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Carcass boneless yield of Braford steers, classified according to fat coverage class

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ABSTRACT - The objective of this study was to evaluate total and individual meat yield of boneless cuts, retail cuts, descarded trimmings and carcass bones of 38 Braford castrated steers, slaughtered at 22 months of age after feedlot finishing. Carcasses were classified in three ranks according to fat coverage: even fat coverage over the carcass, with fat thickness of approximately 6-8 mm on the 12th rib; animals with uneven fat cover, with fat thickness of 3-5 mm and steers with insufficient fat coverage over the carcass, with fat thickness of 1-2 mm. Shrinkage losses decreased as fat coverage increased, and it was 2.57, 2.22, and 1.96%, respectively, for insufficient, uneven, and even fat coverage whereas flank yield increased, reaching values of 13.04, 13.47 and 14.36%. Boneless yield was the highest in carcasses with insufficient fat coverage (78.70%) when compared to even fat coverage (77.62%), which is a result of the lowest trimming percentage, which increased according to coverage fat (4.40; 5.14 and 6.01%, respectively for carcass with insufficient fat coverage, uneven fat coverage and even fat coverage). Back rib and short rib yields were the greatest in carcasses with the largest fat thickness, whereas percentage of silverside and topside were the greatest in carcass with insufficient fat coverage compared to the ones with even fat coverage. Braford castrated steers can be slaughtered with the smallest fat coverage because the low fat coverage does not affect negatively yield of secondary cuts. Increase in coverage fat reduces shrinkage losses mainly in cuts submitted to little fat trimming.

Key Words: cold shrinkage, commercial cuts, deboned cuts, fatness, packing plants, primal cuts

Rendimento de desossa de carcaças de novilhos Bradford classificadas de acordo com a classe de gordura de cobertura

RESUMO - Objetivou-se com este trabalho avaliar os rendimentos cárneos total e individual de cortes desossados, retalho comestível, retalho descartado e ossos de carcaças de 38 novilhos Braford castrados abatidos com 22 meses de idade após terminação em confinamento. As carcaças foram classificadas em três categorias, de acordo com cobertura de gordura: uniforme sobre toda a carcaça, com espessura de gordura de aproximadamente 6-8 mm sobre a 12ª costela; desuniforme, com espessura de gordura de 3-5 mm; e escassa, com espessura de gordura de 1-2 mm. A quebra durante o resfriamento diminuiu com o aumento da gordura de cobertura e foi de 2,57; 2,22 e 1,96%, respectivamente, para as carcaças de cobertura escassa, desuniforme e uniforme, ao passo que o rendimento de ponta-de-agulha aumentou, atingindo valores de 13,04; 13,47 e 14,36%. Os rendimentos de desossa foram maiores nas carcaças de cobertura escassa (78,70%) em relação às de cobertura uniforme (77,62%), e isso é resultado do menor percentual de retalhos descartados, que aumentou de acordo com a gordura de cobertura (4,40; 5,14; e 6,01%, respectivamente para as carcaças de cobertura escassa, desuniforme e uniforme). Os rendimentos de costela-janela e de costela-primeiro-corte foram maiores nas carcaças com maior espessura de gordura, enquanto os percentuais de coxão de fora e de coxão de dentro foram maiores nas carcaças de cobertura escassa em relação às de cobertura uniforme. Novilhos castrados Braford podem ser abatidos com menor cobertura de gordura, pois a baixa cobertura de gordura não prejudica o rendimento de cortes secundários. O aumento de gordura de cobertura diminui as perdas durante o resfriamento, principalmente em cortes com pequenas aparas.

Palavras-chave: acabamento, cortes comerciais, cortes desossados, cortes primários, frigoríficos, quebra ao resfriamento

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Introduction

As the system of beef cattle purchase evolved, paying premiums for meat quality, carcass fat thickness became a key factor in the calculation of premiums paid to farmers. Fat thickness is influenced by several factors, such as season, crossbreeding, animal class, weight, and nutritional background. Market factors related to prices and off seasons in the offer of cattle also make farmers keep their animals for longer, increasing carcass finishing (Vaz & Restle, 2005).

Two decades ago, packing plants determined that steers with good fat thickness also presented good carcass weight and conformation (Di Marco, 1998). In Nelore steers slaughtered at 24 months of age, Vaz et al. (2004) obtained significant correlations between fat thickness and body weight at 12, 18 and 24 months of age, as well as with cold carcass weight and yield and with pistol yield.

Genetic selection for weight gain and precocity has resulted in considerable fat accumulation in the carcass (Vaz & Restle, 2002). However, this accumulation often causes losses to the packer, as intermuscular and subcutaneous fat needs to be completely or partially removed during trimming and deboning (Ledic et al., 2000). At the same time, the evolution of feed intake suggests that diets with lower saturated fat content may be used (Felício, 1997; Rodrigues & Andrade, 2004).

Some countries, such as Japan and USA, demand excessive fat content in the meat, therefore, in the carcass as a whole. Fatter beef cuts have more pronounced flavor than lean cuts (Lawrie, 1970; Berg & Butterfield, 1976). This higher fat content is required for cuts used for grilling and barbecue, but most beef cuts do not need to present high subcutaneous fat (Wood, 1990), such as those used for other forms of cooking.

Another aspect related to meat fat is tenderness, as intramuscular fat favors muscle fiber by destructuring and lubricating the bolus during chewing, increasing the perception of tenderness (Berg & Butterfield, 1976; Wood, 1990; Restle et al., 1999; Restle et al., 2001; Rodrigues & Andrade, 2004). However, genetic selection for tenderness and lower market age, as a development of the genetic selection for weight gain and precocity (Costa et al., 2002; Vaz & Restle, 2002; Bonilha et al., 2007), has produced young steers with high meat tenderness, which was produced before by animals with high finishing degree (Wood, 1990).

Currently, beef steers tend to present adequate body weight and conformation, with no excessive carcass fat accumulation, as demanded by consumers. Therefore, the packing industry needs to define the finishing degree of young steer carcasses that maximizes deboning efficiency, reducing losses. In this context, the objective of the present study was to evaluate the finishing degree of steers slaughtered at 22 months of age on packed cut yields.

Material and Methods

It was used carcasses of 38 Braford steers at an average age of 22 months, derived from the same farm, born in October, 2005, and submitted to the same management, feeding, and health conditions.

In May, 2007, when steers reached an average body weight of 320 kg, they were placed in a feedlot on the same farm and fed sorghum ad libitum and concentrate at 1.35% of their body (on dry matter basis). An average daily weight gain of 1.25 kg/animal/day was obtained, calculated as the difference between regular weighings (performed every 21 days) divided by the number of days between weighings.

At the end of the feedlot period, steers were visually assessed by representatives of a commercial packing plant and considered ready for slaughter as they presented adequate finishing.

Steers were slaughtered according to the routine flow of the packing plant, which functions under federal inspection (Serviço de Inspeção Federal - SIF). After slaughter, carcasses were trimmed according to the SIF rules, with removal of the inguinal fat, of the bleeding wound, and the diaphragm. During trimming, excessive fat in the topside and thin flank were also removed.

After weighing, carcasses were subjectively assessed by three fat finishing evaluators according to the grading scale of Chile adopted by the packing plant. This scale is divided in three fat classes (Gallo et al., 1990): “even fat coverage” = uniform carcass fat coverage, with approximately 6-8 mm fat thickness on the 12th rib; “uneven fat coverage” = sufficient, but non-uniform carcass fat coverage, with approximately 3-5 mm fat thickness on the 12th rib; “insufficient fat coverage” = insufficient carcass fat coverage, with approximately 1-2 mm fat thickness on the 12th rib. In addition to those fat classes, the Chilean scale also included the class “zero fat”, which is attributed to lean carcasses (Gallo et al., 1990). Out of the 38 carcasses, 11 presented even fat coverage, 19 uneven fat coverage, and 8 insufficient fat coverage.

After slaughter, carcasses were chilled at 1^{o}C for 48 hours. Hot and cold dressing percentages were obtained by dividing respective weights by live weight of the steers on the farm.

In order to obtain the yield of each full primal cut, carcasses were divided in pistol or hindquarter special, flank and forequarter (five ribs). Each primal cut was weighed, and then sent to the deboning room to obtain sub-primal cuts.

The pistol was divided in round, rump, and loin and the forequarter in shoulder and chuck, whereas the flank entered the deboning room already as a sub primal cut. All cuts were divided in bone-in and boneless cuts (Figure 1).

In addition to the meat cuts, deboning also produced edible trimmings, discarded trimmings (fat trimmings + tallow + aponeurose), and bones.

The fraction "losses" was calculated as the difference between primal cut initial weight before deboning, and the sum of all products obtained after deboning. Losses include meat and fat pieces lost during deboning which are difficult to recover, bone residues after sawing, and possible drip losses and liquid evaporation from the cuts, although primal cuts had been refrigerated and deboning room temperature was maintained at a maximum of 9ºC, according to SIF regulation.

All forequarter cuts were deboned, as well as pistol cuts, except for short ribs, which were separated from the pistol and packed with the bones. The brisket was only cut and trimmed, and it was not deboned.

All cuts were weighed and deboned during the same shift by a team of five deboning workers, aiming at maintaining the same cut and trimming standards, resulting in the respective boneless beef cuts (Figure 1). In order to further standardize these procedures, moderate to close trimming was used, according to standards of the Brazilian domestic market as shown in the illustrations of the Catálogo Brasileiro de Cortes Bovinos, published by ABIEC (2003).

Meat cuts and edible trimmings were weighed, and considered prepared cuts inasmuch as they sum up the parts sold for human consumption. Discarded bones and trimmings were also weighed to calculate the participation of each fraction relative to cold carcass weight. The same procedure was applied to the forequarters, which produced

Primal cuts	Subdivision	Sub primal cuts	
Pistol	Round	Silverside	Shank
		Topside	Edible trimmings
		Eye of round	Discarded trimmings
		Knuckle	Bones
		Heel	Losses
	Rump	Eye of rump	Discarded trimmings
		Cap of rump	Bones
		Tail of rump	Losses
		Edible trimmings	
	Loin	Tenderloin	Cervical nerve
		Striploin	Edible trimmings
		Cube roll	Discarded trimmings
		Rib cap	Bones
		Back ribs	Losses
Forequarter	Shoulder	Shoulder clod	Fore shank
		Oyster blade	Edible trimmings
		Chuck tender	Discarded trimmings
		Eye of arm clod	Bones
		Chuck cover	Losses
	Chuck	Deboned ribs	Edible trimmings
		Neck	Discarded trimmings
		Brisket	Bones
		Chuck	Losses
Flank		Bone-in Short ribs	Flank steak
		Bone-in Cube roll cover	Edible trimmings
		Subcutaneous muscle	Discarded trimmings
		Thin flank	Losses

Figure 1 - Division of carcass cuts.

all the boneless cuts, including T-bone steaks. Flanks were submitted to a similar process, except for short ribs and rib roast that, along with the T-bone steak, were the only meat cuts prepared and packed with bone.

A completely randomized experimental design was used, with different numbers of replicates. Data were submitted to analysis of variance. Weight classes and conformation were initially tested as co-variables, but because they did not have any significant effect, they were removed from the model. SAS statistical package (SAS, 1997) was used for the statistical analyses.

The following mathematical model was applied:

$$Y_{ij} = m + FC_i + E_{ij},$$

where Y_{ij} = dependent variables; m = mean of all observations; FC_i = effect of the i^{th} fat coverage class, and E_{ij} = residual random error.

When they were significant in the analyses of variance, means were compared by the test of Tukey (SAS, 1997).

Results and Discussion

Average live weight of steers on the farm was 404.0 kg and average hot carcass weight was 206.2 kg. Average cold carcass dressing was 51.05%. There was no difference (P>0.05) in cold carcass weight among steers belonging to the three fat coverage classes.

Despite the differences in finishing, carcasses presented similar (P>0.05) weight and conformation (Table 1), validating the treatments applied in this study. These traits were similar because the lot was contemporary and because animals received adequate nutritional supply as yearlings, which allowed these animals to obtain proper body development and to start the finishing phase with adequate weight and conformation.

Cold shrinkage increased (P>0.05) as fat coverage decreased (Table 1). Carcass weight losses during chilling is related to subcutaneous fat thickness, which acts as thermal insulation, reducing intracellular fluid losses (Lawrie, 1970; Galvão et al., 1991; Restle et al., 2000; Menezes et al., 2005; Pacheco et al., 2005). Mean cold shrinkage losses cannot be compared among studies carried out by different authors because different methodologies were applied and animals presented different weights and finishing degrees. Moreover, there are chilling differences among packing plants, including chilling time, initial and final temperatures, relative humidity, air speed, carcass density, and time to fill the cold chamber.

Forequarter and pistol (or hindquarter special) yields were not different (P>0.05) among carcasses with different finishing degrees. However, carcasses with even fat coverage presented higher yield (P<0.05) as compared to those with insufficient fat coverage (Table 2). According to Vaz et al. (2004), the higher flank yield is a consequence of subcutaneous fat accumulation on the ribs when steers achieve sufficient finishing weight to be marketed.

There was no difference among treatments for pistol deboning yield (P>0.05), but the forequarter deboning yield of steers with insufficient fat coverage was higher (P<0.05) than those with even fat coverage (27.45 and 26.20%, respectively; Table 3). This result may be related to discarded trimmings derived from the forequarters of steers with higher fat coverage.

The difference in yields of flank cuts in favor of the steers with even fat coverage was maintained after deboning (Table 3). This is probably because this primal cut does not suffer much interference, as flank bones are not removed for the domestic market, and only excessive fat, tallow, and aponeuroses are removed. If ribs were deboned, it is expected that the differences among fat coverage classes would be maintained, as the total amount of bones in the ribs is relatively similar among the three finishing degrees.

In crossbred Charolais × Nelore steers, Vaz & Restle (2005) found that subcutaneous fat thickness is directly related to flank yield (r = 0.66), but it is not significantly correlated with carcass weight (r =–0.01) or dressing percentage (r = –0.27).

The best deboning results and yields of meat cuts obtained from carcasses with insufficient fat coverage relative to those with even fat coverage are due to the higher proportion of discarded trimmings in the latter (P<0.05), which increased with finishing degree (Table 4).

Table 1 - Mean parameters evaluated before deboning, according to carcass fat coverage

Parameters	Fat coverage			Mean	CV (%)	P>F
	Even	Uneven	Insufficient			
Number of steers	11	19	8	-	-	-
Cold half-carcass weight, kg	104.3	99.4	100.7	101.46	9.71	0.435
Cold shrinkage, %	1.96b	2.22ab	2.57a	2.25	23.18	0.046
Conformation, score[1]	10.64	11.47	11.12	11.08	9.83	0.146

Means within the same row followed by different letters are different by the test of Tukey at 5%.
[1] Scale with 1-18 scores, in which 10 = “good minus”; 11 = “good typical”; and 12 = “good plus”.

Table 2 - Primal cuts yield as cold carcass percentage of carcasses classified according to fat coverage

Primal cut	Fat coverage class			Mean	CV (%)	P>F
	Even	Uneven	Insufficient			
Pistol	49.21	49.78	49.96	49.65	2.24	0.295
Forequarter	36.43	36.75	37.00	36.73	2.79	0.488
Flank	14.36a	13.47ab	13.04b	13.62	6.35	0.010

Means within the same row followed by different letters are different by Tukey test at 5%.
CV = coefficient of variation; P = probability; F = F value.

There were no differences (P>0.05) in bone percentage among treatments, with an average of 16.56%, which does not take into account hind rib bones and cube roll cover that were produced bone-in. Apple et al. (1999) observed that total de-boned lean meat was 66.4; 70.0; 69.9; 71.8; 70.8; 67.7; 64.5%, respectively, for 2, 3, 4, 5, 6, 7, and 8 body condition scores (scales from 1 to 9). Those authors also found total bone percentage ranged from 16.9% (8 body condition score) to 31.6% (2 body condition score), although the variation among the steers studied by Apple et al. (1999) was wider, inasmuch as steers with a body condition score of 2 were considered thin.

Junqueira et al. (1998) observed 0.43% losses during deboning, and 6.71% discarded trimmings in steer carcasses. The present study determined 5.18% mean discarded trimmings, which decreased as carcass finishing degree was reduced (P<0.05). Apple et al. (1999) observed total fat trimmings of 1.9, 3.2; 5.4; 4.5; 8.2; 13.2 and 18.6%, respectively, for body condition scores of 2, 3, 4, 5, 6, 7 and 8.

Koch et al. (1981) evaluated the dressing percentage of 686 carcasses of feedlot-finished steers of different breeds and reported yields of 66.4, 21.9, and 11.7% for commercial cuts, discarded trimmings, and discarded bones, respectively, in Hereford × Angus animals, and 74.3, 11.5, and 14.2%, in Chianina steers. Restle et al. (2001) also studied the effect of genetic group and observed that in ¾ Charolais × ¼ Nelore heifers, there were significant correlations between subcutaneous fat thickness and cold carcass weight, flank yield, and muscle and fat percentages in the carcass. In contemporary purebred Charolais heifers, whose carcasses were leaner, only the correlation between subcutaneous fat thickness and cold carcass weight was significant.

Table 3 - Mean yields of beef cuts prepared from primal cuts, as cold carcass percentages, according to carcass fat coverage classes

Cut	Fat coverage class			Mean	CV (%)	P>F
	Even	Uneven	Insufficient			
Pistol	37.94	38.47	38.93	38.45	2.81	0.151
Forequarter	26.20b	26.90ab	27.45a	26.85	3.83	0.047
Flank	13.49a	12.70ab	12.32b	12.84	6.45	0.017

Means within the same row followed by different letters are different by Tukey test at 5%.
CV = coefficient of variation; P = probability; F = F value.

Table 4 - Total yield of products derived from deboning, as cold carcass percentage, according to carcass fat coverage

Parameter	Fat coverage class			Mean	CV (%)	P>F
	Even	Uneven	Insufficient			
Prepared beef cuts	77.62b	78.07ab	78.70a	78.13	1.14	0.054
Discarded trimmings	6.01a	5.14b	4.40c	5.18	9.97	0.001
Discarded bones	16.28	16.67	16.74	16.56	5.51	0.470
Inherent losses	0.07	0.12	0.16	0.12	123.33	0.161

Means within the same row followed by different letters are different by Tukey test at 5%.
CV = coefficient of variation; P = probability; F = F value.

Pistol deboning resulted in higher silverside and topside yields (P<0.05) in carcasses with insufficient fat coverage as compared to those with even fat coverage (Table 5). These were the only pistol cuts that presented fat deposition. On the other hand, discarded trimmings percentage was significantly higher (P<0.05) in carcasses with insufficient fat coverage.

The present study confirmed that the yield of some cuts varies when deboning methodology is not defined, such as the case of silverside and cap of rump, which are part of the same muscle mass. According to the packing plant guidelines, the division may be done closer to the edge of the cap of rump or closer to the edge of the silverside.

Table 5 - Total yield (%) of products derived from round deboning, as cold carcass percentage, according to carcass fat coverage

Parameter	Fat coverage class			Mean	CV (%)	P>F
	Even	Uneven	Insufficient			
Silverside	3.97b	4.25ab	4.39a	4.20	6.87	0.01
Topside	6.38b	6.66ab	6.96a	6.67	6.53	0.02
Eye of round	1.80	1.87	1.90	1.86	11.81	0.56
Knuckle	4.04	4.05	4.23	4.11	6.28	0.20
Heel	1.60	1.60	1.66	1.62	6.31	0.34
Shank	1.70	1.68	1.73	1.70	5.83	0.48
Edible trimmings	1.10	1.16	1.08	1.11	31.33	0.84
Discarded trimmings	1.13a	1.07ab	0.85b	1.02	23.21	0.04
Discarded bones	5.34	5.53	5.49	5.45	7.41	0.46
Losses	0.01	0.04	0.03	0.03	129.15	0.19

Means within the same row followed by different letters are different by Tukey test at 5%.
CV = coefficient of variation; P = probability; F = F value.

Cuts are well-defined muscle masses, such as eye of round, tail of rump, knuckle and topside, and should have the least possible variation during deboning and in the comparison among packing plants. The yields of the sub-primal cuts relative to cold carcass weight observed by Junqueira et al. (1998) were 7.02% and 1.94% for the topside and eye of round ½ Marchigiana ½ Nelore steers, respectively. These values are similar to those obtained in the present experiment in steers with insufficient fat coverage (6.96 and 1.90%, respectively). On the other hand, Junqueira et al. (1998) obtained a silverside yield of 3.77%, whereas in the present study, the lowest value was obtained in steers with even fat coverage (3.97%). Coutinho Filho et al. (2006), after deboning steer carcasses, found values of 6.03 and 3.68%, respectively, for topside and silverside yields.

Three out of the five most valuable carcass cuts are located in the rump. There were no differences in the yield of deboned rump cuts (Table 6) among the studied fat coverage classes (P>0.05).

Of all the cuts evaluated after loin deboning (Table 7), only back ribs yield was significantly different among fat coverage classes (P>0.05), being higher for carcasses with even fat coverage (2.75%). Back rib yield is influenced by the place where the pistol is separated from the flank. There are no commercial guidelines as to where the ribs should be cross-sectioned to separate the pistol from the flank, neither for where the back ribs should be separated from the rest of the loin. Conversely, the separation between the striploin and the rib cap is simple and clearly defined.

Lima et al. (2004) evaluated crossbred zebu cows with body condition scores of 3, 4, and 5, and presenting 1.3, 4.2, and 5.5 mm fat thickness, respectively and obtained 9.20, 10.58, and 12.05 kg striploin yields, and tenderloin with cap yields of 4.03, 4.51, and 4.75 kg, respectively.

The values obtained by pistol deboning are obtained by summing up the values on Tables 5, 6, and 7. When the means of deboning byproducts were summed up, as these were not statistically different (P>0.05), it was found that edible trimmings, discarded trimmings, and bones totaled 2.79, 1.99, and 9.15%, respectively. Losses amounted to 0.07%, demonstrating the control of the deboning process in the present study. Working with heavier steers, Coutinho Filho et al. (2006) obtained 10.08, 2.91, and 3.21% for bones, edible trimmings and discarded trimmings yields, respectively.

The yield of discarded trimmings from the shoulder of carcasses with insufficient fat coverage was lower (P<0.05) as compared to carcasses with even fat coverage (Table 8). No effect of carcass finishing was found for the other

Table 6 - Total yield (%) of products derived from rump deboning, as cold carcass percentage, according to carcass fat coverage

Parameter	Fat coverage class					
	Even	Uneven	Insufficient	Mean	CV (%)	P>F
Eye of rump	2.56	2.63	2.75	2.65	6.66	0.08
Cap of rump	1.04	1.02	1.04	1.03	14.36	0.93
Tail of rump	0.82	0.85	0.86	0.84	10.67	0.67
Edible trimmings	0.61	0.59	0.62	0.61	25.3	0.90
Discarded trimmings	0.52	0.42	0.37	0.44	32.24	0.07
Discarded bones	1.23	1.22	1.28	1.24	10.14	0.44
Losses	0.02	0.01	0.01	0.01	142.18	0.91

CV = coefficient of variation; P = probability; F = F value.

Table 7 - Total yield (%) of products derived from loin deboning, as cold carcass percentage, according to carcass fat coverage

Parameter	Fat coverage class					
	Even	Uneven	Insufficient	Mean	CV (%)	P>F
Tenderloin	1.40	1.47	1.47	1.45	9.66	0.38
Striploin	3.98	3.84	3.81	3.88	8.34	0.42
Cube roll	1.84	1.94	1.87	1.88	11.11	0.41
Rib cap	1.14	1.07	1.08	1.10	13.07	0.37
Back ribs	2.75a	2.67a	2.34b	2.59	10.95	0.01
Cervical nerve	0.09	0.08	0.08	0.08	21.24	0.43
Edible trimmings	1.12	1.03	1.05	1.07	18.47	0.46
Discarded trimmings	0.54	0.54	0.51	0.53	29.52	0.87
Discarded bones	2.47	2.46	2.45	2.46	10.87	0.99
Losses	0.03	0.02	0.04	0.03	102	0.37

Means within the same row followed by different letters are different by Tukey test at 5%.
CV = coefficient of variation; P = probability; F = F value.

Table 8 - Total yield (%) of products derived from shoulder deboning, as cold carcass percentage, according to carcass fat coverage

Parameter	Fat coverage class					
	Even	Uneven	Insufficient	Mean	CV (%)	P>F
Shoulder clod	1.14	1.26	1.31	1.24	24.13	0.43
Oyster blade	1.68	1.76	1.68	1.71	8.04	0.23
Chuck tender	0.93	0.96	1.01	0.97	7.55	0.06
Eye of arm clod	2.27	2.24	2.39	2.30	8.27	0.18
Chuck cover	1.19	1.34	1.26	1.26	22.69	0.38
Fore shank	2.88	2.76	3.05	2.90	13.06	0.20
Edible trimmings	0.79	0.82	0.54	0.72	39.91	0.10
Discarded trimmings	1.13a	0.80ab	0.76b	0.90	36.30	0.02
Discarded bones	3.82	3.88	3.87	3.86	6.00	0.82
Losses	0.01	0.01	0.02	0.01	372.41	0.74

Means within the same row followed by different letters are different by Tukey test at 5%.
CV = coefficient of variation; P = probability; F = F value.

fractions (P>0.05). Forequarter cuts, due to their low fat deposition in steer carcasses, were not influenced by fat coverage.

After chuck deboning (Table 9), only discarded trimming yield was influenced by finishing degree (P<0.05), with higher values obtained in carcasses with even fat coverage as compared to those with insufficient fat coverage.

The coefficients of variation (CV) of neck, chuck, deboned ribs and brisket data are higher than those obtained for better defined cuts, such as chuck tender, shoulder clod, and oyster blade (Table 8).

Overall, discarded trimmings, independently of fat coverage class, did not represent noteworthy discard of trimmed fat (Tables 8 and 9). The most important factor that influences forequarter cuts yield is carcass conformation (Rodrigues & Andrade, 2004).

The packing industry will always be interested in carcass with the best conformation and muscularity, considering the growing trend of marketing deboned beef. Few forequarter and pistol cuts are influenced by carcass finishing degree. Suguisawa et al. (2006) did not find any correlation between subcutaneous fat thickness and the yield of deboned cuts in the carcass of young steers.

When deboning the flank or the rib plate (Table 10), discarded trimmings and bone-in short ribs yields were lower in carcasses with insufficient fat coverage as compared to those with even fat coverage (P<0.05), due to fat deposition in the short ribs.

All steers were submitted to the same finishing period; however, if the farmer decides to maintain the animals until they all present even fat coverage, this would result in lower biological efficiency (Arboitte et al., 2004), which could be compensated by the packing plants through the payment of progressive bonuses per fat coverage class. Nevertheless, the current bonus levels, which vary in about 1%, may not be sufficient to pay the costs generated by the lower feed efficiency and the higher inventory resulting from increasing finishing periods (Beretta et al., 2002).

Packing plants are interested in the protection provided by fat coverage to the carcasses, as it reduces drip and evaporation losses, as well as cold shrinkage, which causes meat to loose tenderness. Moreover, fat coverage improves the appearance of cuts used for roasting and grilling. The fact that carcasses with low fat coverage have presented higher cuts yield (Table 4) may be marketed by the farmers, which may stimulate packing plants to prefer these carcasses in young steers to carcasses with subcutaneous fat thickness close to the even fat coverage classification standards.

Table 9 - Total yield (%) of products derived from chuck deboning, as cold carcass percentage, according to carcass fat coverage

Parameter	Fat coverage class					
	Even	Uneven	Insufficient	Mean	CV (%)	P>F
Deboned ribs	3.69	3.74	3.71	3.71	21.47	0.99
Neck	4.30	4.52	4.48	4.43	14.94	0.68
Brisket	2.57	2.72	2.73	2.67	19.88	0.73
Chuck	4.10	4.26	4.78	4.38	14.04	0.06
Edible trimmings	0.65	0.51	0.52	0.56	41.95	0.28
Discarded trimmings	1.84a	1.55ab	1.23b	1.54	22.91	0.01
Discarded bones	3.43	3.58	3.64	3.55	7.93	0.21
Losses	0.01	0.03	0.03	0.02	171.33	0.51

Means within the same row followed by different letters are different by Tukey test at 5%.
CV = coefficient of variation; P = probability; F = F value.

Table 10 - Total yield (%) of products derived from flank or rib plate deboning, as cold carcass percentage, according to carcass fat coverage

Parameter	Fat coverage class					
	Even	Uneven	Insufficient	Mean	CV (%)	P>F
Bone-in short ribs	6.40a	5.93a	5.34b	5.89	9.32	0.01
Bone-in cube roll cover	3.22	3.07	3.17	3.15	12.07	0.57
Subcutaneous muscle	1.34	1.28	1.27	1.30	10.9	0.49
Thin flank	1.72	1.66	1.75	1.71	10.28	0.45
Flank stake	0.41	0.40	0.44	0.42	15.55	0.41
Edible trimmings	0.40	0.35	0.36	0.37	23.28	0.29
Discarded trimmings	0.85a	0.76ab	0.70b	0.77	15.07	0.02
Losses	0.01	0.01	0.02	0.01	129.4	0.81

Means in the same row followed by different letters are different by Tukey test at 5%.
CV = coefficient of variation; P = probability; F = F value.

Packing plants will continue to favor young steers, with carcass weight around 220 kg and a fat coverage of 5-8 mm, with variations according to market niches. Farmers, in turn, should produce these animals, provided they are compensated for the lower biological efficiency; otherwise, they should seek high biological efficiency, reducing market weight and finishing degree.

Conclusions

Carcasses with high fat percentage present lower cold shrinkage, higher flank percentage, and lower silverside and topside percentages as compared to carcasses with insufficient fat coverage. Fatter carcasses present higher short ribs and back ribs yields. There are wider variations in cuts that do not define limits for their separation. Fatter carcasses present higher percentage of discarded trimmings and lower yield of deboned cuts.

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