Consumer Preference for Goat Meat in a Blind Sensory Analysis

Kelyn Jacques\textsuperscript{1} and F. Bailey Norwood\textsuperscript{1,2}

\textsuperscript{1} Department of Agricultural Economics, Oklahoma State University

\textsuperscript{2} Corresponding Author: Dr. F. Bailey Norwood, Dept. of Agricultural Economics, Oklahoma State University, 426 Agricultural Hall, Stillwater, OK 74078; Phone: 405-334-0010; Email: bailey.norwood@gmail.com

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Summary

Though consumed only rarely by Americans, goat meat is commonly eaten around the world, but it is unclear whether this is due to its taste or some other reason. A blind sensory analysis was performed to study U.S. consumer preferences for goat meat compared to beef and pork. Goat shoulder, beef brisket, and pork shoulder were all slow cooked and shredded, and a group of consumers in the State of Oklahoma rated each meat using a 9-point hedonic scale in four categories. Although goat received favorable ratings for tenderness, juiciness, and flavor, ratings for pork and beef were slightly higher. These results help demonstrate why Americans consume more beef and pork than goat, but does not explain why goat is consumed so seldom.

Keywords: Sensory Analysis, Goat Meat, Flavor, Juiciness, Taste, Goat
Introduction

Goat is among the most widely consumed livestock in the world, with much of the population eating goat meat as part of their regular diet (Biswa et al. 2007). This may come as a surprise to Americans because goat meat is rarely included in their diet. When Americans consume meat it usually consists of beef, pork, or poultry. While goat is not favored in western countries, it is popular among developing countries, making up 90 percent of the goat inventory worldwide (Webb et al., 2005). Even in developing countries, however, goat is sometimes seen as a poor person’s food, and raising or eating goat signifies a lack of success (Dubeuf et al., 2004; Morand-Fehr et al. 2004). Nonetheless, more people are consuming goats than ever before (FAO, 2015), and as goat production continues to rise and Americans seek to diversify their agricultural production, goat may deserve a second look.

In 2012 meat-goat production was said to be the most rapidly expanding animal enterprise in the country (Jones, et. al., 2015). Slaughter of goats in federally inspected facilities has risen from just over 200,000 head in 1988 to 589,100 in 2011. Although those numbers fell to 448,800 head in 2016, they are still considerably higher than their 1988 level (NASS, 2017). The rise in goat production was exceeded by consumption increases, as the United States became a net importer of goat in 1991 (Sande, et. al., 2005). The number of imports since then has risen from 1,749 metric tons to 15,752 metric tons in 2011 (Stanton, 2012). This rise in demand has been attributed to 1. a more ethnically diverse America, 2. a keener interest in health foods, and 3. interest in goat from a culinary perspective (Sande, et. al., 2005).

Although the rise in goat demand is good for the goat industry, it could rise much further if the average American began eating goat. The Center for Disease Control and Prevention interviewed 65,536 individuals regarding their food consumption, asking them to keep a food journal for two days out of the year, but only seven out of the 65,536 people ate any goat during those two days. Not only is goat seldom consumed, it does not have a good reputation among Americans. Knight et al. (2005) found in a telephone survey that over 50 percent of individuals were unwilling to even try goat meat, and that people perceive the meat as inexpensive but inconvenient.

It is unclear why goat meat is absent from most kitchen tables and restaurants: is it a supply or demand issue, or both? There is some evidence it is the taste of goat meat that keeps demand low, but much of the evidence is decades old, whereas consumers now seem more adventurous in their food consumption, and few recent evaluations have been conducted. Moreover, limited evidence exists on the likeability of different attributes of goat meat. To further investigate the role of taste in goat meat’s minor role in American food consumption, this study conducts a sensory analysis of shredded goat shoulder meat to 1. determine individuals’ overall satisfaction of goat meat compared to pork and beef, 2. evaluate the distinctness of goat meat compared to pork and beef, and 3. study how the flavor, juiciness, and tenderness of goat meat contributes to its overall likeability.

Materials and Methods

To determine how people rate their eating experiences between goat, pork, and beef, a blind sensory analysis was conducted. The goats were acquired by the Sheep and Goat Center at Oklahoma State University, butchered at a live weight of around 100 lbs, and processed and prepared by a federally inspected facility. All were Boer meat-goat breeds, and although meat from the entire carcass was cooked only shredded meat from the goat shoulder was used in the sensory analysis.

To compare the sensory attributes of goat relative to two other common meats, pork shoulders and beef briskets were acquired from a nearby supplier. Beef brisket instead of beef shoulder was used because, while pork and goat shoulder are a frequently used cut for making shredded barbeque meat, barbeque beef is typically acquired from the brisket. Rather than focusing on identical components of the carcass across the three animal types, we focused on the components that would most likely be used to make shredded, barbeque meat. It is possible that the results would differ had beef shoulder meat had been used.

The pork and beef were seasoned, cooked, and shredded identically to the goat, and each were cooked intact and only shredded after cooking. All three meats were seasoned liberally with Legg’s Old Plantation Seasoning Prime Rib Rub. The meats were then cooked in the same cooker/ smoker as follows: cooked 160°F (dry bulb temperature) for one hour, smoked at 170 °F for two hours, and

Figure 1. Steps 1 & 2 of sensory experiment.

1. Goat shoulder, beef brisket, and pork shoulders are prepared using identical spices and cooked under identical environments, then shredded.

2. Samples of each meat are then placed in containers labeled only with shapes. The shape associated with each meat is randomized.

Note: Photo in background is from the experiment.
then cooked at 190 °F for four hours. As can be seen in Figure 1, the three meats seem to be similar in their final texture and appearance.

A sensory analysis was designed to measure the tenderness, juiciness, flavor, and overall eating experience of the three meats by non-trained panels of Midwestern consumers. The analysis was conducted at two locations to acquire an adult and student sample. The first location was at a local precision agriculture software business in Stillwater, Okla. and the other was a student social gathering on the Oklahoma State University campus. Both experiments provided the participants with a free meal in exchange for partaking in the survey. Respondents from the two locations will be referred to as adults and students, respectively.

Table 1 shows the overall demographics of the participants. The student set contains 57 observations, with both genders represented equally, and an average age of 22. The adult sample is heavily dominated by males, making up over 75 percent of the observations, and is about thirteen years older than the students. Although the samples differed in many ways, both groups consume goat only rarely but pork and beef frequently.

### Hedonics

The objective of this study is to determine how people rate their satisfaction of goat meat compared to pork and beef. Asking consumers directly about their preferences for goat is problematic because only a minority of people have consumed goat, and it may have an unwarranted reputation that influences the meat flavor. Participants must be allowed to taste the three different meats without knowing the identities to allow their responses to measure goat meat’s true experience attributes. This was accomplished by placing each meat into individual cups labeled only as square, circle, or triangle, as shown in Figure 1. The meat associated with each shape was randomized across respondents. Additionally, participants were provided water and unsalted crackers to cleanse their palate before tasting each meat.

The questionnaire asked subjects to indicate the extent to which they liked the tenderness, flavor, juiciness, and overall satisfaction of each meat. The standard 9-point hedonic scale shown in Figure 2 was used (Stone, et. al., 2012), and the questionnaire reminded the subject to bite a cracker and take a sip of water between each meat.

After ranking each meat according to these four attributes participants were asked to rank the three meats (identified only by shapes) corresponding to which was their favorite, where 1 = most favorite. This forces individuals to indicate a preferred meat even if they gave two, or even all three, meats identical ratings on the hedonic scale. The order in which the three shapes were listed was randomized across each questionnaire. The survey asked a number of demographic questions in addition to how often the participant consumed a variety of different meats.

In order to determine which meats were preferred in terms of the four attributes (tenderness, flavor, juiciness, and overall satisfaction) we conducted a simple sign test. The sign test is non-parametric, meaning that it has few assumptions about the nature of the distribution of the test. We paired goat to pork, goat to beef, and finally, beef to pork. Consider a pairing of meat x and y. The comparison has three possible outcomes, x>y, x=y, or x<y. The hypothesis tests defines

\[
P = \frac{\sum_{i=1}^{n} I(x_i > y_i)}{n}
\]

Table 1. Summary of subjects.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Student (N=57)</th>
<th>Adult (N=31)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>51.9%</td>
<td>80.6%</td>
</tr>
<tr>
<td>Age (average)</td>
<td>22</td>
<td>35</td>
</tr>
<tr>
<td>Consumes the meat occasionally or frequently:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goat</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Beef</td>
<td>100%</td>
<td>97%</td>
</tr>
<tr>
<td>Pork</td>
<td>89.9%</td>
<td>87%</td>
</tr>
<tr>
<td>Chicken</td>
<td>98%</td>
<td>100%</td>
</tr>
<tr>
<td>Wildlife</td>
<td>33%</td>
<td>36%</td>
</tr>
<tr>
<td>Percent who agree that meat is:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humanely Raised</td>
<td>82%</td>
<td>84%</td>
</tr>
<tr>
<td>Easy Food Poison Carrier</td>
<td>54%</td>
<td>61%</td>
</tr>
<tr>
<td>Tasty</td>
<td>96%</td>
<td>100%</td>
</tr>
<tr>
<td>Environmentally Friendly</td>
<td>91%</td>
<td>74%</td>
</tr>
<tr>
<td>Reasonably Priced</td>
<td>63%</td>
<td>19%</td>
</tr>
<tr>
<td>Healthy</td>
<td>98%</td>
<td>90%</td>
</tr>
</tbody>
</table>
Pr(x > y | x ≠ y) and then evaluates the null hypothesis that \( P = 0.50 \). Simply put, the null hypothesis says that given a random set of values \( (x, y) \) it is equally possible for \( x \) and \( y \) to be larger than the other.

**Ranking**

The average ranking of the student and adult populations were found by taking the average ranking of each meat: goat, beef, and pork. When asked to rank the meats each respondent was to assign a unique ranking of 1 to their favorite meat and a 3 to their least favorite meat. However, we reversed the rankings so that 1 is the least favorite meat and 3 is the favorite meat, so hereafter a higher number refers to a higher, more desirable ranking.

To test whether the beef and pork rankings are statistically different from the goat ranking, the ranking data are also analyzed using the rank-ordered logit regression in the program STATA. This model assumes that the overall utility or satisfaction from any one meat can be described by the random utility model in (1), where each respondent, \( i \), has a certain utility, \( U_{ij} \), for every choice, \( j \), where \( j = 1, 2, 3 \) and \( V_{ij} \) represents the systematic component. The random component, \( \varepsilon_{ij} \), is assumed to follow a Type II Extreme Value Distribution.

\[
(1) U_{ij} = V_{ij} + \varepsilon_{ij} = \beta_0 (\text{GOAT}_{ij}) + \beta_1 (\text{BEEF}_{ij}) + \beta_2 (\text{PORK}_{ij}) + \varepsilon_{ij}
\]

The variable \( \text{BEEF} = 1 \) if the meat being evaluated is beef; otherwise it equals zero. Likewise, \( \text{PORK} = 1 \) if it is pork and if it is not then \( \text{PORK} = 0 \). Although the variable \( \text{GOAT} \) goes by a similar definition, the coefficient \( \beta_0 \) must be normalized to equal zero (or else the model is not identified), so the equation could be written without the term \( \beta_0 (\text{GOAT}_{ij}) \). Thus, if the meat being considered is goat then \( \text{BEEF} = \text{PORK} = 0 \) and the systematic utility is normalized to equal zero. The coefficients \( \beta_1 \) and \( \beta_2 \) are coefficients to be estimated using maximum likelihood. The sign and statistical significance of the coefficients \( \beta_1 \) and \( \beta_2 \) describe the ranking of beef and pork, respectively, relative to goat. For example, if \( \beta_1 \) is positive and statistically significant, then beef tends to be ranked higher (meaning better) than goat, on average.

Another advantage of the rank-ordered logit model is that it provides an intuitive way of expressing the rankings in terms of consumer choice. Due to the assumption of the error term in (1), the probability that an individual will rank goat over beef is given by the equation

\[
\exp(\beta_0) / \left[ \exp(\beta_0) + \exp(\beta_1) \right]
\]

allowing us to calculate the percentage of subjects who, when given the choice (based on taste alone) between goat or beef, would choose goat.

**Results and Discussion**

A total of 88 individuals participated in the sensory analysis, however some of these observations were excluded. Eight respondents who answered in an incorrect format, such as ranking only one of the three meats and leaving the other two blank, were omitted from the final analysis.

Figure 3. Percent of subjects who rate each meat higher than the other according to tenderness, flavor, juiciness, and overall satisfaction (* denotes statistically significance in a one-tail test at the 95% confidence level).

<table>
<thead>
<tr>
<th>Tenderness</th>
<th>Flavor</th>
<th>Juiciness</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goat vs Pork</td>
<td>Goat vs Beef</td>
<td>Goat vs Pork</td>
<td>Goat vs Beef</td>
</tr>
<tr>
<td>Equal 23%</td>
<td>25%</td>
<td>19%</td>
<td>Equal 22%</td>
</tr>
<tr>
<td>Goat 23%</td>
<td>28%</td>
<td>26%</td>
<td>Goat 23%</td>
</tr>
<tr>
<td>Pork 55%</td>
<td>37%</td>
<td>40%</td>
<td>Beef 40%</td>
</tr>
</tbody>
</table>

**Hedonic Results**

First, the percent of times each meat was assigned a higher sensory rating than another for all four attributes (tenderness, juiciness, flavor, and overall satisfaction) was calculated and is shown in Figure 3. A meat is considered superior in any one attribute if the probability of an individual assigning it a higher rating is greater than 50 percent, and a non-parametric sign test is used to statistically test whether this is the case. For example, Figure 2 shows that in regards to juiciness, people assign pork a higher rating 43 percent of the time and goat a higher rating 33 percent of the time, with 24 percent of people assigning them an equal rating.

Is the 43 percent sufficiently higher than 33 percent to conclude that pork...
has a better juiciness profile? The sign test evaluates this by first distributing the 24 percent of equal ratings equally between pork and goat, making the percentage for pork and goat 55 percent and 45 percent, respectively, and then testing the hypothesis that the 55 percent is not statistically different from 50 percent (Dixon and Mood, 1946). If it is not, then we cannot really say that pork has a better juiciness quality than goat. Indeed, Figure 3 shows that it is not statistically different (using a one-tail test at the 95 percent level), and so we conclude that people like the juiciness of pork and goat about the same.

Consider the first pie chart in the top-left of Figure 3. This shows that 55 percent of the time the tenderness of pork was preferred to the tenderness of goat, 23 percent percent of the time the opposite occurred, and 22 percent of the time both received equal hedonic scores for tenderness. As indicated in the figure, the sign test shows that for those cases where one meat was rated higher, more than 50 percent of the time pork received the higher rating. This doesn’t prove that pork is tenderer than goat, but it does suggest that consumers like the tenderness attribute of pork above that of goat. Move one pie chart to the right, and it shows that 37 percent of people preferred the tenderness of beef to that of goat, with 29 percent rating them equal. These numbers suggest that consumers like the tenderness of goat and beef the same, and the sign test confirms this.

The tenderness, flavor, juiciness, and overall satisfaction of pork was consistently favored over goat; and with the exception of juiciness, pork was also preferred to beef. However, in only a few instances were the differences statistically significant. Taking into account the sign-test we can only say that a. pork has a higher tenderness and flavor rating than goat, b. beef has a higher juiciness and overall satisfaction rating than goat, and c. pork has a higher tenderness rating than beef.

Roughly one-third of individuals rated goat higher than pork and beef overall, so goat does appeal to a considerable number of people. Nonetheless, in every comparison and every attribute beef and pork were rated higher than goat. Still, while goat does not outperform beef and pork in taste tests, it competes well and is received favorably among many.

The histograms in Figure 4 testify to this result. Most of the respondents indicated they do like the tenderness, flavor, juiciness, and overall satisfaction of goat meat. However, as in the sign test it appears that pork is preferred over goat and beef. Nevertheless, there is little variation between the attributes, in that roughly the same number of people liked its tenderness, flavor, and juiciness, so goat performs well on all three measures—as does pork and beef. This suggests similarities among the meats, as one was not considered much more tough, distasteful, or dry than the others.

The similarities in the ratings between the three meats begs the question of whether the meats were distinct from one another. To test this we asked participants to select which two meats were the most similar and which one meat was most distinct. Given that the majority of the participants reported they never eat goat (Table 1), we suspected that goat meat would be the most distinct out of the three meats, but this suspicion was wrong. Figure 5, next page, shows that the majority, 50 percent, of participants found that pork was the most distinct followed by beef (29 percent) then goat (21 percent). This is surprising. Goat, which would be considered a novelty food to most Americans, was actually more similar to beef than pork. However novel the idea of eating goat may be, the actual eating experience is rather ordinary.

**Ranking Results**

Finally, we analyzed the average rankings of each meat. Participants were asked to rank each meat giving their most favorite a ‘1’, next favorite a ‘2’, and least favorite a ‘3’, but these were recoded so that ‘3’ denotes their favorite and ‘1’ their least favorite. In Figure 6 we see the average rankings of the adult and students surveyed. While adults prefer beef, we see that students prefer pork. Although neither group prefers goat, it does have a ranking higher than 1, meaning that it is not consistently the least favorite meat.

It is difficult to tell from Figure 6 whether the rankings for beef and pork are higher than goat for the entire sample. Beef and goat are ranked about the same for students, and pork and goat are ranked similarly for adults. This test is
made using the estimates of the rank-ordered logit model below. Notice that both beef and pork have positive coefficients (the coefficient for goat meat is zero by definition), and since the p-values are less than 0.05 we can conclude they are statistically significant as well. These estimates suggest an equation detailing the utility/satisfaction subjects receive from each meat goes by the equation: 

\[
\text{utility} = 0.00(\text{Goat}) + 0.429(\text{Beef}) + 0.448(\text{Pork}).
\]

When eating goat the utility is 0.00, when eating beef the utility is 0.429, and when eating pork utility is 0.448. Another way of interpreting this equation is to note that, if given the choice between goat or beef, and the person made their choice based solely on blind taste, there is only a \(\frac{e^0}{e^0 + e^{0.429}} = 39\%\) percent chance they would choose goat but a \(\frac{e^{0.429}}{e^0 + e^{0.429}} = 61\%\) percent chance they would choose beef. If given the choice between pork and goat, the percentages (after rounding) are the same. So although beef and pork are definitely ranked higher than goat for the sample as a whole, when given the choice between beef and goat or pork and goat, about a third of the subjects would still choose the goat.

**Discussion**

We evaluated Midwestern-consumer preferences for shredded, slow-cooked goat meat in comparison to two commonly consumed red meats: pork and beef. Although consumers preferred the pork and beef to goat, they still viewed goat meat favorably. A meat type does not have to be the highest ranked meat to find a permanent place at Americans’ dinner tables, so long as people possess different tastes and desire variety. Whatever the reason goat is seldom eaten in the United States, its taste is not the obvious one.

This study was conducted on the basis that goat’s rare dinner table appearance is a curious fact and that only a few studies have compared its taste to other popular meats. Two notable exceptions are Rhee, Myers, & Waldron (2003) and Degner and Lin (1988), who also used untrained subjects in a blind taste test, but their experiments differed in a number of ways. The Rhee study compared unseasoned ground beef and goat, both made from various cuts of the animal carcass, whereas our study focused on shredded shoulder and chest meat and provided identical seasoning to both. Using unseasoned meat, it is not surprising that the Rhee study found lower overall hedonic scores (they used the same 9-point scale) than those in our study. What is surprising is that the Rhee study found that their subjects tended to prefer whatever meat they ate first. Goat was preferred to beef, so long as goat was tasted first (and vice-versa). However, this preference effect was not present in our data, as goat’s overall score for satisfaction was lowest when it was tasted first.

The Degner study better resembled...
our experimental design in that the beef and goat were slow-cooked and presented in a blind taste test, but differed in that their meat was cut into 0.5 inch cubes (instead of shredded) and no seasonings were used (we used seasonings). They did, however, allow their subjects access to salt shakers. They used only the bottom rounds of the beef carcass and most of the whole goat carcass, so our study differs in this respect as well. Subjects in the Degner study were on average indifferent between the two meats, rating both about the same in regards to tenderness, flavor, and overall appeal. Goat was appraised as too dry, as opposed to beef’s ‘just right’ juicy rating, but still the authors conclude that, “In terms of the meats’ smell, overall taste and overall appeal, the ratings suggest that participants did not have strong preferences toward either of the meats,” (Degner and Lin, 1988, page 7).

In all studies considered, including the present one, when goat is compared to other familiar meats in a taste test, it performs well. This does not imply that many consumers will purchase goat meat, though. If individuals knew the identities of the meats they might penalize or reward goat based on perceptions independent of its actual taste. Preconceived notions not only affect demand for products but the actual perception of taste. This is why people claim to prefer the taste of regular meat falsely labeled as humanely raised (Anderson and Barrett, 2016), and prefer the taste of regular tomatoes falsely labeled as organic (Johansson, et. al., 1999).

A bias against goat meat might arise if it is perceived as undesirable. Some might assume it is not good simply because so few stores or restaurants serve it. A recent internet survey found that most Americans perceive the taste of goat meat to be “neither tasty nor untasty” suggesting that for the average person they are neither biased against or for it. However, this rating was considerably lower than that for beef, so most people do expect beef to taste better than goat meat (Lusk, 2016). Moreover, a telephone study by Knight et. al. (2006) found that 57 percent of respondents in southeastern states were unwilling to consume goat meat, so there does seem an aversion to the meat from a considerable number of people. These considerations might cause goat meat to be rated higher in a blind taste test compared to a setting where they knew the identity of the meat.

On the other hand, those displaying a social desirability bias might rate the goat meat higher than it would in a blind taste test. If a researcher is advertising free samples of goat meat, then subjects might perceive the researchers are interested in promoting the product, and in appreciation for the sample may tell the researcher they like it more than they really do.

The fact that preconceived notions and social desirability bias impacts taste perceptions makes the study by Nelson et. al. (2004) less relevant to the present study, as they asked people to taste barbecued goat meat in a context where people knew what they were eating. Nevertheless, the Nelson study does provide insights into the acceptability of goat meat, so it is worth noting that although after tasting the goat most people indicated it was as good as beef or pork barbeque. Although they only tasted goat barbeque, they were asked to first rate it compared to beef barbeque and then compare it to pork barbeque. When the subjects did not rate it “about the same” as beef or pork barbeque, they tended to rate goat better than beef barbeque but not as good as pork barbeque. This preference for pork relative to beef and goat is probably related to the location of the experiment. Barbeque in the southeast is dominated by pork, and so by holding the experiment in Georgia, it was natural that pork would be rated highest. Regardless, the Nelson study concurs with our findings that even if goat is not considered the superior tasting meat, it is certainly acceptable and provides a pleasurable eating experience to many.

Table 2. Estimate of rank ordered logit model (N = 80).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient (P-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goat</td>
<td>0.000</td>
</tr>
<tr>
<td>Beef</td>
<td>0.049</td>
</tr>
<tr>
<td>Pork</td>
<td>0.035</td>
</tr>
</tbody>
</table>

Conclusion

Although it appears pork and beef producers do not need to fret about the potential of goat meat taking a large portion of their consumers, it is evident that people find goat meat to be palatable. The present study, which compared pork and beef directly to goat, found goat to be the least favored meat of the three but nevertheless receiving favorable ratings. While we are located in a college town with a variety of people, our study was skewed with a majority of the participants being Caucasians. Considering previous studies suggested that Hispanics and African Americans were more likely to be consumers of goat meat, this may have had an effect on our results. Another drawback to our study is the blind taste test. Since the participants were not aware of what they were eating, their shopping preferences were not evident. While this is desirable for evaluating the experience attributes of meats, it cannot be used to predict actual store purchases. Finally, we chose to season all three meats which may have masked the flavor of the three meats giving them all a similar taste resulting in most of the hedonic scores falling in a small, close range. Having established that goat meat is enjoyable to most of the participants leads us to believe that there is a need for future research in this area to discover why goat meat is seldom eaten in the United States.

Literature Cited


