | | |
|--|--|
| <input type="checkbox"/> less than \$10,000 | <input type="checkbox"/> \$60,00 to \$69,999 |
| <input type="checkbox"/> \$10,00 to \$19,999 | <input type="checkbox"/> \$70,00 to \$79,999 |
| <input type="checkbox"/> \$20,00 to \$29,999 | <input type="checkbox"/> \$80,00 to \$89,999 |
| <input type="checkbox"/> \$30,00 to \$39,999 | <input type="checkbox"/> \$90,00 to \$99,999 |
| <input type="checkbox"/> \$40,00 to \$49,999 | <input type="checkbox"/> \$100,00 or more |
| <input type="checkbox"/> \$50,00 to \$59,999 | |

IF YOU ARE A COLLEGE STUDENT, PLEASE ANSWER THE FOLLOWING QUESTION.

(F.8) Which class best describes your status as a college student? *Check one.*

**Only for
respondents
who are
college
students**

- | | | |
|-----------------------------------|---|---------------------------------|
| <input type="checkbox"/> Freshman | <input type="checkbox"/> Sophomore | <input type="checkbox"/> Junior |
| <input type="checkbox"/> Senior | <input type="checkbox"/> Graduate student | <input type="checkbox"/> Other |

IF YOU ARE NOT A COLLEGE STUDENT, PLEASE ANSWER THE NEXT TWO QUESTIONS.

(F.9) Are you the primary shopper for your household? *Please check one.*

Yes

No

I share equally in the food purchasing decisions

**Only for
respondents
who are not
college
students**

(F.10) What is your relationship with OSU? *Please check one.*

Faculty

Staff

Other employment by
OSU

I am not employed by
OSU

(F.11) Overall, what did you think of your experience today? *Please check all that apply.*

I liked the food

I liked the atmosphere

The taste test was fun

The directions were clear
and easy to follow

APPENDIX C

NLOGIT Code

It should be noted that in the code below, ground beef types were identified as *OBLUE* (corresponds to ground beef not containing FTB), *ORED* (corresponds to ground beef containing maximum FTB), and *OWHITE* (corresponds to ground beef containing 15% FTB) to prevent researchers from knowing the true identity of the samples during the process of data analysis.

```
/*
CREATING NEW VARIABLES AND
IDENTIFYING DATA TO REJECT
    We throw out people who did not indicate their gender
        and anyone under the age of 18
        and anyone who didn't answer how often they purchase ground
beef
        and anyone who can't be clearly placed into an adult or
student category
*/
sample; all$

reject; gender<1$
reject; age<18$
reject; GrBeefBu<1$

create; anymeat=Oblue + Ored + Owhite $
create; if(gender=2) female=1$
create; if(gender=1) female=0$

/*
IDENTIFYING STUDENTS AND ADULTS
    A STUDENT is a freshman, sophomore, junior, or senior who is
under the age of 25
    We don't include those who say their student status is "other" in
fear they might not actually be students, nor do we include grad
students because they may
        be too similar to adults. We also exclude those who are older
than 25 from being a student.

    An ADULT is one who indicated they are faculty, staff, other
employment, or not employed by OSU, and are older than 25 years of age
*/
create; if(csclass=1) student=1$
create; if(csclass=2) student=1$
create; if(csclass=3) student=1$
create; if(csclass=4) student=1$
create; if(csclass=5) student=0$
create; if(csclass=6) student=0$
create; if(age>25) student=0$

create; if(NSatOSU>=1) adult=1$
create; if(age<=25) adult=0$

create; usehere=student + adult$
```

```

reject; usehere=0$

create; Ianymeat=anymeat*student$
create; Iprice=price*student$
create; Iobblue=obblue*student$
create; Iored=ored*student$
create; Iowwhite=owwhite*student$

create; Fanymeat=anymeat*female$
create; Fobblue=obblue*female$
create; Fored=ored*female$
create; Fowwhite=owwhite*female$
create; Fprice=price*female$

/*
IDENTIFYING WEIGHTS FOR USE IN WEIGHTED LIKELIHOOD ESTIMATION
*/

create; Nweight=7-GrBeefBu$

/*
TEST A

SEEING IF ALL THE MEATS ARE BASICALLY THE SAME.
Results of all tests are in the sheet LRtests.xlsx
*/

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs= Oblue,
Ored, Owhite, price$
nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs= anymeat,
price$

/*
TEST B

Allowing different preferences for students
*/

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs= Oblue,
Ored, Owhite, price, Iobblue, Iored, Iowwhite, Iprice$
nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs= anymeat,
price, Ianymeat, Iprice$

/*
TEST C

```

```

Allowing for different preferences between genders
*/

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs= Oblue,
Ored, Owhite, price, fobblue, fored, fowwhite, fprice$
nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs= anymeat,
price, fanymeat, fprice$

/*
TEST C.1
    Now weighting each observation based on how often ground beef is
purchased
*/

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone; rhs= Oblue, Ored,
Owhite, price;
wts=Nweight
$

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone; rhs= anymeat,
price;
wts=Nweight
$

/*
TEST D
    Now determining if there might be some latent classes in
preferences
*/

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs=Oblue,
Ored, Owhite, price;
$

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs=Oblue,
Ored, Owhite, price;
lcm;
pds=pds2; pts=2
$

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs=Oblue,
Ored, Owhite, price;
lcm;
pds=pds2; pts=3
$

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs=Oblue,
Ored, Owhite, price;
lcm;
pds=pds2; pts=4
$

```

```

/*
TEST E
    Okay, from AIC and BIC it is not clear whether there are latent
classes. AIC says use lots of classes and BIC says use none. Let us
strike a compromise and use 2 latent classes to see if there
    is a preference for one beef over the other
*/

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs=Oblue,
Ored, Owhite, price;
lcm;
pds=pds2; pts=2
$

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs=anymeat,
price;
lcm;
pds=pds2; pts=2
$

/*
TEST F
    Now allowing three latent classes
*/

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs=Oblue,
Ored, Owhite, price;
lcm;
pds=pds2; pts=3
$

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs=anymeat,
price;
lcm;
pds=pds2; pts=3
$

/*
TEST F
    Three latent classes seems to give us something, so now let us
see which is really different from the others, red, blue, or white?
*/

create; BlueRed=Oblue + Ored $
create; BlueWhit=Oblue + Owhite $
create; RedWhite=Owhite + Ored $

nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs=BlueRed,
OWhite, price;
lcm;
pds=pds2; pts=3
$

```



```
nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs=RedWhite,
OBlue, price;
lcm;
pds=pds2; pts=3
$
```

```
nlogit; lhs=best; choices=Cblue, Cred, Cwhite, Cnone;   rhs=BlueWhit,
ored, price;
lcm;
pds=pds2; pts=3
$
```

```
/*
END OF ANALYSIS OF CHOICE EXPERIMENTS
*/
```

```
/*
Now running ordered logit estimates for RED1BIT ... BLUE2BIT
need to only use observations where question = 1 and options = 1
```

```
Note in surveys 128, 153, 175, 187 they did not complete the ratings so
we discard those observations
*/
```

```
reject; QUESTION>1$
reject; OPTIONS>1$
reject; survey=128$
reject; survey=153$
reject; survey=175$
reject; survey=187$
```

```
create; Rbitel=red1bite-1$
create; Wbitel=white1bi-1$
create; Bbitel=blue1bit-1$
```

```
create; Rbite2=red2bite-1$
create; Wbite2=white2bi-1$
create; Bbite2=blue2bit-1$
```

```
DSTAT; rhs=question, options, Rbitel, Bbite2$
```

VITA

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Master of Science

Thesis: CONSUMER PREFERENCES FOR FINELY TEXTURED BEEF (FTB) IN
GROUND BEEF FORMULATIONS

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