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PROXIMATE COMPOSITION AND FAT RETENTION OF BEEF STEAKS AS INFLUENCED BY TISSUE COMPOSITION, USDA QUALITY GRADE, AND COOKING METHOD

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Introduction

Various factors are known to affect lipid content, and consequently, the overall proximate composition of meat. Some of these factors include retail cut (Jones et al., 1992b; Wahrmund-Wyle et al., 2000b), cooking method (Jones et al., 1992b; Renk et al., 1985, Morgan et al., 1988), USDA quality grade (Jones et al., 1992b; Wahrmund-Wyle et al., 2000b), and the extent of fat trimming and fat retention (Coleman et al., 1988; Jones et al., 1992b). While several researchers have reported that increasing amounts of surface fat left on retail cuts before cooking increases fat retention (Coleman et al., 1988; Morgan et al., 1988; Jones et al., 1992c) and the corresponding fat concentration of the separable lean (Jones et al., 1992c; Coleman et al., 1988; Morgan et al., 1988), others have disregarded such claims (Novakofski et al., 1989) or found mixed results (Goihl et al., 1992; Wahrmund-Wyle et al., 2000a) in beef cuts. Evidenced by the relatively high amount of chemical fat retained in some retail cuts trimmed of surface fat, it has been suggested that fat migration can be also attributed to the seam fat (Jones et al., 1992c). Therefore, further studies are needed to elucidate the effect of the relative proportion of separable fat depots left in retail cuts on fat retention and nutrient content of the edible portion across cooking methods and quality grades.

Objectives

a) To examine the variation in raw tissue composition, cooking yield, fat retention, and proximate composition of the edible portion of four retail cuts differing in seam and surface fat. b) To identify the influence of cooking method and quality grade on the same response variables.

Methodology

Carcass selection and fabrication

The right side of six USDA Choice and six USDA Select carcasses was fabricated into the following four subprimals as described by their USDA (1996) Institutional Meat Purchase Specifications (IMPS) Number: Ribeye (IMPS# 112); Shoulder Clod (IMPS# 114); Top round (IMPS# 168); and Tenderloin (IMPS# 190). Steaks, 2.54 cm thick, were cut from each listed subprimal, assigned a cooking method, vacuum packaged, and frozen for subsequent cooking and proximate composition analysis. Ribeye steaks were trimmed of any surface fat while top round and shoulder clod steaks were trimmed to 0.32 cm surface fat. Tenderloins were defatted (no surface fat present) but not trimmed of any seam fat.

Dissection and Cooking

All retail cuts were vacuum packaged, grouped according to cooking method, and stored frozen at -23ºC until needed for cooking and dissection. Steaks were analyzed as a broiled, oven broiled, or raw sample. Samples that were treated as raw were thawed and dissected into separable tissue components (separable lean, surface fat, seam fat, and waste) that were weighed and converted to percentages. Broiled steaks were cooked to an internal temperature of 70°C in an electric Farberware Open-Hearth Broiler. Steaks designated as oven broiled were cooked to an internal temperature of 65°C in a preheated broiler. Raw, cooked, and cold weights (used to determine percentage yield) along with on and off temperatures were recorded. Cooked weights of beef retail cuts taken after cuts were chilled and were used to calculate cooking yields as follows:

$$\text{Percentage cooking yield} = (\text{cooked weight})/(\text{raw weight}) \times 100$$

Proximate composition

Separable lean from raw and cooked steaks was homogenized in a Cuisinart® food processor. Protein, moisture, and ash analyses were conducted by AOAC methods (AOAC, 1990). Fat analysis was determined by the Modified Folch Method (Folch et al., 1957).

Fat retention

Fat retention values were determined for each sample using raw versus cooked data as described by Jones et al. (1992c), and expressed as follows:

$$\text{Percentage fat retention} = (\%\text{ fat in cooked lean})/(\%\text{ fat in raw lean}) \times \%\text{ cooking yield}$$

Statistical analysis

Data were analyzed using SAS (2002) PROC GLM. Main effects and interactions were analyzed. Independent variables not significant for the interactions were pooled into the error term. A significance level of $P < 0.05$ was used, and means were separated using the PDIFF option of SAS.

Results & Discussion

Table 1
Least squares means and standard errors for percentages of raw tissues components of four retail steaks

	Retail cut			
	Ribeye steaks (n=12)	Tenderloin Steaks (n=12)	Shoulder clod steaks (n=10)	Top round steaks (n=12)
Separable lean, %	77.5±1.8a	82.1±1.8ab	77.8±2.0a	85.9±1.8b
Surface fat, %	0.0±1.1a	0.0±1.1a	4.4±1.2b	6.0±1.1b
Seam fat, %	15.2±1.8a	12.0±1.8ab	10.5±1.9ab	2.9±1.8c
Waste, %	6.7±1.1	4.9±1.1	6.9.±1.2	4.6±1.1

Means in the same row lacking a common letter differ ($P < 0.05$)

Raw tissue composition

Percentage waste was the only dissectible component affected ($P < 0.01$) by USDA quality grade (results not shown in tabular form). Choice steaks yielded 3% more ($P < 0.05$) waste than their Select counterparts (percentage LS Means and SE were 7.4 ± 0.8 vs. 4.3 ± 0.8, respectively). Conversely, Wahrmund-Wyle et al. (2000a) did not find any differences in percent waste between USDA Select and Choice.

Retail cuts varied significantly in tissue components (Table 1). Ribeye and shoulder clod steaks produced the lower amounts of separable lean ($P < 0.05$) whereas top round steaks ranked highest in lean yield.

Cooking yield

USDA grade or cooking method did not affect cooking yield ($P > 0.05$). Lack of variation in cooking yield due to USDA grade has been reported previously (Jones et al., 1992c; Wahrmund-Wyle et al., 2000b). Retail cuts trimmed to zero surface fat (i.e., ribeye and tenderloin) had lower ($P < 0.05$) cooking losses and exhibited the higher yields (Table 2). This finding contradicts that of Jones et al. (1992c) where cooking yields were not significantly affected by surface trim levels and an inverse trend to our results was observed for most cuts (i.e., lower numerical values for predicted cooking yields were found in those retails cuts trimmed to zero before cooking).

Table 2

Least squares means and standard errors for cooking yield and related variables of four retail cuts

	Retail cut			
	Ribeye steaks	Tenderloin	Shoulder clod	Top round

	(n=24)	steak (n=24)	steak (n=23)	steak (n=24)
Raw weight, g	263.5 ± 12.4a	188.1 ± 12.4b	515.3 ± 12.6c	333.8 ± 12.4d
Cooked weight, g	209.8 ± 10.4a	146.9 ± 10.4b	394.5 ± 10.7c	251.5 ± 10.4d
Cook loss, g	42.7 ± 2.9a	34.8 ± 2.9a	79.4 ± 3.0b	62.3 ± 2.9c
Cook yield, %	75.9 ± 0.8a	74.3 ± 0.8a,b	73.5 ± 0.8b	72.7 ± 0.8b

Means in the same row lacking a common letter differ (*P*<0.05)

Proximate composition and fat retention of the separable lean

Chemical fat. Cooked samples had higher (*P* < 0.05) fat contents (7.6% and 6.8% for broiled and oven broiled steaks, respectively) than their raw (4.5%) counterparts (Figure 1). The higher fat extraction in cooked samples is widely supported (Renk et al.,1985; Smith et al.,1989; Goihl et al., 1992; Jones et al., 1992c), but Wahrmund-Wyle et al. (2000b) found the opposite. The significant variation in fat content due to broiling method was not found by Renk et al. (1985) in pork samples.

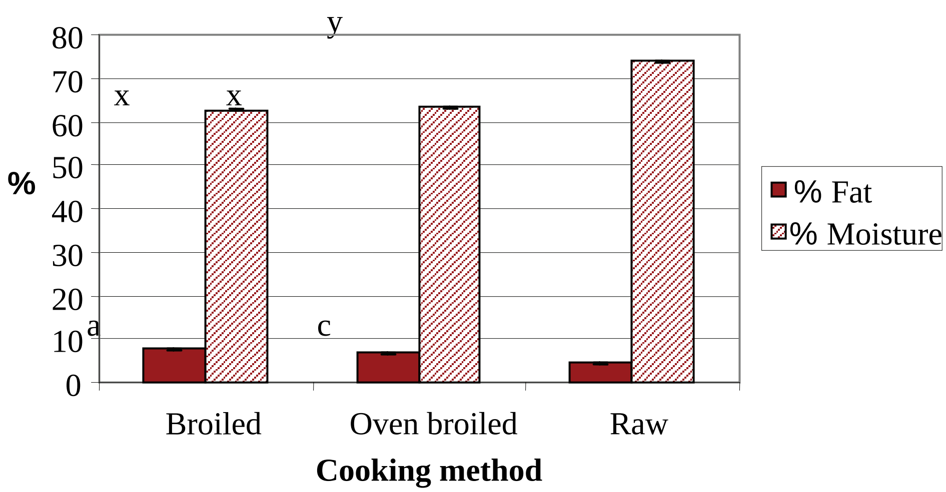

Figure 1. Least squares means and standard errors for percentages of chemical fat and moisture from proximate analysis of broiled, oven broiled and raw retail cuts. Columns with different letters differ (*P* < 0.05).

The general trend reported previously by Wahrmund-Wyle et al., (2000b) and Jones et al. (1992b) was that Choice steaks had significantly more percentage chemical fat than their Select counterparts. However, there was an interaction (*P* < 0.0001) between retail cut and USDA quality grade (Figure 2). Whereas fat content progressively decreased as seam fat proportion in Choice retail cuts decreased (in the order: Ribeye > Tenderloin > Shoulder clod > Top round), an irregular pattern in fat content was observed among retail cuts of the Select grade.

Moisture. Raw samples had higher ($P < 0.05$) moisture contents compared to counterparts of broiled or oven broiled steaks (Figure 3). The lower percentage moisture in the cooked steaks has been reported previously (Smith et al., 1989; Goihl et al., 1992; Jones et al., 1992b). Comparison of quality grades shows a similar tendency to that reported by Wahrmund-Wyle et al. (2000b) and Jones et al. (1992b) in that separable lean of Select steaks had more moisture than their Choice counterparts. However, there was an interaction ($P = 0.0028$) between retail cut and USDA quality grade (Figure 3) that shows an opposite trend to that described for the fat content. Whereas moisture content progressively increased as seam fat in Choice retail cuts decreased (in the order: Ribeye > Tenderloin > Shoulder clod > Top round), an irregular pattern in moisture content was observed among retail cuts of the Select grade.

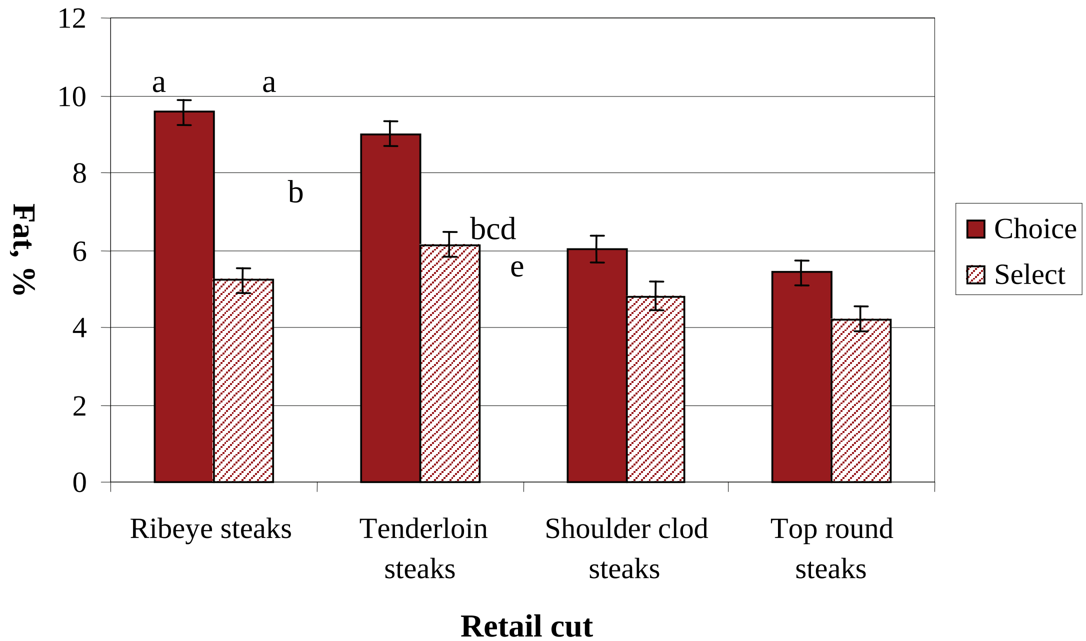

Figure 2. Least squares means and standard errors for percentages of fat from proximate analysis as affected by retail cut and USDA quality grade. Columns with different letters differ (*P* < 0.05).

Protein. There were two significant two-way interactions for protein: cooking method × USDA quality grade ($P = 0.0217$) and retail cut × cooking method ($P = 0.0043$).

Figure 4 shows that broiled steaks of the Select grade had more ($P < 0.05$) protein than their Choice counterparts ($P < 0.05$) but such differences (if any) in grade were of lesser magnitude and not significant for oven broiled or raw steaks (Figure 5). Cooked steaks did not differ in percent protein within the same USDA quality grade whereas protein contents of raw steaks regardless of USDA grade were lower than Choice and Select cooked steaks ($P < 0.05$).

Figure 5 depicts the relationship between retail cut and cooking method, showing that variations in protein content due to cooking treatments were of different magnitudes across retail cuts although the protein content was always lowest in the raw samples.

Ash. Percent ash of the separable lean was only affected by retail cut ($P = 0.0109$), but differences were minor among cuts (results not shown in tabular form). Top round steaks exhibited the highest ash percentage (1.09 ± 0.03), different ($P < 0.05$) from ribeye (0.96 ± 0.03) and tenderloin (0.99 ± 0.03) steaks but similar to shoulder clod (1.01 ± 0.03) steaks ($P = 0.0554$).

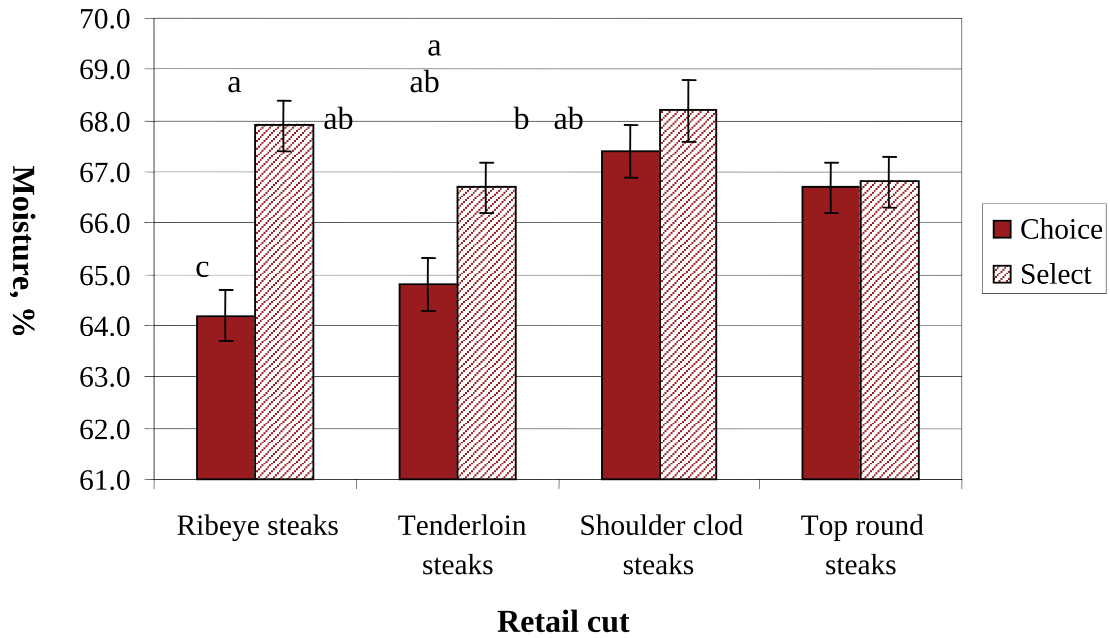

Figure 3. Least squares means and standard errors for percentages of moisture as affected by retail cut and USDA quality grade. Columns with different letters differ (*P* < 0.05).

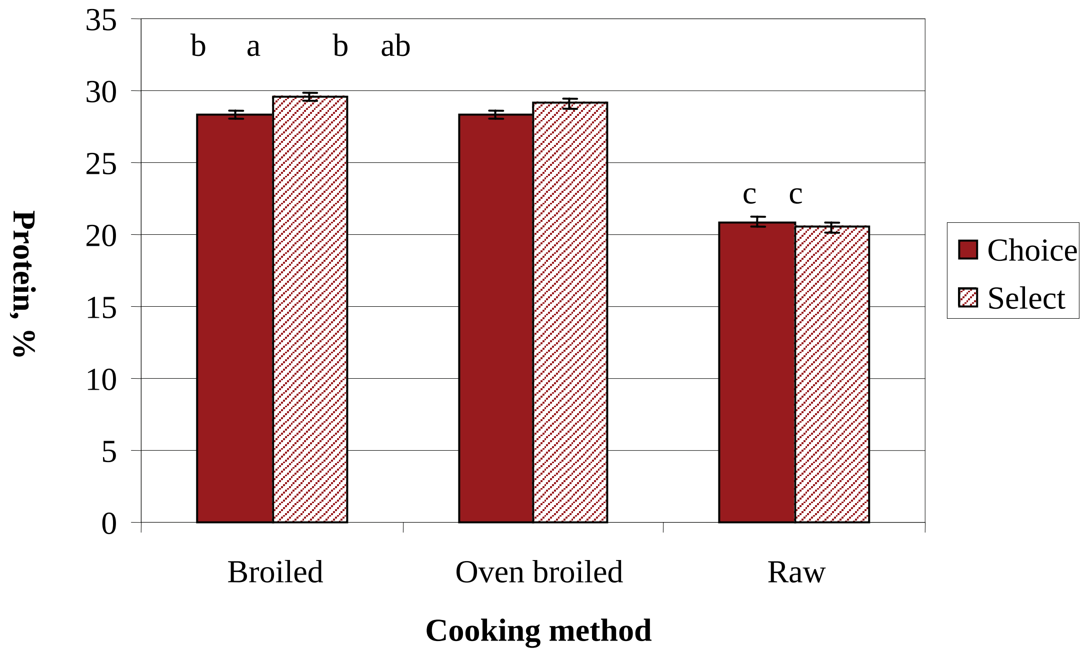

Figure 4. Least squares means and standard errors for percentages of protein as affected by USDA quality grade and cooking method. Columns with different letters differ (*P* < 0.05).

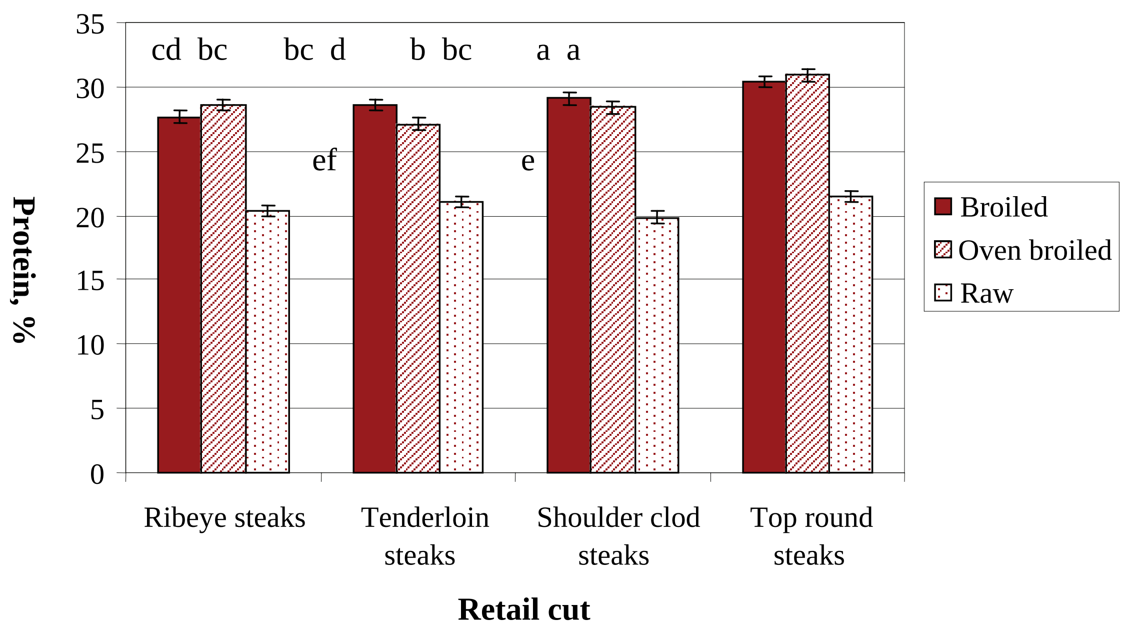

Figure 5. Least squares means and standard errors for percentages of protein as affected by retail cut and cooking method. Columns with different letters differ (*P* < 0.05).

Fat retention. Retention of fat within the lean after cooking was only affected significantly by USDA quality grade (*P* = 0.0128) and cooking method (*P* = 0.0053). The non-significant variation in fat retention due to retail cut (Figure 6) does not agree with the findings of Morgan et al. (1988) and Jones et al. (1992c). It also contradicts our hypothesis that fat retention would be affected by retail cut due to the wide range of seam and surface fat present in the selected retail cuts. Adjusted means for fat retention in the lean portion exceeded 100% in all selected retail cuts (Figure 6), supporting the common suspicion that lipids from other depots migrated into the lean. However, lack of significant variation in fat retention among retail cuts differing in proportion or seam fat does not contribute to support the influence of rendered lipids migrating from the seam fat depots into the lean edible portion as suggested by Jones et al. (1992c) or Renk et al. (1985).

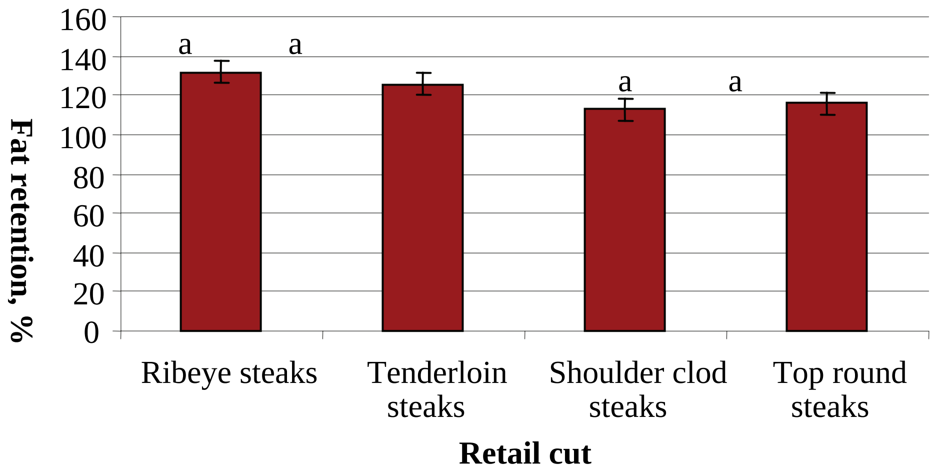

Figure 6. Least squares means and standard errors for fat retention percentages of ribeye, tenderloin, shoulder clod, and top round steaks. Columns with different letters differ (*P* < 0.05).

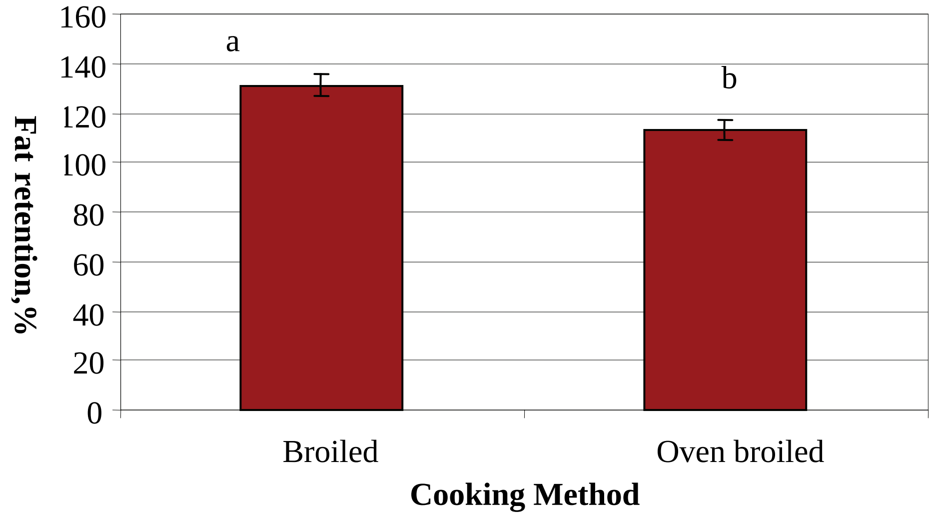

Figure 7. Least squares means and standard errors for percentage of fat retention of broiled and oven broiled steaks. Columns with different letters differ (*P* < 0.05).

Percentage fat retention was higher (*P* = 0.0026) for broiled steaks (Figure 7). Conversely, Renk et al. (1985) reported that cooking method did not affect fat retention. Fat retention was higher in separable lean of Select steaks than in Choice steaks (Figure 8). However, Renk et al. (1985) reported that degree of marbling did not have an effect on fat retention.

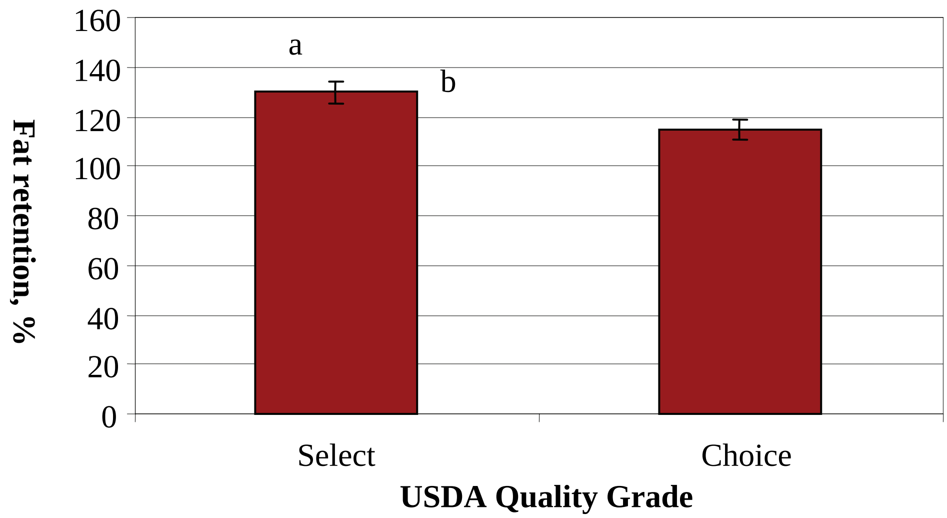

Figure 8. Least squares means and standard errors for fat retention percentages of Select and Choice steaks. Columns with different letters differ (*P* < 0.05).

Conclusions

Retail cuts, due to their anatomical location, are physically composed of different percentages of lean, surface fat, and seam fat. Retail cut had a direct effect on dissection yields and an indirect effect on proximate composition values simply because of the amount of fat deposition and fat trimming level. Cooking method did alter the percentage of proximate composition with regards to percentage chemical fat and moisture. Migration of fat throughout the lean is affected by cooking method. However, the question regarding the original source of these migrating lipids remains unresolved.

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