1-1-2007

Ranking Beef Muscles for Warner-Bratzler Shear Force and Trained Sensory Panel Ratings

Gary A. Sullivan
University of Nebraska-Lincoln, gary.sullivan@unl.edu

Chris R. Calkins
University of Nebraska-Lincoln, ccalkins1@unl.edu

Ranking Beef Muscles for Warner-Bratzler Shear Force and Trained Sensory Panel Ratings

Gary A. Sullivan
Chris R. Calkins[1]

Summary

Combining 60 years of published research, 40 different beef muscles were ranked by Warner-Bratzler shear force. Relative ranks for tenderness, juiciness and beef flavor ratings were also determined. The psoas major and infraspinatus are the two most tender. Sensory tenderness ratings correlated to shear force means (-0.85; p=0.001) where a desirable tenderness rating reflected a low shear force. These data help reconcile differences among various studies of beef tenderness and provide a weighted ranking for beef muscles, which will be useful when selecting muscles for value-added beef products.

Introduction

For over 60 years meat scientists have been investigating characteristics of individual muscles. Through the years scientists have completed studies involving many muscles and few animals; as well as few muscles over many animals. Not surprisingly among studies, the relative tenderness rank of specific muscles has not always agreed. The objective of this study was to create a weighted ranking of muscles based on a comprehensive review of the literature.

Procedure

A comprehensive review of literature began by searching for all papers that studied at least three muscles from a minimum of three animals for any of following: Warner-Bratzler shear force (WBS), sensory panel ratings for tenderness, juiciness, and beef flavor. The muscle number criterion was set to select papers comparing and analyzing individual muscles. At the same time, if fewer than three animals were used, the study offered less comparative value.

Following the initial criteria, 58 papers were identified spanning six decades and many institutions. However, these studies included a wide variety of protocols. Age of animals varied from 10 months to over 11 years of age. Heifers, steers, and bulls from *Bos indicus* to dairy type breeds were used. USDA yield grades ranged from 1 to 5 and quality grades included nearly all grades for both young and mature beef. Aging periods varied from 1 to 28 days. Both steaks and roasts were cooked to an end point temperature ranging from 135 – 185°F using a wide variety of cooking methods. Samples were then evaluated for WBS using .47, .5, .51, .79, or 1 inch cores. Sensory panel rating scales offered 5 to 10 classifications.

Due to these differences, constraints were placed on which papers were used to determine overall rankings. Selection was based around traits typical of the U.S. market beef population. Acceptable studies included steers, heifers, or both under 30 months of age or were A or B maturity carcasses from any quality grade. Purebred *Bos indicus* were excluded, but crossbreds were allowed. Additional constraints were added to handling and testing techniques. Steaks were cooked or frozen from 5 to 14 days post slaughter. Moist cooking methods were excluded for consistency and products were cooked to an end point temperature range of 158 – 171°F. Papers were narrowed to those that used .47-.51 in. cores for WBS. Only trained sensory panels were chosen but no selection was placed on rating scale. Ultimately, 22 papers were used for ranking muscles on the basis of WBS. There were 11 papers for ranking on tenderness ratings, 11 for ranking by juiciness, and six for beef flavor.

Muscles, weighted by number of observations, were analyzed for WBS using Proc GLM and LS Means function of SAS to create a rank. Sensory panel ratings were analyzed in the same method after being standardized to a 100 point scale where 100 is most tender, juicy, or beef flavor. Proc Corr was used to analyze the correlation of ranks and means for WBS and sensory panel.

Muscles were placed in three tenderness groups on the basis of WBS: tender (<8.58 lb), intermediate (8.58 lb<x< 10.12 lb), and tough (>10.12 lb). The sensory panel results were placed in eight groups: <18.75, and in increments of 12.5 beyond that for tenderness, juiciness, and beef flavor. Higher ratings reflect more desirable sensory traits.

Table 1. Abbreviations for the muscles ranked.

Abbreviation	Muscle
ADD	Adductor
BIB	Biceps brachii
BIF	Biceps femoris
BRA	Brachialis
BCO	Brachiocephalicus omotransversarius
COM	Complexus
COB	Cutaneous-omo brachialis
DEP	Deep pectoral (pectoralis profundus)
DEL	Deltoideus
ECR	Extensor capri radialis
GAS	Gastrocnemius
GLU	Gluteus medius
BRA	Gracilis
INF	Infraspinatus
LAT	Latissimus dorsi
LNG	Longissimus dorsi
LDC	Longissimus dorsi (chuck)
LLU	Longissimus lumborum
LTH	Longissimus thoracis
MUL	Multifidus dorsi
OEA	Obliquus externus abdominis
OIA	Obliquus internus abdominus
PSM	Psoas major
QDF	Quadriceps femoris
REA	Rectus abdominis
REF	Rectus femoris
RHO	Rhomboideus
SEM	Semimembranosus
SET	Semitendinosus
SEV	Serratus ventralis
SPI	Spinalis dorsi
SPL	Splenius
SUB	Subscapularis
SPP	Superficial pectora
SPS	Supraspinatus
TFL	Tensor fascia latae
TER	Teres major
TRA	Trapezius
TRI	Triceps brachii
VAL	Vastus lateralis
VAM	Vastus medialis

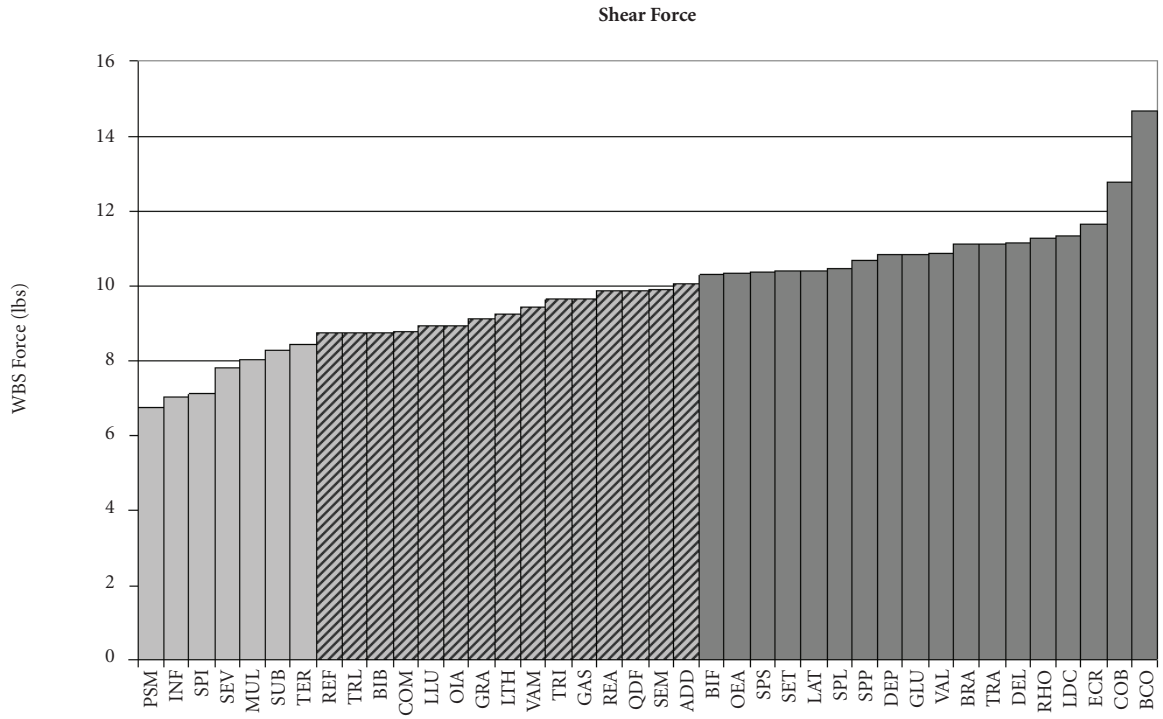

Figure 1. Rank of muscles based on WBS values (n=40).

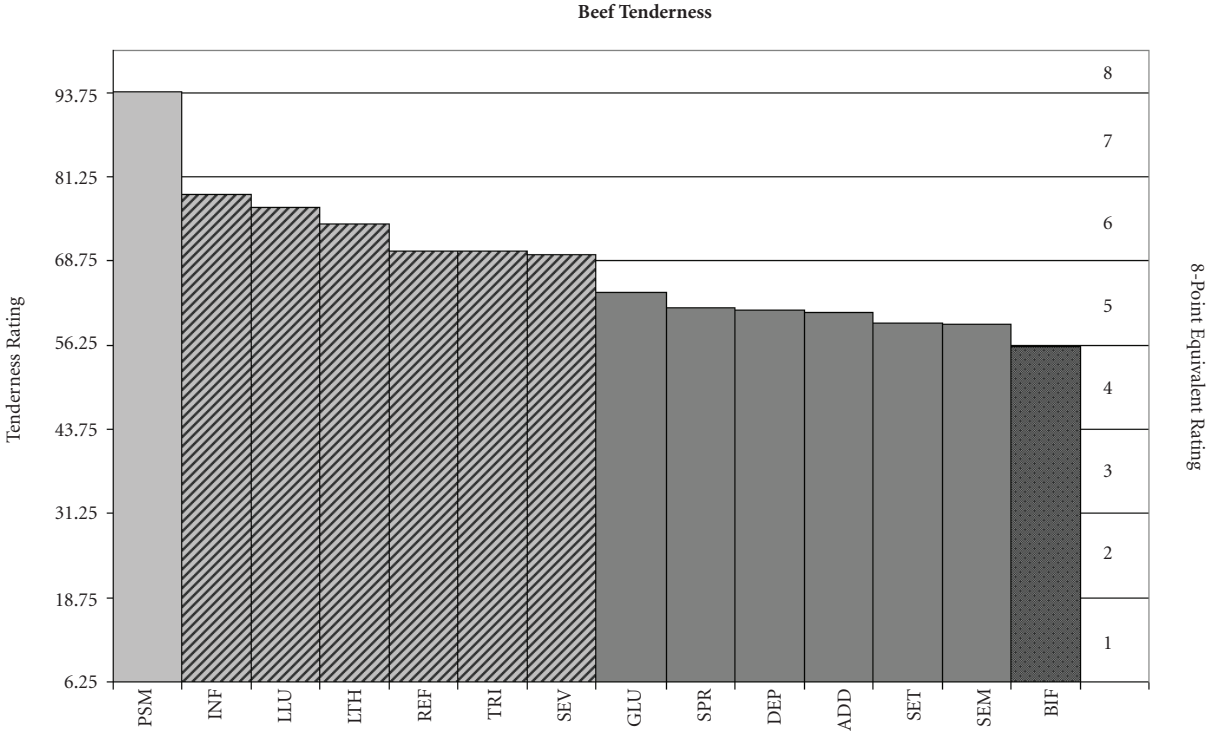

Figure 2. Rank of muscles based on sensory panel ratings for tenderness (n=14).

Results

Of the 40 muscles ranked for WBS (Table 1), psoas major, infraspinatus, spinalis dorsi, serratus ventralis, multifidus dorsi, subscapularis, teres major were classified as tender (<8.58 lb). The psoas major has long been utilized for its tenderness. The multifidus dorsi and spinalis dorsi are found in ribeye steaks. The infraspinatus and teres major have been increasingly utilized as "value cut" steaks. However, the serratus ventralis and subscapularis are under-utilized in relationship to their inherent shear values. The major muscles classified as tough (>10.12 lb) were biceps femoris, supraspinatus, semitendinosus, deep pectoral, gluteus

(Continued on next page)

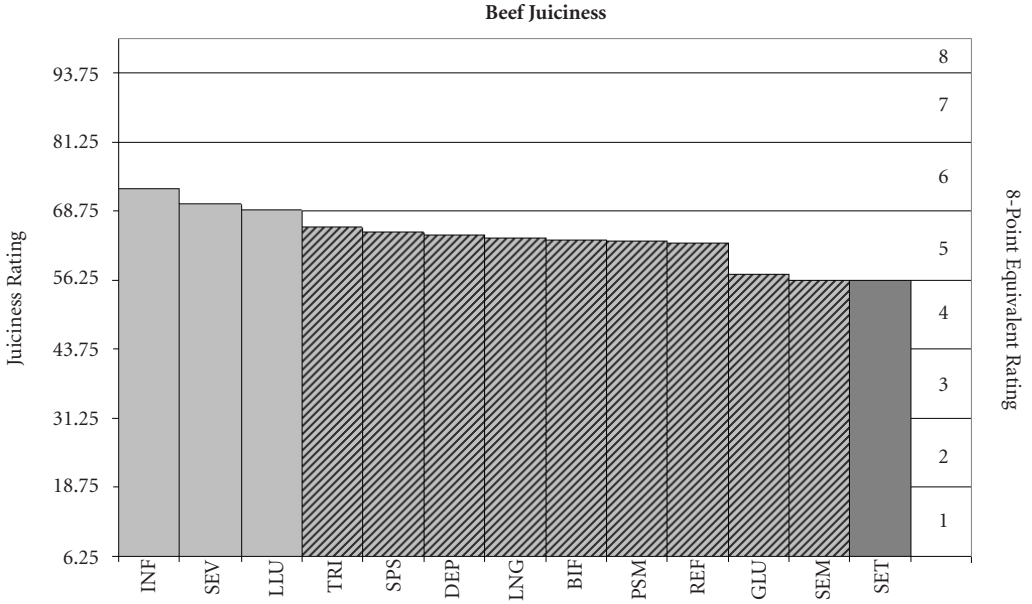

Figure 3. Rank of muscles based on sensory panel ratings for juiciness (n=13).

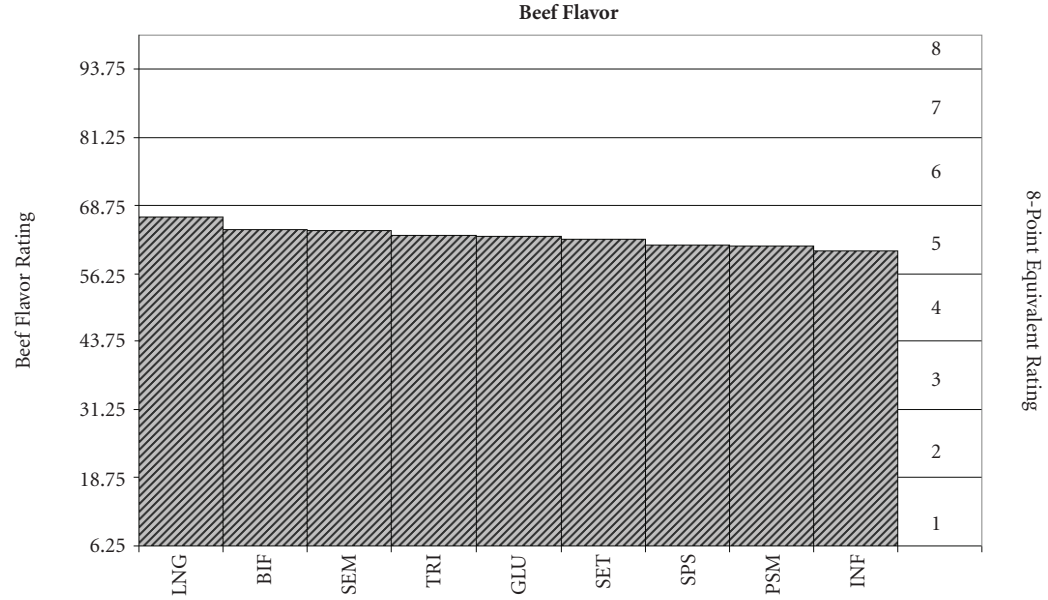

Figure 4. Rank of muscles based on sensory panel ratings for beef flavor (n=9).

medius, vastus lateralis, rhomboideus, and the longissimus dorsi in the chuck region. Although the gluteus medius is often used as a steak, it only ranked 31 of 40 for WBS values.

For muscles analyzed by sensory panel, all steaks that had a tenderness (n=14) rating greater than or equal to a 6 point equivalent on an 8-point scale also had a WBS less than 9.9 lb. For juiciness (n=13), the Infraspinatus, serratus ventralis, and longissimus lumborum were among the highest rated and gluteus medius, Semimembranosus, and semitendinosus were among the least juicy. There were no differences in sensory ratings for beef flavor (n=9).

The correlation between sensory panel tenderness ratings and WBS values for 14 muscles was evaluated. Mean tenderness ratings had a correlation to mean shear force value, by muscle, of -0.85 (*P=0.001*). The numerical ranks had a correlation of 0.74 (*P=.003*). It is well known that muscles vary in tenderness from one end to the other. Unfortunately, authors rarely describe the precise anatomical location from which samples are derived. In addition, differences exist in the relative contribution of connective tissue and muscle fiber tenderness to WBS versus sensory tenderness ratings. These two situations may account for some of the differences in correlation.

---

[1]Gary A. Sullivan, graduate student; and Chris R. Calkins, professor, Animal Science, Lincoln.

[2]This project was funded in part, by beef and veal producers and importers through their $1-per-head checkoff and was produced for the Cattlemen's Beef Board and state beef councils by the National Cattlemen's Beef Association.