NUTRIENT CONTENT OF BEEF STEAKS AS INFLUENCED BY USDA QUALITY GRADE AND DEGREE OF DONENESS

A Senior Scholars Thesis

by

AMANDA MARIAN SMITH

Submitted to the Office of Undergraduate Research
Texas A&M University
in partial fulfillment of the requirements for the designation as

UNDERGRADUATE RESEARCH SCHOLAR

April 2010

Major: Animal Science

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	Kerri B. Harris
Associate Dean for Undergraduate Research:	Robert C. Webb

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ABSTRACT

Nutrient Content of Beef Steaks as Influenced by USDA Quality Grade and Degree of Doneness. (April 2010)

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The purpose of this study was to determine the influence of various degrees of doneness on the nutrient content of beef. Ten steaks were obtained from each of five USDA Prime, five USDA Choice, and five USDA Select strip loins and assigned to one of five degree of doneness treatments (two sets of treatments per strip loin): uncooked, medium rare (63 °C), medium (71 °C), well done (77 °C), and very well done (82 °C). Steaks then were dissected into separable tissue components consisting of lean, fat, and refuse. Lean tissue was used to obtain proximate analyses of protein, moisture, fat, and ash. This study showed that degree of doneness did influence ($P < 0.05$) the nutrient composition of beef steaks. As the degree of doneness increased, percent fat and protein increased, while percent moisture decreased. Thus, cooking steaks to a higher degree of doneness will result in a higher calorie steak.

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NOMENCLATURE

AMSA	American Meat Science Association
Ch	USDA Choice
DOD	Degree(s) of Doneness
IMPS	Institutional Meat Purchase Specifications
QG	USDA Quality Grade
Pr	USDA Prime
Se	USDA Select
SE	Standard Error
USDA	United States Department of Agriculture
YG	USDA Yield Grade

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CHAPTER I

INTRODUCTION

Consumers' concerns over dietary fat have been responsible for emphasizing the production of leaner retail beef cuts. According to Breidenstein and Carpenter (1983), in 1957, consumers purchased red meat without hesitation and with little or no regard towards its healthfulness. From 1960 to 1979, United States per capita consumption of beef increased by 23.8 percent while the demand for lamb, veal, and pork decreased by 69.8, 69.2, and 8.0 percent, respectively (Breidenstein & Carpenter, 1983). Many economic, cultural, and technological factors allowed the industry to match consumer demand. One factor leading to the increased supply of meat was the introduction of new, more efficient breeds of cattle and crossbreeding, allowing for an increased genetic base for producers. In the 1960s, there was a dramatic geographical change in finishing operations from rail to truck transport. This resulted in an increase in commercial feeding operations throughout the Great Plains region and the establishment of large, modern meat packing facilities in this same region, thus decentralizing the meat industry into true cattle producing areas (Koch & Algeo, 1983). Furthermore, the increased use of growth promotants, processed grain, and boxed beef allowed beef to reach the retail case faster. Whether by increasing carcass weight, decreasing time on feed, or allowing subprimals to move directly to stores, the beef industry was becoming more efficient.

This thesis follows the style of *Meat Science*.

Meanwhile, increased awareness of the health implications of a high-fat diet and the demand from consumers for leaner products (Breidenstein & Carpenter, 1983) led the beef industry to place added emphasis on USDA Yield Grades—estimated yield of boneless, closely trimmed retail cuts—by adopting them into the USDA grading standards in 1965. Carcasses can be assigned to one of 5 USDA Yield Grades, U.S. No. 1, U.S. No. 2, U.S. No. 3, U.S. No. 4, and U.S. No. 5. As numerical USDA Yield Grade increases, the percentage of closely trimmed retail cuts expected to result from that carcass decreases. Factors that influence USDA Yield Grade are ribeye area, adjusted fat thickness, hot carcass weight, and the percentage of kidney, pelvic, and heart fat remaining in the carcass.

Composition of beef carcasses and cuts has been a long-standing research area for meat scientists throughout the world. The National Consumer Retail Beef Study (Savell et al., 1989) concluded that retail cuts with excessive external fat were not only considered wasteful by consumers, but also projected negative connotations as to the taste and healthfulness of beef. The National Beef Market Basket Surveys (Mason et al., 2009; Savell, Harris, Cross, Hale, & Beasley, 1991) and the National Meat Case Studies (Reicks et al., 2008) showed an increased offering of lean cuts in the retail case, thus showing the industry's adaptation to meet consumer demand for a leaner product.

According to the 2005 Dietary Guidelines for Americans (U.S. Department of Health and Human Services and U.S. Department of Agriculture, 2005), Americans are increasingly overfed and yet undernourished. These guidelines recommend individuals focus on eating lean meat in adequate portion sizes. Furthermore, according the Centers for Disease Control (CDC), there is a strong correlation between high fat diets and obesity. People who are overweight or obese are at a higher risk for chronic conditions such as high blood pressure, diabetes, and high cholesterol (CDC, 2009). With these concerns on the horizon, it is essential that consumers be provided with accurate caloric values in order to make educated dietary choices.

The United States Department of Agriculture's (USDA) Agricultural Research Service houses the Nutrient Data Laboratory. According to their website (USDA, 2010), the purpose of the Nutrient Data Laboratory is "to develop authoritative food composition databases and state of the art methods to acquire, evaluate, compile and disseminate composition data on foods and dietary supplements available in the United States." Prior to 1992, nutrient information of meat was published in USDA's Agriculture Handbook No. 8, "Composition of Foods: Beef Products; Raw, Processed Prepared," which was first compiled in 1950 and has hence been revised four times in order to reflect the aforementioned industry changes. The printed handbook has been converted to a computerized database, the USDA National Nutrient Database for Standard Reference (Nutrient Database). The latest version of the Nutrient Database is Release 22, which was issued in 2009. This database provides data for national nutrition policies, diet therapy, nutrition education programs, guidance for pediatric, obstetric, and geriatric populations, as well as a source of information for menu calculations for schools, nursing homes, and hospitals (USDA, 2009b). Information in the Nutrient Database also is used to provide nutrition information for on-package labeling of nutrient claims.

In addition to the Nutrient Database, USDA has also created a Nutrient Data Set for Retail Beef Cuts (USDA, 2009a). This resource was designed to provide more accurate estimates of beef data to eventually update the Nutrient Database and to be used in nutrient labeling. Currently, a collaborative effort by Texas A&M University, Texas Tech University, and Colorado State University is underway to extend the number of cuts available in both the database and the Nutrient Data Set for Retail Beef Cuts.

Factors influencing beef composition

Fat

Long-chain fatty acids contribute to important aspects of meat quality, central to both nutritional and sensory values of meat. Medical professionals recommend a reduction in total fat intake in order to reduce the potentially adverse effects of fats on obesity and coronary heart disease. However, according to Webb and O'Neill (2008), recommendations are now shifting away from lipid quantity and towards lipid quality, emphasizing the need for conjugated linoleic acids and other omega-three fatty acids.

Conjugated linoleic acid, a polyunsaturated fatty acid with a similar structure to linoleic acid, has received increase attention in recent years due to its anticarcinogenic effects, antidiabetic properties, enhanced immune response, and positive effects on lean muscle mass in relation to body fat (Council for Women's Nutrition Solutions/Everyday

Solutions Roundtable, 2001). Furthermore, beef has the highest concentration of conjugated linoleic acid of any protein source.

Cooking

Thorough cooking is essential to achieve a safe product and a palatable product. Cooking can decrease the fat content by 17.9% to 44.4% and therefore concomitantly influence the content of different fatty acids (Gerber, Scheeder, & Wenk, 2009). In order to better understand cooking loss and fat retention, both cooking method and degree of doneness should be considered. The most commonly used degrees of doneness follow the "Beef Steak Color Guide" (AMSA, Board, & USDA/ARS, 1995) and are described as rare (60 °C or less), medium rare (63 °C), medium (71 °C), well done (77 °C), and very well done (82 °C). For food safety purposes, the Food Safety and Inspection Service (FSIS) recommends that beef be cooked to an internal temperature of 145°F, or 63°C.

Variations in cooking methods have been shown to affect sensory, mechanical, and cooking properties of beef. Wheeler, Koohmaraie, Cundiff, and Dikeman (1994) confirmed that cooking method can influence tenderness. Likewise, the Beef Customer Satisfaction study (Lorenzen et al., 2003; Lorenzen et al., 1999; Neely et al., 1999; Savell et al., 1999) showed that cooking method could affect consumer ratings of beef.

When establishing an appropriate cooking method for this study, a clam-shell type cooker was selected. McKenna, King, and Savell (2003) showed that this method was an acceptable alternative to the previously used electric boiler for cooking steaks. The clam-shell satisfies the requirements outlined by Lorenzen et al. (1999) of being similar to what consumers use at home, reducing the variation between research and reality.

One of the unique features of beef is that consumers have preferences for the degree of doneness of the steaks they prepare or have prepared for them. This is not the case for pork or poultry where the endpoint temperature tends to be less variable and on the well-done end of the spectrum. Degree of doneness impacts the amount of moisture and possibly the amount of fat that may be present in a steak. These factors then affect the flavor, juiciness, and overall palatability of beef.

In addition, fat retention—the amount of fat that remains in a steak after it is cooked—may be influenced by the degree of doneness of the steak. Previous research has demonstrated an increase in fat retention in the separable lean of cuts cooked with external fat still attached as compared to those cooked without the external fat (Coleman, Rhee, & Cross, 1988; Smith, Savell, Smith, & Cross, 1989). This increase in fat retention has been attributed to fat migration during cooking; fat from the external fat layer migrates into the muscle tissue during cooking, causing greater than 100% retention of fat in the separable lean portion (Goihl, Harris, Savell, & Cross, 1992). Further research by Harris, Harberson, Savell, Cross, and Smith (1992) showed that external fat trim level and degree of doneness influenced the amount of fat in steaks, but did not alter the fatty acid composition.

As far back as the early 1970s, several studies were conducted to better understand the effect of degree of doneness on palatability (Cross, Stanfield, & Koch, 1976; Luchak et al., 1998; Parrish, Olson, Miner, & Rust, 1973). Regardless of USDA Quality Grade or external fat trim, increasing internal endpoint temperature results in tougher, drier cuts with longer cooking times and greater cooking loss (Luchak et al., 1998). However, the role of degree of doneness on fat retention and concentration of protein of steaks is not fully understood, especially when evaluated over a wide range of fatness levels in steaks that come from USDA Prime, Choice, and Select beef strip loins.

Tenderness

Though nutrition is the primary concern in this study, it is important to realize that the increased healthfulness of beef should not come at the expense of tenderness and palatability. The National Consumer Retail Beef Study (Savell et al., 1989) revealed that tenderness or meat texture is the single most important factor affecting taste or consumers' perceptions of taste. This was also shown in the Beef Customer Satisfaction Study (Lorenzen et al., 1999; Neely et al., 1999; Savell et al., 1999). Moreover, it has been well documented that consumers are willing to pay more for beef products that are known to be tender (Boleman et al., 1997; Killinger, Calkins, Umberger, Feuz, & Eskridge, 2004).

Objectives

Consumers have become increasingly more aware of the relationship between health and nutrition. Extensive research is under way to ensure consumers are provided the most accurate data on the nutrient composition of beef retail cuts; however, the effect that degree of doneness has on the nutrient content of beef is not yet understood. Information on the differences in caloric values based on degree of doneness would allow the consumer to make better-informed decisions.

The objective of this study was to determine the role of USDA Quality Grade on the nutrient composition of beef steaks when cooked to different degrees of doneness.

CHAPTER II

METHODS

Carcass and cut selection

Carcasses (n=15) were selected from a commercial beef plant in the Texas Panhandle for use in this study. Five USDA Prime, 5 USDA Choice, and 5 USDA Select (USDA, 1997) beef carcasses were fabricated, and the beef loin, strip loin, boneless (IMPS 180) (NAMP, 2005; USDA, 1996) was obtained and vacuum packaged. The mean carcass characteristics are shown in Table 1. The strip loins were shipped to Texas Tech University, stored under refrigeration for approximately 3 days, and then transported on ice to the Texas A&M University Rosenthal Meat Science and Technology Center for fabrication into retail cuts.

Table 1
Mean carcass characteristics of beef carcasses used for subprimal selection.

	USDA Prime		USDA Choice			USDA Select	
Carcass characteristic	YG 2 *(n = 1)*	YG 3 *(n = 4)*	YG 1 *(n = 1)*	YG 2 *(n = 2)*	YG 3 *(n = 2)*	YG 2 *(n = 3)*	YG 3 *(n = 2)*
Adjusted PYG	3.6	3.8	3.0	3.1	3.8	3.2	4.0
Kidney, pelvic and heart fat, %	3.7	3.6	2.8	2.7	2.9	3.0	2.4
Ribeye area, cm^2	103.87	92.9	96.77	94.19	95.48	91.61	94.19
Hot carcass weight, lb.	371.49	367.32	318.88	375.57	402.79	353.48	376.03
USDA Yield Grade	2.8	3.6	1.8	2.6	3.5	2.7	3.4
USDA marbling score	Moderately Abundant^{10}	Moderately Abundant^{23}	Modest^{50}	Small^{90}	Small^{90}	Slight^{50}	Slight^{55}

Retail cut fabrication

After aging for a minimum of 14 days, each strip loin was cut into a minimum of 10 Top loin steaks. This was accomplished by using a band saw, and each steak was measured to ensure a thickness of 2.54 cm. Steaks were trimmed so that external fat did not exceed 0.64 cm. Each steak was vacuum packaged individually, labeled, and frozen at -23 °C for subsequent cooking and dissection.

Cooking

Retail cuts were thawed overnight in a cooler maintained at 4±2 ºC prior to weighing and cooking according to the assigned method for one of five degrees of doneness. Degrees of doneness included: uncooked, medium rare (63 °C), medium (71 °C), well done (77 °C), and very well done (82 °C). The steaks were cooked on clam-shell cookers using George Foreman® Grills (model GGR62, Salton, Inc., Lake Forest, IL). The temperature of each retail cut was monitored using a digital, hand-held thermometer (model 91100-50, Cole-Parmer Instrument Co., Vernon Hills, IL) with a type K thermocouple (model KTSS-HH, Omega Engineering, Inc., Stamford, CT) inserted into the geometric center of the cut. After cooking, the steaks were chilled overnight in a 4±2 ºC cooler. Cooked weights of beef retail cuts were taken after chilling and used to calculate cooking yields using the following formula:

$$\text{Percentage cooking yield} = \left(\frac{\text{cooked weight (g)}}{\text{raw weight (g)}}\right) \times 100.$$

Sample preparation

Both raw and cooked steaks were dissected to produce groups of lean, fat, and waste. Included within the lean portion was all muscle, intramuscular fat, and any connective tissue that was considered edible. The fat portion consisted of external fat and seam fat. The external fat group was composed of any adipose tissue located on the outer surface of the cut, above the bridge of the muscles. Seam fat was considered any intermuscular fat within the cut. The waste portion included any heavy connective tissue, which was considered inedible, within the steaks.

The separable lean components of steaks from the same strip loin were combined with their counterpart with the same degree of doneness in Ziploc® bags with proper identification and were held in a cooler (4±2 ºC) for same-day homogenization. Samples were removed from refrigeration one at a time, cubed into 2.5-cm^3 or less pieces, and submerged in liquid nitrogen in a 2-quart (1.89-L) insulated foam nitrogen bucket. Using a stainless steel long handled spoon, the samples were stirred to incorporate the nitrogen and ensure that all pieces were completely frozen. After draining excess liquid nitrogen into another foam bucket, the frozen samples were transferred into a 7-quart (6.62-L) Robot Coupe BLIXER 6V (Robot Coupe, Robot Coupe USA, Inc., Jackson, MS) and blended/powdered until appearing finely powdered and homogenized. Each samples was blended for approximately 10 seconds on low speed (1500 rpm) and 30 seconds on high speed (3500 rpm), after which a small amount of liquid nitrogen was added to the sample before a second homogenization in the Robot Coupe began. When the sample was completely homogenized, 60 grams were removed for proximate analysis and 100 grams for proximate backup. The remaining sample was disposed. All aliquots were placed in a pre-labeled whirl-pak bags, double bagged and stored in a freezer for further analysis.

Proximate analyses

Moisture

Moisture analysis was performed using the oven-drying method 950.46 (AOAC International, 1990). Samples of approximately 5 grams were weighed out into pre-dried, pre-weighed aluminum dishes and allowed to dry for 16-18 hours at 100 °C in the drying oven. Following drying, samples then were placed in a dessicator to cool. Cooled samples were weighed and loss in weight was reported as moisture.

Ash

Ash was determined using the ash oven method 942.05 (AOAC International, 1990). The samples remaining from the moisture analysis were placed into a box furnace at 600 °C for 10.5 hours and then were held at 100 °C until samples were removed. The samples then were cooled in a dessicator. Cooled samples were weighed and loss in weight was used to calculate ash.

Lipids

Lipid was extracted using the modified Folch et al. (1957) method. Samples (approx.

0.5 g) were homogenized with 15 mL chloroform methanol (2:1) in a 55 mL screw top culture tube. The homogenate was filtered through a Buchner funnel with slight suction. The filter was rinsed with chloroform methanol. The filtrate was transferred into a 50 mL tube, and 8 mL of a 0.74% KC1 solution was added. The total volume of the chloroform methanol layer was recorded. After separation, the upper phase was siphoned off and the lower phase was transferred into pre-dried, pre-weighed graduated cylinder. The percent lipid concentration was calculated using the formula:

$$\%\ \text{Lipid} = \left(\frac{(\text{Total volume of Ch. Meth.} \div 10)\ \text{x}\ (\text{Lipid (g)})}{\text{Sample Weight}} \right)\ \text{x}\ 100$$

Protein

Percent protein determination was achieved by use of a rapid N cube (Elementar Analysensysteme GmbH, Hanau, Germany) nitrogen analyzer. Approximately 250 mg of each sample was weighed into foil weigh boats and a pellet was formed. Sample and standards pellets (3 – 200 mg Aspartic Acid standards) were placed in the carousel and the nitrogen analysis was run. The percent protein was determined and reported by the machine.

Statistical analyses

Data were analyzed using PROC GLM of SAS (SAS Institute, Inc., Cary, NC). Least squares means were generated for main effects and separated using PDIFF option when appropriate with an alpha-level ($P < 0.05$). For comparative purposes, all USDA quality grade were combined into an “All Grades” category.

CHAPTER III

RESULTS

Cooking yields of the beef Top loin steaks are shown in Table 2. As degree of doneness increased, cooking yield decreased. This is most likely due to moisture loss during cooking. As steaks are cooked, they begin to lose moisture, thus decreasing overall weight (Aberle, Forrest, Gerrard, & Mills, 2001), which in turn causes an increase in cooking loss. Theoretically, steaks that had a higher intramuscular lipid content would have a greater amount of cooking loss; however, there was no relationship ($P > 0.05$) between grade and cooking yield.

Table 2
Means for cooking yields from Top loin steaks cooked to various degrees of doneness as influenced by USDA Quality Grade.

	Percentage			
Degree of doneness	All Grades	Prime	Choice	Select
Medium Rare	89.73	88.58	91.53	87.84
Medium	87.14	87.50	87.28	86.30
Well Done	82.71	81.54	80.45	80.90
Very Well Done	80.94	82.57	83.61	81.68

Top loin steaks in this study were dissected into three separable components; separable lean, separable fat, and connective tissue considered inedible, also referred to as refuse. Table 3 reports the means and standard deviations for the separable components of steaks cooked to varying degrees of doneness and grade. The values are described on a weight basis. As degree of doneness increased, so did the weight of separable lean. There was a relationship ($P < 0.05$) between separable lean and both degree of doneness and grade. However, there was no interaction ($P > 0.05$) between grade and degree of doneness in relation to separable lean. There was a significant ($P < 0.05$) interaction between grade and both separable fat and refuse, but no interaction ($P > 0.05$) between degree of doneness and these two components.

Table 3
Least squares means and standard errors (SE) for weights of the separable tissue components from selected, beef Top loin steaks cooked to various degrees of doneness (DOD) as influenced by USDA Quality Grade.

	Weights (grams)											
	Separable Lean				Seam Fat				Refuse			
DOD	Pr.	Ch.	Se.	SE	Pr.	Ch.	Se.	SE	Pr.	Ch.	Se.	SE
Raw	228.3	246.7	217.3	5.85	42.1	39.9	30.4	3.89	15.4	20.9	19.5	1.87
Med. Rare	201.1	223.9	192.9	5.85	36.8	38.3	27.9	3.89	15.8	17.0	15.1	1.87
Med.	192.5	215.3	181.7	5.85	34.1	39.1	25.5	3.89	15.7	15.8	18.6	1.87
Well Done	181.5	204.4	169.2	5.85	35.2	29.8	23.3	3.89	14.3	20.9	18.1	1.87
Very Well Done	174.5	190.1	163.9	5.85	36.0	32.9	21.0	3.89	13.0	16.8	20.7	1.87

Percent total chemical fat, moisture, protein, and ash analyses were conducted on the separable lean component obtained from the dissection of each retail cut. Separable fat and refuse components were not considered because these groups would generally be left on the plate by most consumers. There was an interaction ($P < 0.05$) between grade and the percentage of chemical fat, moisture, protein, and ash found in Top loin steaks (Table 4). Here, it is evident that fat tends to increase as grade increases. This is expected because with an increase in USDA Quality Grade, there was an increase in intramuscular fat. Also, mean percentage of moisture decreased as the mean percentage of total fat increased. Jones et al. (1992) and Wahrmund-Wyle et al. (2000) both reported parallel findings.

Table 4
Least squares means and standard errors (SE) for percentage chemical fat, moisture, protein, and ash from selected beef Top loin steaks as influenced by USDA Quality Grade.

	Percentage							
Grade	Fat	SE	Moisture	SE	Protein	SE	Ash	SE
Prime	14.8^a	(0.3)	60.0^b	(0.4)	24.9^c	(0.2)	1.103^b	(0.02)
Choice	7.9^b	(0.3)	66.0^a	(0.4)	26.3^b	(0.2)	1.157^b	(0.02)
Select	5.4^c	(0.3)	67.0^a	(0.4)	27.7^a	(0.2)	1.243^a	(0.02)

$^{a\text{-}c}$Means within the same column lacking a common letter differ ($P < 0.05$)

When looking at the percentages for proximate data in Table 4, it is important to note the mean effects amongst each proximate group. As expected, there was no mean effect for protein or fat; however, there was a mean effect for ash and moisture. The least squares means for ash showed that USDA Choice and USDA Prime steaks were similar in ash, while USDA Select steaks differed. When considering moisture, USDA Choice and USDA Select steaks were similar, but Prime was substantially lower.

Table 5 shows there was an interaction ($P < 0.05$) between degree of doneness and the percentage of chemical fat, moisture, protein, and ash found in Top loin steaks. As the degree of doneness increases, percent fat and protein increase. However, percent moisture decreases. This is due to the fact that the cooking process causes a loss of moisture. In the raw counterparts, there is more moisture so the nutrient components of the steaks are more diluted down and thus occupy a lower percentage of the total. As expected, percentage ash is relatively constant amongst all USDA Quality Grades and all degrees of doneness. Few significant differences were found for ash content due to degree of doneness or USDA Quality Grade.

Table 5
Least squares means and standard errors (SE) for percentage chemical fat, moisture, protein, and ash from selected beef Top loin steaks as influenced by degree of doneness (DOD).

	Percentage							
DOD	Fat	SE	Moisture	SE	Protein	SE	Ash	SE
Raw	7.3[b]	(0.3)	70.1[a]	(0.4)	22.3[e]	(0.2)	1.122[b]	(0.02)
Medium Rare	9.6[a]	(0.3)	64.7[b]	(0.4)	25.8[d]	(0.2)	1.136[b]	(0.02)
Medium	9.9[a]	(0.3)	63.4[b]	(0.4)	26.8[c]	(0.2)	1.138[b]	(0.02)
Well Done	9.8[a]	(0.3)	62.2[b,c]	(0.4)	27.9[b]	(0.2)	1.20[a,b]	(0.02)
Very Well Done	10.2[a]	(0.3)	61.2[c]	(0.4)	28.6[a]	(0.2)	1.24[a]	(0.02)

[a-e]Means within the same column lacking a common letter differ ($P < 0.05$)

Besides noticing trends in the least squares means expressed in Table 5, mean effects should also be considered for the percentages for proximate data. There was no mean effect for protein amongst differing degrees of doneness. The raw samples were significantly lower in fat as compared to the cooked samples. Furthermore, moisture showed that raw values differed from cooked samples. Amongst the cooked samples for moisture, medium rare, medium, and well done were similar. Well done and very well done were also similar. As far as ash was concerned, the well done and very well done samples were higher than samples from the lower degrees of doneness.

Both of these tables can be used to convert to actual caloric values using the Atwater conversion factors of 4, 9, 4 for protein, fat, and carbohydrate, respectively. There is no conversion factor for ash or moisture, since these components do not offer caloric values. Tables 6 and 7 use the Atwater conversions to derive a predicted caloric value for Top loin steaks, based on the two treatments used in this study. The recommended serving size of beef is 3 ounces (USDA, 2009b), which converts to 85.05 grams. Therefore, amounts are calculated to represent a serving of meat. Though Tables 6 and 7 represent the same trends as seen in Tables 4 and 5, they display the values in a form more widely understood by consumers. As USDA Quality Grade increases, so does caloric value. Similarly, as steaks are cooked to a higher endpoint temperature the caloric value increases.

Table 6
Caloric values of beef Top loin steaks as influenced by USDA Quality Grade using Atwater conversions.

	Calories per 100 grams		
Grade	Fat	Protein	Total
Prime	113.29	84.71	198.00
Choice	60.47	89.47	149.94
Select	41.33	94.24	135.57

Table 7
Caloric values of beef Top loin steaks as influenced by degree of doneness (DOD) using Atwater conversions.

	Calories per 100 grams		
DOD	Fat	Protein	Total
Raw	55.88	75.86	131.74
Medium Rare	73.48	87.77	161.25
Medium	75.78	91.17	166.95
Well Done	75.01	94.92	169.93
Very Well Done	78.08	97.30	175.37

The proximate values found in this study differ from those recorded in the current Nutrient Database to a certain degree. The values from the current Nutrient Database are listed in Table 8. The important thing to note is that the Nutrient Database values are formulated from separable lean and fat, unlike in this study where only separable lean was used.

Table 8
Percentage chemical fat, moisture, protein, and ash of separable lean and fat of beef Top loin steaks as influenced by USDA Quality Grade as recorded in the USDA National Nutrient Database for Standard Reference.

		Percentage			
Raw/Cooked	Grade	Fat	Moisture	Protein	Ash
Raw	All	15.49	63.43	20.61	.90
Raw	Prime	22.17	58.42	22.17	.77
Raw	Choice	15.95	62.91	15.95	.93
Raw	Select	15.04	63.95	20.59	.87
Cooked	All	16.78	56.48	26.44	1.03
Cooked	Prime	22.12	51.34	25.92	1.06
Cooked	Choice	18.45	54.99	26.16	1.02
Cooked	Select	15.11	57.96	26.72	1.04

CHAPTER IV

SUMMARY AND CONCLUSIONS

Consumers have become increasingly more aware of the relationship between health and nutrition. One of the unique features of beef is that consumers have preferences for the doneness of the steaks they prepare or have prepared for them. This is not the case for pork or poultry where endpoint doneness tends to be less variable and on the well-done end of the spectrum. Nutritive values of beef are available for different United States Department of Agriculture (USDA) Quality Grades, but there are no published values for steaks cooked to different degrees of doneness. The added understanding of the differences in caloric values based on degree of doneness would allow the consumer to make more informed decisions.

This study showed that degree of doneness influences the nutrient composition of beef steaks. As the degree of doneness increases, percent fat and protein increase, while percent moisture decreases. Thus, cooking steaks to a higher degree of doneness will result in a higher calorie steak.

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