Customer Satisfaction and National Tenderness Survey

Jason M Scheffler[1]

[1] UF/IFAS Department of Animal Sciences, Gainesville, FL

The primary end product of cattle production is beef, thus the profitability of cattle producers is dictated by the value placed on that end product. In Florida, the primary product is a weaned calf that is often headed out of the state on a truck to backgrounders, stockers, and feedlots further west. It is easy to be insulated from the market cues at the end product level. However, as consumer demand for beef increases or decreases, the change in value is passed on through the entire system and will inevitably be felt by cow-calf producers. Therefore it is important to recognize the contribution of each segment of cattle production to end consumer satisfaction.

Palatability

Palatability of beef is primarily dependent on three major factors: flavor, juiciness, and tenderness (Smith et al., 1974). For decades, the beef industry in particular, and the meat industry as a whole, have been supporting work on improving these traits to maintain or increase consumer demand. A recent meta-analysis of 11 studies including 1,500 beef samples and 1,800 consumers indicated that about 43% of the variation predicting overall palatability was attributed to flavor, 7% to juiciness, and 49% to tenderness (O'Quinn et al., 2018). Combined, those three factors account for over 99% of the variation in predicting overall palatability. Surprisingly, they did not find an interaction between those three factors nor was there appreciable error in the prediction that could be attributed to other factors.

Flavor is perhaps the most difficult target to hit as consumers have a wide variety of preference with one person's desirable flavor being another's off flavor. Perception of flavor is a complex interaction of the taste buds of the tongue (sweet, sour, bitter, salty, and umamai), perception of aroma by the olfactory bulb, and somatosensory perception by trigeminal nerves (Kerth and Miller, 2015). Flavor compounds are largely produced through degradation of lipids by heat, non-enzymatic browning or Maillard reaction, and the interaction of lipids and Maillard products (Kerth and Miller, 2015) but is certainly an oversimplified summary of all the processes contributing to perception of flavor.

Juiciness is primarily attributed to fat content (Egbert et al., 1991) and degree of doneness (O'Quinn et al., 2012). As degree of marbling increases, so too does the perception of juiciness. There is a perception that increased marbling provides "insurance" against overcooking; higher levels of marbling can be subjected to a wider range of degree of doneness and still be considered palatable. However, recent work indicates that this may not be the case. Higher degrees of doneness reduces palatability independent of marbling level; higher marbling levels did not show any protective effect (Lucherk et al., 2016). Taken together, these data indicate both improving marbling and educating consumers on cookery are needed to improve eating experience.

Improvement of beef tenderness has been an important area research for at least the last three decades. Different assessments of willingness-to-pay indicate consumers may pay an additional $1-2 per lbs if they can be assured of a more tender product (Lusk et al. 2001, Igo et al. 2013). To capture the changes in tenderness The National Beef Tenderness Survey has been conducted periodically over that period to benchmark changes in tenderness over that period (Morgan et al., 1991; Brooks et al., 2000; Voges et al., 2007; Guelker et al., 2013; Igo et al., 2015; Martinez et al., 2017). If we compare the 2015 audit with the

1998 audit (Figure 1), we see a 23-27% improvement in Warner-Bratzler shear force (WBSF) in the retail top loin, boneless ribeye, top sirloin, and bottom round (Brooks et al., 2000; Martinez et al., 2017).

Changes in how meat is sorted and distributed down different supply chains may have an influence. The 2015 audit shows top loin steaks sold to foodservice had 23% higher WBSF than those sold at retail (Martinez et al., 2017). Ribeye steaks had 44% higher WBSF. When comparing the 2015 audit to the 2006 audit (Voges et al., 2007; Martinez et al., 2017), the percentage of ribeyes, top loins, and top sirloins considered very tender (WBSF < 7.05 lbs) has decreased 15.5%, 7.1%, and 6.2%, respectively. When coupled with an observed reduction in packer and store brands, it may indicate that other branding programs may be successful in sorting more tender beef.

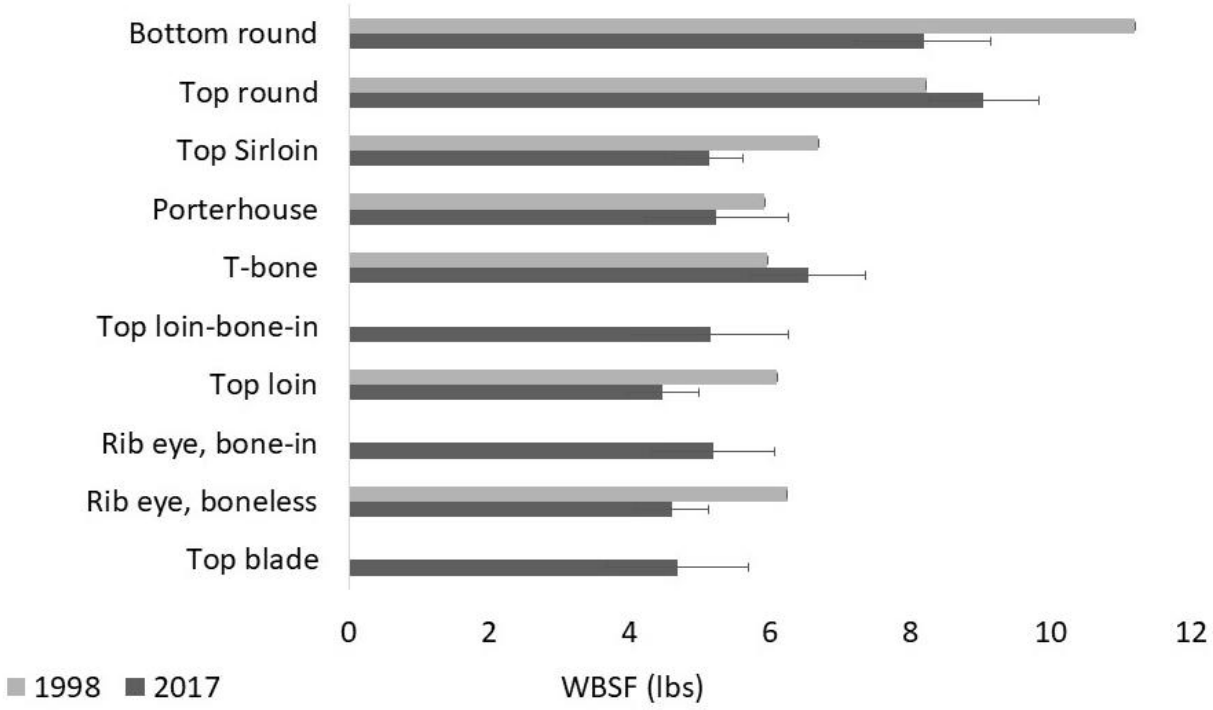

Figure 1. Warner-Bratzler shear force values of selected retail steaks. Adapted from Brooks et al. 1998 and Martinez et al. 2015. Data are presented as mean ± SEM; SEM from Martinez et al 2015 was not provided.

A common, and not surprising, observation across all the tenderness audits is differential in tenderness between muscles of the round (top and bottom round) and muscles of the rib and loin. Functional differences between muscle groups contribute to most of the difference so it is unlikely top round will ever be as tender as a top loin. However, there was still improvement, at least in the bottom round. Improved tenderness may lend that muscle to new applications which could improve carcass value.

Tenderness

While there have been some improvements in beef tenderness over the last three decades, it is possible to look at the data and be somewhat disappointed that we have not made more progress considering the resources allocated to addressing this challenge. Tenderness is very complicated trait that is the function of intramuscular fat (Duckett and Pratt, 2014), myofibrillar protein degradation (Huff Lonergan et al., 2010), and connective tissue (Purslow et al., 2011). In some cases, changes in some of those traits may be antagonistic to more economically important traits like growth and feed efficiency.

In the 1990's Olson et al (2000) tried selecting for improved WBSF in Angus bulls over several generations at the University of Florida. High and low WBSF bulls were utilized for breeding the Angus herd at the Santa Fe Ranch and Beef Research Unit expecting to demonstrate divergence in WBSF for further study. However, both high and low WBSF groups showed reduction in WBSF over five generations. However an interesting comment in the summary that selection for meat quality traits "may have unintended consequences such as losses in other traits such as growth rate, live or carcass weight, muscling (ribeye area) and even in maternal traits such as fertility and milk yield" perhaps alluding to observed issues with the study cohort.

Intramuscular fat or marbling can be improved with genetic selection, while carcasses can be sorted and valuated based on USDA quality grade. The industry had made steady progress increasing the percentage of USDA Prime and Choice carcasses as indicated by the National Beef Quality Audit (Boykin et al., 2017).

Myofibrilar degradation utilizes enzymes involved in protein degradation in the living animal. The primary enzyme associated with tenderization is the calcium-activated protease, calpain. (Goll et al., 1998; Huff Lonergan et al., 2010). This protease is activated by intracellular calcium, autolyzes, and cleaves several target proteins found to be degraded during post mortem metabolism. Myofibrillar degradation can be improved, to an extent, with carcass aging (Colle et al., 2015). An inhibitor of calpain is calpastatin. Both the abundance and activity of calpastatin appear to influence tenderness. Brahman cattle have higher calpastatin activity (Pringle et al., 1999) and content (Wright et al., 2018) that may partly explain the variation in tenderness, but with aging, calpastatatin in both Brahman and Angus cattle is degraded. Perhaps the biggest challenge is the recognition that caplains and calpastatin have activity in the living animal. Protein accretion is the net result of synthesis and breakdown. Increased calpain activity may result in more protein turnover in the living animal resulting in slower, less efficient growth. The value of more tender product will likely not offset increased feed costs or fewer pounds of salable product. We simply cannot just select for more calpain or less calpastatin without recognizing the ramifications on animal growth.

Connective tissue is found in the extracellular matrix (ECM), a complex network of proteins that provide structural support to the muscle fibers. Collagen is the primary protein of the ECM and is often the target of research investigating muscle tenderness. As the animal ages, the amount of collagen increases, as does the amount crosslinks between collagen fibers (McCormick, 1999). More mature collagen cross-links are more heat stable and less likely to solubilize during cooking (McCormick, 1994). The challenges with connective tissue include no genetic selection markers, very broad sorting parameters like carcass maturity, no improvement with aging (Purslow, 2005; Nishimura, 2015).

Conclusions

Improving beef palatability continues to be an important endeavor that will contribute to the profitiability of beef producers. Consumers have indicated they would be willing to pay more for products with an assurance of being more tender. Current efforts in improving tenderness are producing slow, but steady progress. Advances in beef tenderness need to be balanced against other economically important traits to ensure a net gain.

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