TENDERNESS AND PH EVALUATION OF BEEF LOINS AND COOKING LOSS OF GROUND BEEF FROM THREE DIFFERENT SOURCES

By

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LIST OF ABBREVIATIONS

Abbreviation	Description
CL	Cooking Loss
TND	Tenderness
WHC	Water Holding Capacity
WTCL	Weight of Cooked Liquid
WTCS	Weight of Cooked Solid

I. INTRODUCTION

Background

When dealing with marketing beef, consumers' needs must be met to successfully sell the product. Appearance is one of the main things a consumer looks at when acquiring to buy meat. Therefore, it is of vital importance that the meat be held to a certain standard of appearance and quality. The consumer will look for and appraise physical properties such as tenderness, juiciness, and the color of meat. However, appearance is not a good appraisal of meat quality. To meet the desirable needs of the consumers, researchers have set out to understand the different mechanisms of meat properties such as water, muscle structure, and pH to create the best quality beef. The growth in consumer demand for higher quality products has led to a progression in the use of new technologies (Schellekens, 1996).

Purpose of This Study

The purpose of this study was to describe the research factors that affect tenderness, cooking loss, and pH of loin roasts; and cooking loss of ground beef. Specifically, this research was conducted on three different beef sources to determine if there were differences in their tenderness and to establish if there were correlations to pH and cooking loss of the meat.

Limitations of This Study

The capacity of the lab facility used in conducting this research limited the quantity of samples that could be processed and availability of instruments available to investigate quality traits. However, equipment and facilities needed to store, cook, and test loins and ground beef in this research were excellent for the scope of the experiment.

Implications of This Study

This research should provide a better understanding of the effects of quality grade on tenderness, pH, and cooking loss of strip loins and ground beef. When these characteristics of the meat are better understood, it will provide ways to make modifications to meet consumers' needs, thus providing the highest quality of beef possible. By using the same approaches done in this study, the beef industry could benefit from creating a more consistent product for their consumers.

Research Questions

1) Is there a difference in tenderness of loins from three different sources?
2) Is there a difference in pH of cooked loins from three different sources?
3) Is there a difference in cooking loss of loins from three different sources?
4) Is there a positive or negative correlation between tenderness and cooking loss of loin roasts?
5) Is there a difference in overall cooking loss of ground beef from three different sources?

6) Is there a difference in liquid cooking loss from ground beef patties from three difference sources?

7) Is there a difference in solid cooking loss from ground beef patties from the three different sources?

II. LITERATURE REVIEW

The ability of post-mortem muscle to hold its natural water content is known as water-holding capacity (WHC) (Toldra, 2011). WHC is studied expansively because of its immense economic importance. WHC is an important meat quality trait because it can be used to determine juiciness in steaks (Huff Lonergan, Zhang, & Lonergan, 2010; Muchenje et al., 2009; Reardon, Mullen, Sweeney, & Hamill, 2010). When meats have irregular WHC they typically have a watery or dry appearance that is considered to be a profit loss factor in the meat industry (Devine, Wells, Lowe, & Waller, 2014; G. Offer et al., 1989; Reardon et al., 2010). These benefits have been indirectly linked to the influence of increased pH on the water-holding capacity (WHC) of meat above the iso-electric point (IEP) of the myofibrillar proteins (Gault, 1985). Additionally, the pH of muscle cells can effect on the ability of protein to bind to water and therefore plays a vital role in determining beef quality.

Fresh Meat Components

It is a common misconception to think muscle is mostly made up of protein; the muscle is actually primarily made up of water. Water, protein, fat, carbohydrates and other soluble compounds make up the skeletal muscle of meat (Toldra, 2003).

Constituent	Range (%)	Forms Present
Water	70-78	Immobilized and free, mainly in association with the proteins
Protein	15-22	Sarcoplasmic, myofibrilar, and stromal proteins
Lipid	1-13	Tracylglycerides, phosphoglycerides, glycolipids, proteolipids, and depot fat.
Lipid	0.5-3.0	Mainly in membranes as glycolipidsand preoteolipids, some as fat droplets in sarcoplasm
Carbohydrate	1-2	Glycogen, monosaccharides and other metabolic intermediates, glycolipids, and acid mucopolysaccharides
Minerals	1-2	Constituents of extracellular and intracellular fluids, also may be bound to tissue
Vitamins	µg % range	Largely found bound as coenzymes or constituents of tissue
Nitrogenous nonprotein extractives	1.5-1.8	Free amino acids, creatine, carnosine, anserine, glutathione, and various hormones.

Figure 1. Proximate composition of muscle. The forms present and changes during development (Pearson & Young, 1989).

Muscle consists of approximately 75% water, 20% protein, 3% fat, and 2% soluble non-protein substances (Tornberg, 2005). Water makes up 75 percent of lean muscle tissue composition: 85 percent of it located in the myofibrillar protein network (Bertram, Purslow, & Andersen, 2002; Huff-Lonergan & Lonergan, 2005; Muchenje et al., 2009; 5 Pearce et al., 2011). The vast majority of water within muscle is found inside the

myofibrils in the areas between thick and thin filaments; A portion of this water is in free form whereas the rest is bound to proteins, specifically myosin and actin which exemplify the main percentage of myofibrillar proteins (Toldra, 2011).

Water

Water is a chemical compound and polar molecule. The nucleus of the oxygen pulls the electrons closer to it, which leaves one end positive and the other end negative. This produces a partial charge of delta – on the oxygen and a delta + charge on the hydrogen. This net dipole moment produces the V- shape structure of water, which allows the water molecule to become much like a magnet. Because of this, water is attracted to charged particles like proteins. Proteins usually contain charged amino acids, thus water is attracted to the charge.

Water within the muscle can be held between the myofibrils, within the myofibrils, between the muscle cells or between the muscle bundles, or between the myofibrils and sarcolemma. (Huff- Lonergan & Lonergan, 2005). Water within the muscle can be sorted into three different categories: free, bound and immobilized. Free water accounts for 16-18%, immobilized accounts for 14-75%, and bound water accounts for 7-8% of water within the muscle.

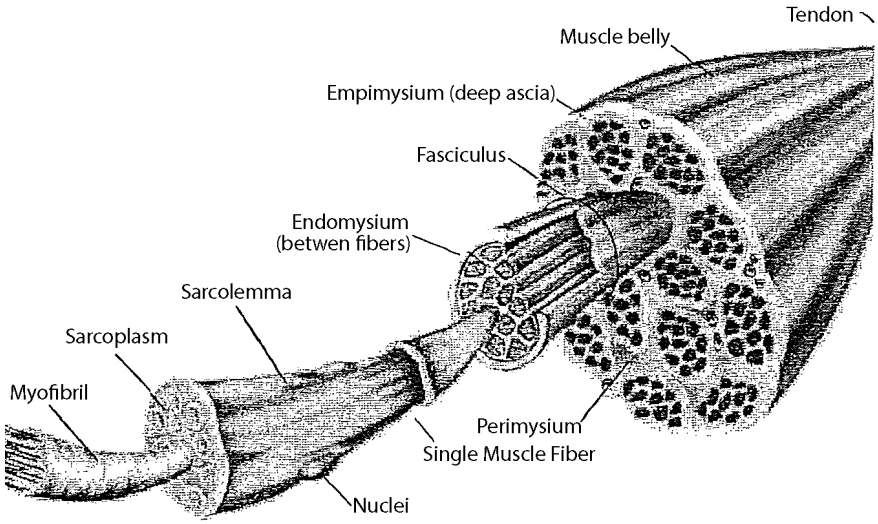

Figure 2. The muscle split into various component parts that show locations of muscle water. (Baechle & Earle, 2008)

Intra- myofibrillar space is said to contain about 85% of the myowater, the remaining 15% can be found outside of the myofibrillar network in the extra-myofibrillar spaces. (Pearce et al., 2011).

Free Water

Free water is the water in the tissue that can move from the tissue easily and is located in sarcomeres. Free water makes up about 16 to 18 percent of the water in beef. Free water can be redistributed by physical forces or can be repelled from the muscle (Pearce et al., 2011). When meat is cut, free water will drain from the surface under gravity if the capillary forces do not retain it (Honikel, 1998). Free water is referred to as 'drip loss', drip loss is defined as the fluid that is expelled from the meat without the use of mechanical force.

Drip loss is dependent on the shortening of sarcomeres, which is regulated by the interaction of muscle temperature and the development of rigor. (Fischer, 2007).

Immobilized Water

The quantity of free water immobilized inside the tissue is shaped by the spatial molecular arrangement of the myofibril proteins (Lawrie, 1969). The tighter the network of proteins are the less immobilized water there is, which increases the amount of expressible water and vise versa. Immobilized water makes up about 80 percent of the water forms in beef. The amount of immobilized water depends on the availability of space between the myofibrils in the sarcomeres. (Toldra, 2003). Immobilized water is the highest percentage of water in the muscle and has the largest influence on WHC.

Bound Water

Although meat contains about 75 percent water, only about 1-2 percent of it is tightly bound (bound water) to the muscle proteins (Lee, 1983). Bound water is the strongest of the three but also the smallest accounting for 1-2%.Polar groups of the side chains of amino acids in the meat proteins bind the water molecules on surfaces by Van der Waals forces (Puolanne & Halonen, 2010).

Tenderness

When looking at what influences consumer satisfaction the most, meat tenderness is seen as the most vital (Koohmaraie & Geesink, 2006; Silva et al., 2015). Tenderness is a main determinant for people's view on the overall quality of the meat they are buying.

Tenderness for consumers means a better looking cut and a better tasting meat. "Beef tenderness is determined by three main factors: the degree of contraction of muscle fibers following the rigour mortis, intensity of degradation of muscle proteins responsible for the maintenance of sarcomere structure resulting from postmodern proteolysis, and specific phenotypic features" (Moczkowska et al., 2007). The level of juiciness in meat is strongly related to how water acts in muscle (Guignot, Vignon, & Monin, 1993; Muchenje et al., 2009; Ouali et al., 2006; Pearce et al., 2011). The variations in tenderness are determined by genetic and environmental factors and their mutual interactions (Hoquette et al., 2012). Additionally, there has been findings that sex of the animal has an effect on the relationship between marbling and tenderness. Tenderness has been found to increase as the marbling increases (Emerson et al., 2013). The tenderness of beef is mainly caused by the architecture and integrity of muscle tissue cells (Huff Lonegran et al., 2010).

Effects of pH in. Beef

There is strong evidence showing an increase in tenderness as the pH rises from 6 to 7 (Bouton, Shorthose, & Harris, 1971). Both the cooking loss and the quantity of fluid expressible from the unheated tissue (Jolley et al., 1981) decreases slightly and continuously with the post-mortem fall of pH. Proteins ability to bind to water is vastly effected by muscle pH. The pH in living muscles at rest is 7.2 to 7.4 but in beef postmortem it is close to 5. Postmortem oxygen is no longer delivered to cells in the body because there is no blood circulation, which in turn causes the oxygen concentration to

drop. This drop decreases the redox potential of the cell and inhibits the mitochondrial system after the first several hours post mortem (Scheffler et all 2015). The pH of the muscle is altered by accumulation of lactate when there is no oxygen available.

Lactate Accumulation Effect on pH

Lactic acid has been used to decontaminate carcasses, which has proven to have a significant drop in the microbial load for pathogenic and non- pathogenic microorganisms (Van Netter et al., 1998, Castillo et al., 2001, Ikeda et al., 2003). The effect of the lactic acid could be because of the changes that occur from acid/ base equilibrium, the donation of protons, and the interference of cell energy production. If the intracellular pH is larger than the acid dissociation constant (pka), then this in turn will make the acid dissociate by releasing a proton, which acidifies the cytoplasm of the microorganism. (Booth 1985).

A drastic drop in pH from 7.0 to 5.6-5.9 is seen as the lactate accumulates in the muscle. (Hudson, 2012; Scheffler et al., 2015; Toldra, 2011). 'Glycolytic potential' is defined as the measure of all compounds in the muscle that can be converted into lactic acid (Hamilton et al., 2003). This is an index of the muscles capacity for post- mortem glycolysis and because of this, the muscle pH declines after slaughter (Monin & Sellier, 1985).

Cooking of Beef

The rate at which temperature falls in muscle after slaughter can negatively impact water binding (Cheng & Sun, 2008). Studies indicate that the final temperature of

meat has a great influence on tenderness and weight loss (Laakkonen, 1970). During the cooking process temperature plays an important role in the generation of toughness and appears to be inf luence by collagen, myofibrillar proteins, and cytoskeleton proteins (Hughes et al., 2014). Cooking can be defined as the heating of meat to a high enough temperature to denature proteins. (Davey & Gilbert, 1974). Proteins in the muscle undergo structural alter that change quality characteristics that are dependent on muscle structure, such as water holding and tenderness. When the meat is in the process of heating, structural changes begin happening to the meat: meat fibers shrink, cell membranes are destructed, gel formation occurs by aggregation of sarcoplasmic and myofibril proteins, and the connective tissues shrink. (Tornberg, 2005). When meat is heated the muscle structure changes and the connective tissues within shrink, reducing the space that held approximately 80 percent of water found in muscle prior to cooking (Barbera & Tassone, 2006). While cooking, meats can lose a big portion of mass in the form of meat juice and the quantity is temperature and time dependent. (Hughes et al., 2014). The time used to cook the meat and the temperature the meat is cooked at will play a large role in the physical properties and eating quality of the meat.

Myofibril

The main structural component of meat is the myofibril, which occupies about 70 percent of the volume of lean meat. Myofibrils contain about 20 percent protein, the remainder being water. Thus, the majority of the water in meat is present within the myofibrils in the spaces between the thick and thin filaments (Offer & Trinick).

Myofibrillar proteins (MPs) are one of the main components responsible for the textural properties of processed meat products (Yasui, Ishioroshi & Samejima, 1980; Asghar, Samejima & Yasui, 1985). Myofibrillar proteins constitute about 55-60% of the total muscle protein. (Asghar, Samejima & Yasui, 1985). The heat-induced gelation of myofibrillar proteins is a main factor that establishes the characteristics of meat products such as the sensory quality, texture, emulsifying stability, WHC, and meat tenderness (Xiong, 2000). The formation of heat-induced gels is a multifaceted thermodynamic process that is associated to the muscle sources and kinds as well as the different cooking circumstances such as temperature, pH, protein concentrations, and ionic strength (Lanier et al., 2013) The myofibrillar network also holds a great amount of mineral ions. Depending on the kind of ions and the quantity of them, they can have a large effect on water binding characteristics of muscle proteins.

III. TENDERNESS, pH EVALUATION, AND COOKING LOSS OF BEEF LOINS FROM THREE DIFFERENT SOURCES

Treatments

This experiment was designed to determine the effects of three different sources of beef striploins on tenderness, pH, and cooking loss. The three distinct sources of beef loins tested were as follows.

A) Control: HEB commercial grocery store- Choice Grade loins

B) HeartBrand Beef company- Prime Grade loins

C) PrimeLine Beef company- Prime Grade loins

Experimental Procedures

There were three beef treatment sources of strip loins, involving three full strip loins per treatment source. Each loin was cut to provide six roasts per loin for a total of six roasts (replications) per treatment source. The cutting and cooking of strip loins was conducted upon arrival at the meat laboratory in the Agriculture Department at Texas State University.

The control and the other two treatment sources were cooked in a multi-purpose smokehouse (UltraSource Grand Prize™ 3) set at 104.4° C (220° F). All of the loin samples (roasts) were heated to an internal temperature of 74° C (165° F). No smoke or humidity was applied during cooking. Roasts were allowed to cool at room temperature 13.9- 15 ° C (57-59° F) for 30 minutes and then put in gallon- size, freezer Ziploc bags and placed in a walk-in cooler at -1.1- 0.6 ° C (30-33° F) overnight. After 20-28 hours in

the cooler, roasts were removed and (six) core samples from the Longissimus muscle of each steak was taken for Warner- Bratzler Shear Force tenderness determinations, and pH determinations. Next, weight loss was determined from cooking. Warner- Bratzler Shear Force was determined on the core samples by established procedures (G-R Manufacturing, Tall Grass Solutions, Manhattan, KS).

Core samples were used to make up a 50 gram composite of meat, if more quantity was needed another core sample was taken close to the initial six. The 50-gram sample was emulsified in a blender with 50ml of distilled water to create a meat slurry. The pH was then determined on the meat slurry. These steps were repeated for all six roasts from an individual loin. There was a replicate procedure used for each of the three loins across the three meat treatment sources.

Table 1. Shows the experimental design used in the quality evaluations of the three strip loin sources.

TABLE 1

Experimental Design

- Three beef treatment sources of strip loins
- Three full strip loins per treatment source
- Six roasts cut from each strip loin and cooked as a group
- Six meat cores taken from each roast for tenderness determinations
- pH determinations taken from one pooled sample per roast
- Cooking weight loss measured from each roast

Table 2. Gives the criteria used to evaluate loin sources

TABLE 2

Variables To Evaluate Treatments

- Warner- Bratzler Shear Force
- pH
- Loin cooking weight loss

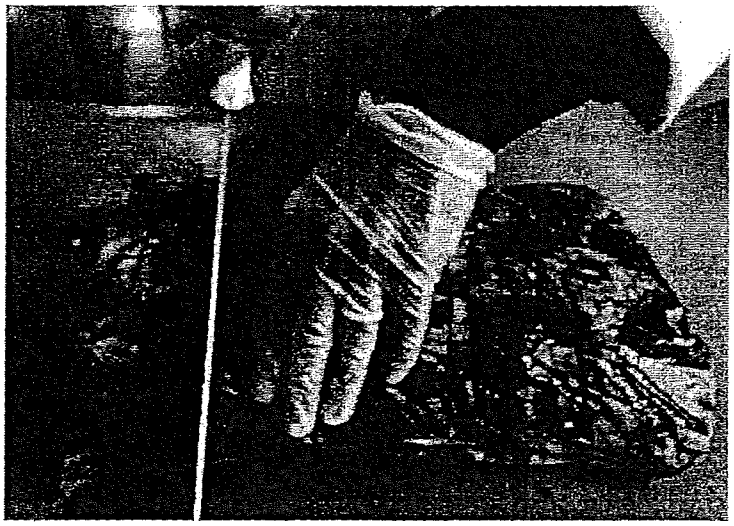

Figure 3. Cutting a loin into six roasts

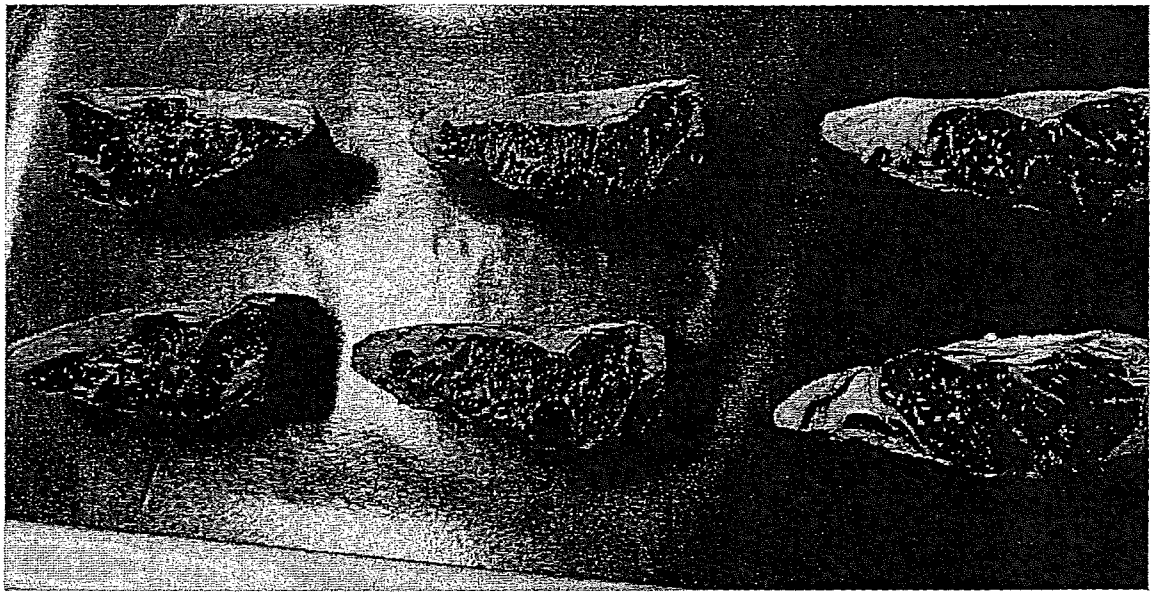

Figure 4. Cut and labeled roasts

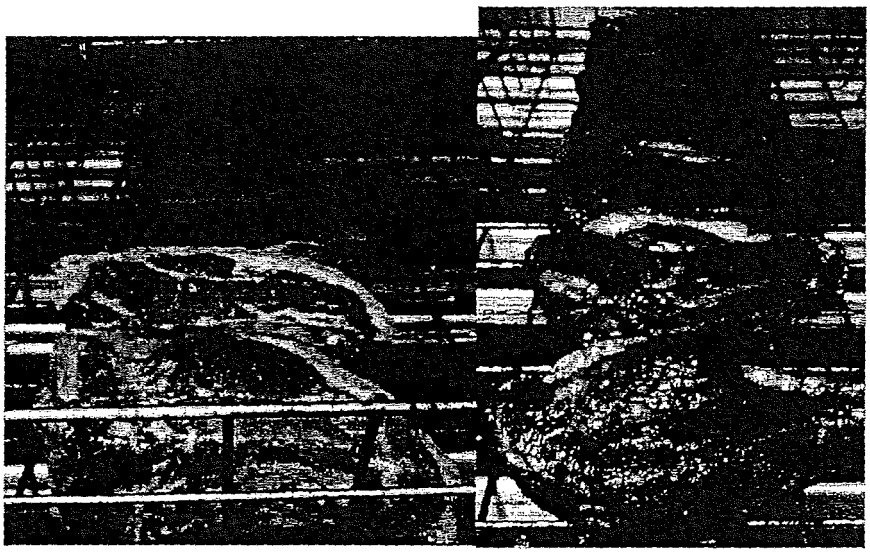

Figure 5. Roasts in smoker before and after with thermometer inserted into the thickest portion of one steak (steak #6)

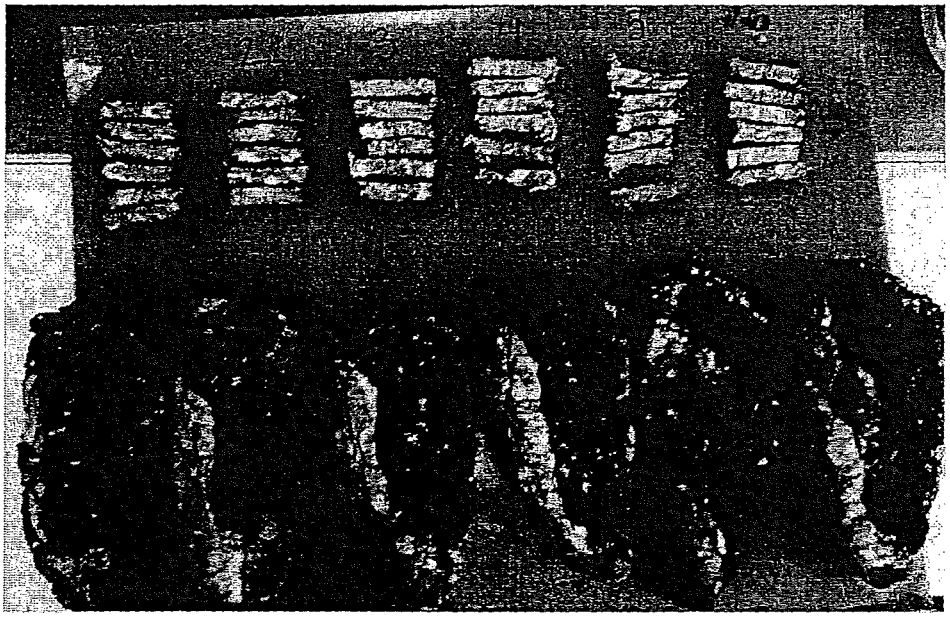

Figure 6. Roasts Cored and labeled

Results and Discussion

TABLE 3
Warner- Bratzler Shear Force Values of Loin Roasts, kgf

Choice Strip Loin- HEB No. 1

Roast No.	1	2	3	4	5	6
Core A	4.51	2.84	2.26	2.26	1.96	1.44
Core B	4.29	2.96	3.31	2.60	2.92	2.74
Core C	3.74	3.18	3.39	2.97	2.92	1.77
Core D	3.82	3.12	2.95	2.67	2.95	2.42
Core E	3.62	2.93	3.27	2.98	3.12	1.98
Core F	3.66	2.94	3.38	2.26	2.88	2.62
MEAN	3.94	3.00	3.09	2.62	2.79	2.16
STD	0.368	0.250	0.558	0.293	0.380	0.469

Overall mean for strip loin No. 1= 2.93

Choice Strip Loin- HEB No. 2

Roast No.	1	2	3	4	5	6
Core A	2.13	2.89	2.61	1.88	1.81	1.56
Core B	2.55	2.43	2.22	1.88	1.62	1.43
Core C	1.79	1.75	2.54	2.10	1.21	2.40
Core D	1.83	2.74	2.30	1.94	1.71	2.18
Core E	2.44	1.94	1.81	2.33	1.84	1.81
Core F	1.42	1.91	1.97	1.45	2.48	2.81
MEAN	2.03	2.28	2.24	1.93	1.78	2.03
STD	0.249	0.436	0.285	0.266	0.376	0.483

Overall mean for strip loin No. 2= 2.05

Choice Strip Loin- HEB No. 3

Roast No.	1	2	3	4	5	6
Core A	2.09	2.16	1.89	1.68	1.97	1.36
Core B	1.41	1.75	1.98	2.10	1.58	2.40
Core C	1.47	1.68	1.93	2.13	1.90	2.07
Core D	1.27	1.84	1.48	1.16	1.63	1.66
Core E	0.90	1.93	1.84	1.89	1.98	1.68
Core F	1.41	1.72	1.76	1.25	1.32	2.17
MEAN	1.43	1.85	1.81	1.70	1.73	1.89
STD	0.352	0.162	0.164	0.335	0.241	0.353

Overall mean for strip loin No. 3= 2.65

TABLE 4
Warner- Bratzler Shear Force Values of Loin Roasts, kgf

Prime Strip Loin- HeartBrand No. 1

Roast No.	1	2	3	4	5	6
Core A	2.09	2.74	3.18	2.44	3.65	3.24
Core B	2.87	3.22	3.35	2.12	1.93	3.35
Core C	2.52	2.57	1.77	2.50	2.95	1.65
Core D	2.77	2.96	2.41	1.91	3.04	2.07
Core E	3.00	3.19	2.31	1.89	3.90	2.81
Core F	2.83	3.64	1.45	2.81	1.90	2.44
MEAN	2.68	3.05	2.41	2.28	2.90	2.59
STD	0.091	0.122	0.470	0.111	0.587	0.371

Overall mean for strip loin No. 1= 1.74

Prime Strip Loin- HeartBrand No. 2

Roasts	1	2	3	4	5	6
Core A	1.51	1.91	1.93	1.12	2.32	1.93
Core B	2.18	1.89	2.53	1.69	1.83	1.32
Core C	2.07	2.62	1.86	1.13	2.05	1.47
Core D	2.38	2.96	2.30	1.93	1.50	1.48
Core E	1.60	3.00	2.32	1.32	2.62	1.61
Core F	1.70	2.72	2.15	1.75	2.00	1.90
MEAN	1.91	2.52	2.18	1.49	2.05	1.62
STD	0.321	0.455	0.568	0.772	0.354	0.226

Overall mean for strip loin No. 2= 1.96

Prime Strip Loin- HeartBrand No. 3

Roasts	1	2	3	4	5	6
Core A	1.81	1.17	1.38	2.00	1.52	1.54
Core B	1.13	3.38	1.38	2.42	1.91	1.23
Core C	0.70	1.54	1.80	1.21	1.32	1.90
Core D	1.75	1.82	1.70	1.87	2.21	1.60
Core E	1.81	1.83	2.08	1.85	2.45	1.61
Core F	1.50	1.55	1.15	1.33	1.25	1.42
MEAN	1.45	1.88	1.58	1.78	1.78	1.55
STD	0.456	0.705	0.310	0.408	0.449	0.203

Overall mean for strip loin No. 2= 1.67

TABLE 5
Warner- Bratzler Shear Force Values of Loin Roasts, kgf

Prime Strip Loin- PrimeLine No. 1

Roasts	1	2	3	4	5	6
Core A	2.85	3.41	2.10	1.79	2.80	3.24
Core B	2.53	1.63	3.03	2.03	2.85	2.94
Core C	2.90	3.12	2.12	2.53	2.89	2.70
Core D	2.55	1.90	2.70	2.56	3.36	3.11
Core E	2.30	1.42	2.24	2.81	2.34	3.22
Core F	2.39	2.54	2.85	3.40	2.94	1.75
MEAN	2.59	2.34	2.51	2.52	2.86	2.83
STD	0.221	0.745	0.369	0.522	0.298	0.515

Overall mean for strip loin No. 1= 2.61

Prime Strip Loin- PrimeLine No. 2

Roasts	1	2	3	4	5	6
Core A	2.65	2.40	2.03	3.24	1.79	2.85
Core B	2.50	4.03	1.99	1.96	2.04	2.67
Core C	2.78	2.70	1.88	1.71	3.09	2.45
Core D	3.01	1.92	2.67	2.44	2.49	1.97
Core E	2.31	3.74	2.66	1.53	3.31	1.74
Core F	2.69	2.43	2.72	2.13	1.74	2.48
MEAN	2.66	2.87	2.33	2.17	2.41	2.36
STD	0.218	0.758	0.362	0.561	0.612	0.504

Overall mean for strip loin No. 2= 2.47

Prime Strip Loin- PrimeLine No. 3

Roasts	1	2	3	4	5	6
Core A	1.76	1.75	1.36	1.88	2.36	2.97
Core B	1.83	2.22	2.14	1.55	1.94	1.81
Core C	2.15	2.66	2.09	1.98	1.79	1.48
Core D	2.60	1.86	2.33	2.33	1.55	1.96
Core E	2.04	1.70	1.91	1.93	2.08	2.65
Core F	2.30	2.68	1.63	2.08	2.35	2.90
MEAN	2.11	2.15	1.91	1.96	2.01	2.30
STD	0.284	0.407	0.327	0.233	0.291	0.572

Overall mean for strip loin No. 3= 2.07

TABLE 6
pH Determinations of Loin Roasts

Item	Choice Strip Loin- HEB No. 1					
ROAST NO.	1	2	3	4	5	6
pH	6.01	6.07	6.02	6.00	5.97	5.98

Mean for strip loin No. 1= 6.01

Item	Choice Strip Loin- HEB No. 2					
ROAST NO.	1	2	3	4	5	6
pH	5.79	5.79	5.47	5.72	5.76	5.77

Mean for strip loin No. 2= 5.71

Item	Choice Strip Loin- HEB No. 3					
ROAST NO.	1	2	3	4	5	6
pH	5.92	5.92	5.96	5.92	5.90	5.89

Mean for strip loin No. 3= 5.92

TABLE 7
pH Determinations of Loin Roasts

Item	Choice Strip Loin- HeartBrand No. 1					
ROAST NO.	1	2	3	4	5	6
pH	6.08	6.12	6.15	6.16	6.18	6.19

Mean for strip loin No. 1= 6.15

Item	Choice Strip Loin- HeartBrand No. 2					
ROAST NO.	1	2	3	4	5	6
pH	5.98	5.99	6.00	5.97	6.01	6.00

Mean for strip loin No. 2= 5.99

Item	Choice Strip Loin- HeartBrand No. 3					
ROAST NO.	1	2	3	4	5	6
pH	6.01	6.03	6.07	6.06	6.06	6.07

Mean for strip loin No. 3= 6.03

TABLE 8
pH Determinations of Loin Roasts

Item	Choice Strip Loin- PrimeLine No. 1					
ROAST NO.	1	2	3	4	5	6
pH	6.16	6.19	6.18	6.21	6.22	6.23

Mean for strip loin No. 1= 6.20

Item	Choice Strip Loin- PrimeLine No. 2					
ROAST NO.		2	3	4	5	6
pH	5.98	5.99	5.98	5.97	5.94	5.92

Mean for strip loin No. 2= 5.97

Item	Choice Strip Loin- PrimeLine No. 3					
ROAST NO.	1	2	3	4	5	6
pH	6.07	6.03	6.02	6.02	6.01	6.02

Mean for strip loin No. 3= 6.03

TABLE 9
Cooking Weight Loss of Loin Roasts

Item	Choice Strip Loin- HEB No. 1					
ROAST NO.	1	2	3	4	5	6
Cooking loss	266	236	242	260	246	274

Mean for strip loin No. 1= 254

Item	Choice Strip Loin- HEB No. 2					
ROAST NO.	1	2	3	4	5	6
Cooking loss	212	188	172	182	178	214

Mean for strip loin No. 2= 191

Item	Choice Strip Loin- HEB No. 3					
ROAST NO.	1	2	3	4	5	6
Cooking loss	286	310	306	290	310	320

Mean for strip loin No. 3= 304

TABLE 10
Cooking Weight Loss of Loin Roasts

Item	Choice Strip Loin- HeartBrand No. 1					
ROAST NO.	1	2	3	4	5	6
Cooking loss	157	136	127	121	131	146

Mean for strip loin No. 1= 136

Item	Choice Strip Loin- HeartBrand No. 2					
ROAST NO.	1	2	3	4	5	6
Cooking loss	254	252	263	268	216	161

Mean for strip loin No. 2= 236

Item	Choice Strip Loin- HeartBrand No. 3					
ROAST NO.	1	2	3	4	5	6
Cooking loss	366	259	295	317	415	265

Mean for strip loin No. 3= 320

TABLE 11
Cooking Weight Loss of Loin Roasts

Item	Choice Strip Loin- PrimeLine No. 1					
ROAST NO.	1	2	3	4	5	6
Cooking loss	215	202	207	202	195	207

Overall mean for strip loin No. 1= 205

Item	Choice Strip Loin- PrimeLine No. 2					
ROAST NO.	1	2	3	4	5	6
Cooking loss	164	204	215	202	213	242

Overall mean for strip loin No. 2= 207

Item	Choice Strip Loin- PrimeLine No. 3					
ROAST NO.	1	2	3	4	5	6
Cooking loss	318	317	311	317	286	322

Overall mean for strip loin No. 3= 312

TABLE 12

Tenderness, pH, And Cooking Loss of Loin Roast from Three Different Sources

ITEM	N	TREATMENT [1]		
		Choice Grade Loins- HEB	Prime Grade Loins-HeartBrand	Prime Grade Loins-PrimeLine
Warner-Bratzler Shear Force, Kg f	54	2.54[a]	1.79[b]	2.38[b]
pH	18	5.88[a]	6.06[b]	6.06[b]
Cooking loss, %	18	18.32[a]	12.45[b]	14.30[b]

[1] Means in the same row with different superscripts differ ($P < 0.05$)

The results of variables measured to evaluate treatments will be discussed on an individual basis after the following comments concerning experimental conditions. The control treatment (HEB commercial grocery store- Choice Grade strip loins) was selected to represent typical high quality strip loins consumers usually buy. The other two treatments were both Prime Grade loins from known genetics. Because marbling is higher in prime grade as compared to choice grade, treatment comparisons allowed direct measurements of marbling on tenderness, pH, and cooking loss; and indirect evaluation of marbling on water holding capacity.

IV. COOKING LOSS AND pH OF GROUND BEEF FROM THREE DIFFERENT SOURCES

This experiment was designed to determine the effects of three different sources of ground beef on overall cooking loss, liquid cooking loss, and solid cooking loss. The three distinct sources of ground beef tested were as follows.

Treatments

A) Control: HEB commercial grocery store (80:20 ground beef)

B) HeartBrand Beef company (80:20 ground beef)

C) PrimeLine Beef company (80:20 ground beef)

Experimental Procedures

There were three treatment sources of ground beef, involving 16 one- pound packages per treatment source. Each one- pound package was equally divided and individually weighed to provide 4 patties per package, providing 64 hamburger patties (replications) per treatment source. Preparation of patties was conducted upon arrival at the meat laboratory in the Agriculture Department at Texas State University. Hamburger patties were grilled on one of the four George Forman Grills available (Model GR2080R), to an internal temperature of 74° C (165° F). Each one- pound package of ground beef (four patties) was grilled at one time. Thus, 16 separated grilling time-blocks were required to cook each treatment, for a total of 48 grilling time- blocks. Thermometers were placed in two patties on the grill, for each one- pound package being cooked (back left and front right). Collective drippings were measured and weighed after

the grilling of each pound of ground beef; liquid and solid portions were separated and weighed individually. The pH of cooked patties was determined from emulsified samples. Quality measurements conducted on ground beef hamburgers were.

1) Liquid dripping weight loss
2) Solid drippings weight loss
3) Total cooking weight loss (calculated)
4) pH

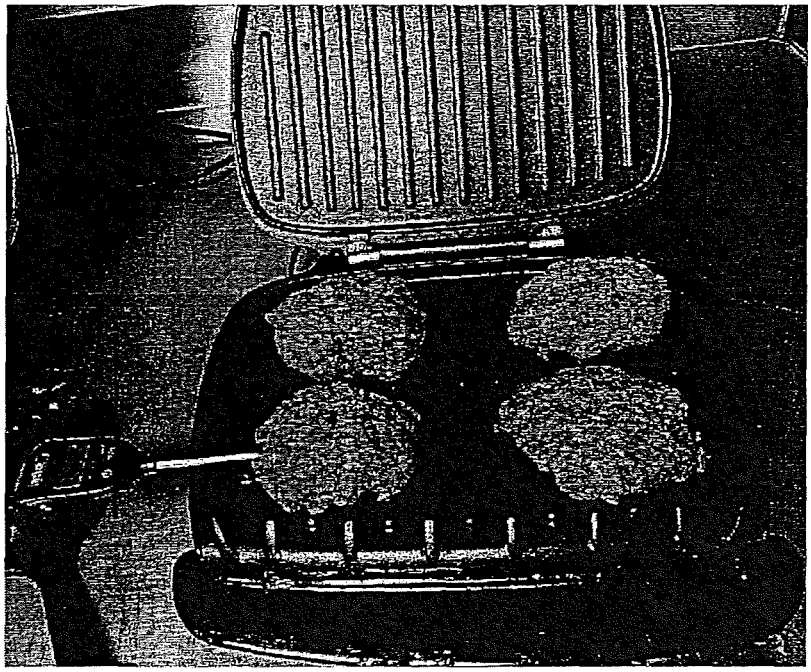

Figure 7. Burgers on George Foreman before cooking

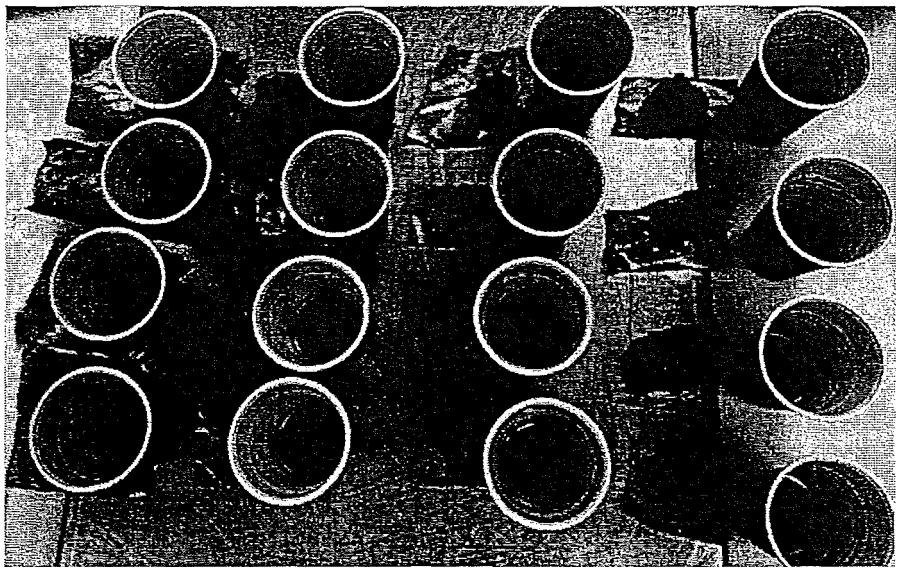

Figure 8. Liquid and solid drippings collected

Results and Discussion

TABLE 13

Cooking Loss of Ground Beef Sources

Replication *80:20 Ground Beef- HEB*

	Liquid loss %	Solid loss %	Total loss %	pH
1	20.26	0.22	20.48	5.768
2	19.78	1.57	20.85	5.832
3	21.61	1.48	23.09	5.888
4	16.59	0.22	16.82	5.921
5	16.81	0.22	17.04	5.683
6	20.98	1.56	17.75	5.774
7	17.98	1.97	19.96	5.926
8	15.22	0.22	15.43	5.837
9	23.74	0.91	24.66	5.768
10	17.86	0.22	18.08	5.920
11	15.49	0.22	15.71	6.020
12	16.53	0.21	16.74	5.868
13	16.23	1.10	15.13	5.867
14	17.47	0.44	17.90	5.918
15	16.45	0.22	16.67	5.890
16	16.59	0.22	16.82	5.960
Mean	18.07	0.69	18.45	5.870

TABLE 14

Cooking Loss of Ground Beef Sources

Replication *80:20 Ground Beef- HeartBrand*

	Liquid loss %	Solid loss %	Total loss %	pH
1	13.27	1.99	15.27	5.620
2	15.55	5.18	20.73	5.939
3	13.22	3.62	16.84	5.903
4	15.32	3.06	18.38	5.988
5	14.35	3.26	17.61	5.683
6	16.41	2.88	19.29	5.697
7	10.00	1.82	11.82	6.185
8	5.79	3.24	9.03	5.895
9	5.49	0.23	5.72	5.834
10	6.71	1.79	8.50	5.918
11	7.11	2.67	9.78	6.119
12	6.36	1.59	7.95	6.113
13	10.07	0.23	10.30	5.988
14	9.30	1.63	10.93	5.881
15	5.79	0.93	6.71	6.374
16	10.11	0.23	10.34	6.057
Mean	10.30	2.15	12.26	5.950

TABLE 15

Cooking Loss of Ground Beef Sources

Replication *80:20 Ground Beef- PrimeLine*

	Liquid loss %	Solid loss %	Total loss %	pH
1	7.61	1.74	9.34	6.287
2	4.67	0.72	5.39	5.980
3	5.87	1.47	7.33	5.850
4	13.37	1.32	14.69	5.980
5	10.71	1.73	12.44	6.055
6	15.63	2.87	18.50	6.119
7	13.19	2.17	15.35	6.119
8	12.73	5.06	17.79	6.124
9	14.83	2.76	17.59	5.839
10	15.96	1.82	17.78	5.839
11	9.94	1.86	11.80	5.981
12	10.95	4.06	15.01	5.942
13	12.94	2.65	15.59	5.792
14	12.38	2.73	15.11	6.129
15	13.95	1.85	15.80	5.879
16	13.52	5.69	19.22	5.956
Mean	11.77	2.53	14.30	5.992

TABLE 16

Cooking Loss and pH of Ground Beef from Three Different Sources

ITEM	TREATMENT[1]					
	80:20		80:20		80:20	
	HEB	N	HeartBrand	N	PrimeLine	N
Liquid cooking loss %	16.07[a]	16	10.30[b]	16	11.77[b]	16
Solid Cooking Loss %	0.69[a]	16	2.19[b]	16	2.53[b]	16
Cooking loss %	18.45[a]	16	12.26[b]	16	14.30[b]	16
pH	5.87[a]	16	5.95[a,b]	16	5.99[b]	16

[1]Means in the same row with different superscripts differ (P<0.05)

V. SUMMARY

Beef loins and ground beef were studied to determine the effect of beef source and quality grade on tenderness, pH, and cooking loss. Three distinct sources of strip loins and ground beef were evaluated.

Two experiments involving 9 animals, and 48 packages of ground beef from three different sources were used in these experiments. Each strip loin was divided into 6 roasts to provide a total of 54 loin roasts. There were 16 one-pound packages of ground beef used from each of the three sources. The total amounting to 48 packages and 192 individual ground beef patties.

These studies revealed that beef source is a variable factor related to quality consistency that is not fully accounted for in the quality grade or lean to fat ratio. Significant differences were found for all variables studied.

In the loin roast experiment, it was found that the tenderness of both prime grade sources were better ($P<0.05$) than the choice control. However, both prime grade sources were higher ($P<0.05$) in pH than the choice grade control. Furthermore, it was found that both prime grade sources had lower ($P<0.05$) total cooking loss than the choice grade control.

Tenderness, pH, and cooking loss of loin roasts were all affected by beef source (quality grade and/ or genetics) and this difference is likely due to forms of water in the meat. The relative amount of water forms (free, bound, and immobilized) reflects water-holding capacity. Water holding capacity is a function of physiological composition and

is correlated with intramuscular fat (marbling) and lean to fat ratio. Data from this loin roast experiment support this physiological explanation.

The ground beef experiment involved the same three commercial sources of beef as did the loin experiment, but different in respect to known individual animals. Commercial ground beef, as we used, results from blending of lean and fat usually from more than one animal. Thus, any reference to quality grade of carcasses is usually unknown. Instead od quality grade, ground beef is normally marketed on a lean to fat percentage basis. All ground beef used in this experiment was labeled 80:20 (80% lean and 20% fat).

Liquid cooking loss, solid cooking loss, total cooking loss, and pH were measured in the ground beef experiment. All procedures and methods were developed in our lab and validated by repeated measures.

It appears from the data that quality assessments of beef loins and ground beef are not fully apparent or known from quality grade or lean to fat ratio, respectively. Further evaluation, in addition to quality grade and lean to fat ratio, seems warranted in light of relationships of quality assessment factors to tenderness, pH, and cooking loss.

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