Meat Quality and Thermotolerance in *Bos Indicus* Influenced Cattle

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Meat Quality

Beef product quality is a top priority for beef industry - because it has a great power to influence demand and also because the beef industry has the ability to improve it. Great effort was dedicated to understanding how consumers perceive beef quality and all studies point out that the strongest quality attributes are tenderness, juiciness, and flavor, followed by healthiness and nutritional value. These issues are of particular importance for Brahman crosses as they are routinely penalized for inadequate tenderness and relatively low marbling score.

The relationship between the USDA quality grade and tenderness is an important one, because the beef industry is using the USDA grading system to determine premium and discounts, to predict the palatability of the meat from a beef carcass and to communicate it to the consumers. However, we believe that the system has a limited ability to predict eating quality, and substantial variation in the degree of tenderness exists within each quality grade. This relationship is even more important to characterize in crossbred cattle, which are routinely penalized for inadequate tenderness and relatively low marbling score. A dataset of 1,360 animals spanning the range from 100% Angus to 100% Brahman with Warner-Bratzler shear force (WBSF) and USDA quality grade was used to investigate this relationship. The WBSF is an objective measure of tenderness and it measures the force required to shear a cooked steak (in kg) – the lower the number, the less force is required indicating a more tender steak. The USDA - Agricultural Marketing Service is engaged in designing standards to indicate the degree of tenderness for beef. In this program, a steak with a WBSF < 4.2 kg is considered tender and a steak with WBSF < 3.7 kg is considered very tender. The average WBSF for the population used in this study was 3.98 kg and, using the USDA-AMS standard, 37% of our animals would be considered tough, 15% tender and 48% would qualify as very tender.

Based on USDA grading system, cattle in our data were classified as *Standard* (5.6%), *Select* (47.1%), *Choice-* (32.1%), *Choice* (10.8%), *Choice+* (3.4%) and *Prime* (1.2%). The scatterplot in Figure 1 shows the distribution of our cattle across these quality grades and their respective toughness/tenderness measured by WBSF. There are three important points to take from this figure:

1. There is considerable variation in the degree of tenderness across all quality grades. There is a small trend in the average tenderness across quality grades, described by the solid line, indicating that on average steaks from higher quality grades tend to be more tender (lower WBSF). However, it is also clear that, most of the variability in tenderness is within a quality grades and not between grades. The tenderness of steaks from carcasses graded *Select* or *Choice* (the majority of our animals) varied from very tender to very tough. This highlights the limitation of the USDA grading system to predict eating quality or tenderness.

2. On the right side of the graph, for steaks graded higher (*Choice* and *Choice+*), about 34% are in fact "tough" based on WBSF. Consumers buying these steaks are paying a premium and they expect a high-quality product, but 34% of the time, they will end up with a tough steak and therefore a less then desirable eating experience. This in the long run will translate into decreased beef demand negatively impacting all sectors of the beef industry.

3. On the left side of the graph, 58% of the steaks from carcasses graded *Standard* or *Select* are in fact tender or very tender. Consumers buying these steaks are paying a lower price purchasing a very tender steak that will provide a very positive eating experience. This is great from the consumer and will help increase beef demand, but this is an opportunity loss for the producers as they are selling a high-quality product for a lower (or even discounted) price.

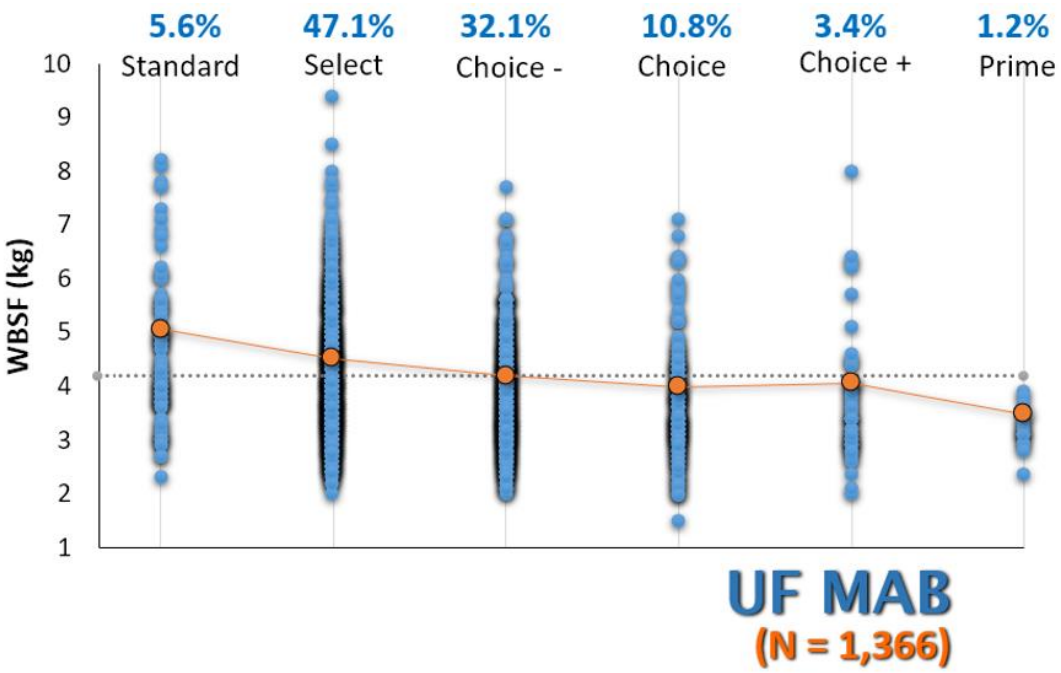


Figure 1. Cattle (n = 1,366; from 100% Brahman to 100% Angus) classified USDA quality grade and WBSF (low WBSF = tender meat, high WBSF = tough meat). High level of variation in tenderness is present within each quality grade indicating that marbling accounts for just a small portion of the variation in tenderness. The orange dot in each quality grade is the average WBSF for that quality grade and the horizontal line represents the threshold for a steak to be considered tender (steaks below the threshold are tender and very tender steaks, steaks above the threshold would be qualified as tough).

Although no errors are desirable, from the consumer and marketing point of view errors may have different consequences. We could speculate that misclassification errors for moderately tender group have relatively small market consequences because, if the price of the product reflects eating quality (as it would with a "certified tender" program), the consumer is paying and expecting average eating quality and this expectation is most likely met. On the other hand, misclassifications of a product with "tough" or "tender" quality may have a greater negative impact on consumers. Again, if we assume the eating quality is positively associated with the price of the product, not meeting quality expectations leads to dissatisfied consumers. This could have important consequences as past experience is a critical factor regarding attitude toward food. A report (SMART, 1994) evaluating the factors contributing to the intent of consumers to repurchase a product concluded that eating quality was the most important factor (65%), followed by price (28%). Unfulfilled eating quality expectations lead to consumers' dissatisfaction, reduced future beef purchases and lower demand. The negative consequences associated with misclassifications of carcasses with "tender" into "moderately tender" or "tough" groups are of different nature. These errors represent opportunity losses for the industry, as the product is undervalued.

Programs to improve eating experience when consuming beef and the ability to better predict the eating quality level for marketing purposes are critical to increase consumers' confidence and, subsequently, improve the economic position of the beef industry through increased demand for beef products.

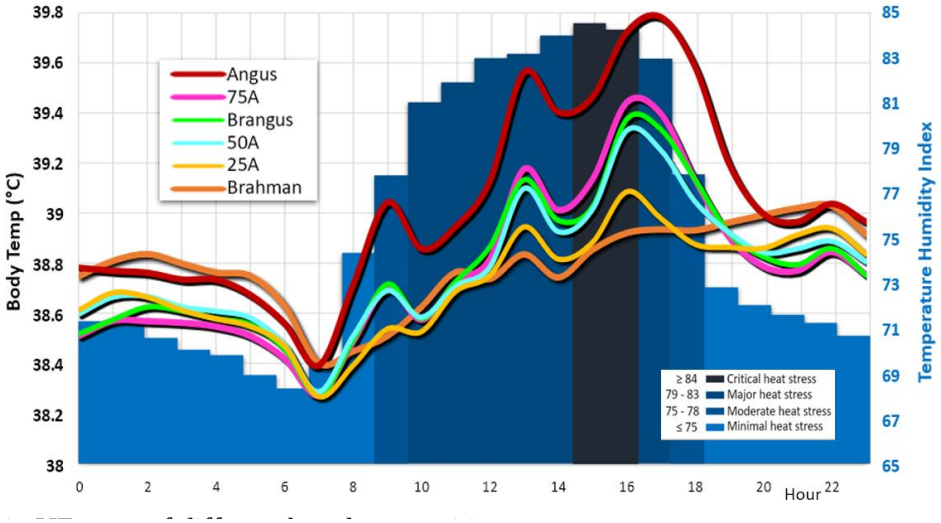
Thermotolerance

Climatic stress is a major limiting factor of production efficiency in beef cattle in tropical and subtropical environments and in dairy cattle throughout most of the world. This stress is expected to increase due to climate change. More than half of the cattle in the world are maintained in hot and humid environments, including about 40% of beef cows in the US. Substantial differences in thermal tolerance exist among breeds and among animals within breeds indicative of opportunities for selective improvement. Use of genomic tools to produce an animal with superior ability for both thermal adaptation and food production represents an energy-efficient sustainable approach to meet the challenge of global climate change.

Core body temperature was measured every 15 minutes over a 5-day period using an iButton temperature measuring device implanted in a blank CIDR in heifers from the University of Florida multibreed herd (ranging from 100% Angus to 100% Brahman) and two-year old Brangus heifers from the Seminole Tribe of Florida. Hair samples were collected and measured for length and diameter. Skin biopsies were used for histological measurement of several skin properties including sweat gland number and size.

Figure 2 shows the pattern of hourly variation in core body temperature for Angus, 3/4Angus x 1/4Brahman (3/4A, 1/4B), Brangus, 1/2Angus x 1/2Brahman (1/2A, 1/2B), 1/4Angus x 3/4Brahman (1/4A, 3/4B) and Brahman cows. Brahman cattle were the only ones able to maintain a lower core body temperature throughout the 24h-day during high heat stress conditions. Coat score had a significant effect on body temperature, where cows with shorter and slicker hair maintain lower body temperatures. Brahman cattle had larger sweat glands closer to the surface of the skin (Figure 3).

Figure 2. Daily variation in core body temperature



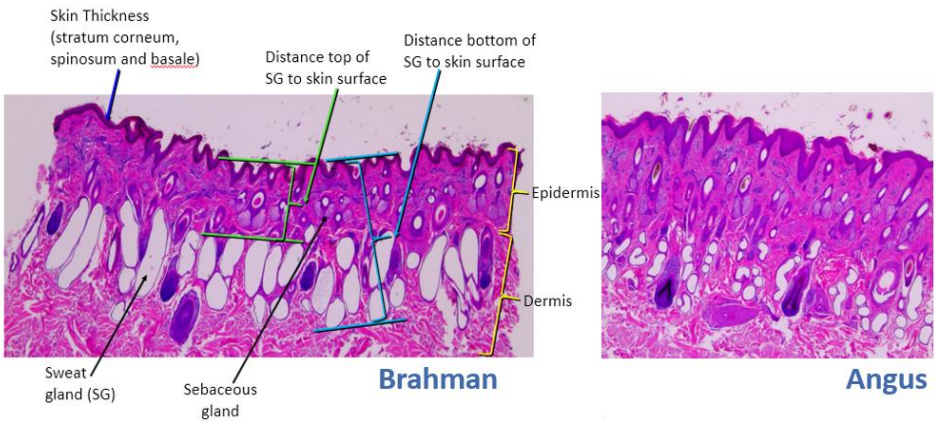


Figure 3. Skin histology showing the difference in sweat gland size and sweat gland proximity to the skin surface in Brahman versus Angus cows.

Improvements in production, such as increased growth rate, lead to increased metabolic heat production, and exacerbate the problem of thermoregulation and a good example is the negative genetic correlation between milk yield and ability to regulate body temperature during heat stress in dairy cattle. Unless accompanied by changes that increase heat loss capacity, improvements in production make animals more susceptible to hyperthermia during heat stress.