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CARCASS CHARACTERISTICS OF STEERS WEANED AT 91 AND 160 DAYS FINISHED IN PASTURE AND SLAUGHTERED AT SIXTEEN MONTHS WITH DIFFERENT WEIGHTS

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ABSTRACT

Carcass quantitative characteristics of 68 Braford steers previously submitted to two weaning ages: 91 days, early weaning (EW), or 160 days, conventional weaning (CW); classified at slaughter in three live weight groups: light (≤ 350 kg), medium (351 to 370 kg) and heavy (≥ 371 kg), were evaluated. Steers were finished on summer pasture (*Pennisetum americanum*) and slaughtered at 16 months of age. No significant differences were observed between weaning ages for final weight (EW = 360.0 kg; CW = 359.2 kg), hot carcass yield percentage (EW = 53.76%; CW = 53.84%) and cold carcass yield percentage (EW = 52.45%; CW = 52.54%), hot carcass weight (EW = 193.0 kg; CW = 193.2 kg) and cold carcass weight (EW = 188.6 kg; CW = 188.5 kg). Steers were also similar regarding carcass conformation, hindquarter and forequarter percentages and other measures of carcass development. The average slaughter weight of steers classified as light, medium and heavy was 338.7; 358.6 and 381.6 kg, respectively. Heavier steers produced carcasses with yield percentage of 52.55% and subcutaneous fat thickness of 4.54 mm, similar to medium (52.65 and 4.39 mm, respectively) and light steers (52.93% and 3.99 mm, respectively). Weight increase did not affect hindquarter and forequarter percentages, but cushion thickness was significantly increased as the weight increased from 338.7 to 381.6 kg. It can be concluded that early weaning does not alter the weight and finishing of steers´ carcasses.

KEYWORDS: carcass yield; carcass weight; conformation; early weaning; subcutaneous fat.

CARACTERÍSTICAS DA CARCAÇA DE NOVILHOS DESMAMADOS AOS 91 OU 160 DIAS TERMINADOS EM PASTAGEM E ABATIDOS AOS DEZESSEIS MESES COM DIFERENTES PESOS

RESUMO

Avaliaram-se neste estudo as características quantitativas da carcaça de 68 novilhos Braford desmamados em duas idades: desmame precoce (DP), com média de 91 dias de idade; e desmame convencional (DC), média de 160 dias de idade. Terminados em pastagem cultivada de verão (*Pennisetum americanum*) e abatidos aos dezesseis meses de idade, os novilhos foram classificados ao abate em três grupos de peso: leves (≤ 350 kg), médios (351 a 370 kg) e pesados (≥ 371 kg). Não houve diferença significativa entre as idades de desmame no peso de abate (DP = 360,0 kg; DC = 359,2 kg), rendimento de carcaça quente (DP = 53,76%; DC = 53,84%), rendimento de carcaça fria (DP = 52,45%; DC = 52,54%), peso de carcaça quente (DP = 193,0 kg; DC = 193,2 kg) e peso de carcaça fria (DP =

188,6 kg; DC = 188,5 kg). Os resultados foram também similares em conformação de carcaça, percentagem dos quartos traseiro e dianteiro e outras variáveis de desenvolvimento da carcaça. Os pesos médios de abate foram 338,7; 358,6 e 381,6 kg, respectivamente, para novilhos leves, médios e pesados. Os novilhos pesados produziram carcaças com rendimento (52,55%) e espessura de gordura subcutânea (4,54 mm) similares aos dos médios (52,65% e 4,39 mm, respectivamente) e leves (52,93% e 3,99 mm, respectivamente). O aumento dos pesos de abate não alterou os percentuais dos cortes traseiro e dianteiro, mas a espessura de coxão teve aumento significativo quando o peso médio passou de 338,7 para 381,6 kg. Conclui-se que animais desmamados aos 91 dias de idade apresentam carcaças com peso e acabamento similares aos desmamados aos 160 dias.

PALAVRAS-CHAVE: Desmame precoce; gordura de cobertura; conformação; peso de carcaça; rendimento de carcaça.

INTRODUCTION

Natality rates higher than 80% associated ith slaughter of steers and first service of heifers until two years of age are fundamental for achieveing the expected productivity in beef herds (PÖTTER *et al*., 1998; BERETTA *et al*., 2002).

Significant and necessary increments in pregnancy rates in beef herds are obtained by reduction of stocking rate with consequently increase of pasture offer (QUADROS & LOBATO, 1996; SIMEONE & LOBATO, 1996; PÖTTER & LOBATO, 2004) or by the emplyment of early weaning (MOOJEN *et al*., 1994; SIMEONE & LOBATO, 1996; LOBATO *et al*., 2000; ALMEIDA & LOBATO, 2002), reducing the cows´nutritional requirements.

The double requirement of increasing pregnance rates and reducing slaughter age has led to the carry out of researches which have not shown harmful efects of early weaning on the developement, slaughter and carcass of steers at 24 to 26 months of age (MORAES & LOBATO, 1993; ALBOSPINO & LOBATO, 1994; RESTLE *et al*., 1999b, d).

External markets require heavier and well-finished carcasses; however, in internal markets, the consuption of younger animals with lighter and well-finished carcasses is guaranteed by meat “brands” and restaurants targeting high-income groups (SANTOS *et al*., 2008). According to LAWRIE (1970), the interest in young animals´ meat is directly connected to sensorial characteristics, specially tenderness.

An important factor to increase meat quality is the reduction of slaughter age of steers to 14 to 16 months of age (RESTLE *et al*., 1997a; SANTOS *et al*., 2008). This age group also results in better feed efficiency, as this feature decreases as the animals´age advances (RESTLE *et al*., 2002). Confinement (RESTLE *et al.*, 2002) or supplementation on cultivated pastures (PÖTTER & Lobato, 2003), both in early post-weaning periods, show the possibility of slaughtering steers between 14 and 16 months of age.

RESTLE *et al.* (1999b) did not identify quantitative differences in the carcasses of steers slaughtered at 24 months of age, as well as RESTLE *et al.* (1999a) did not find differences between Braford calves weaned at 72 or at 210 days of age, slaughtered at 14 months old. However, PÖTTER & Lobato (2003), by studying slaughter between 13 to 14 months of age, found lower slaughter and cold carcass weights of calves weaned at 100 days compared with those weaned at 180 days.

Due to differences of work conditions, whether nutritional environment, genetic groups or weaning ages, this study focused on the carcass characteristics of steers submitted to early weaning or not, with growing and finishing phases on cultivated pasture and aged between 14 and 16 months.

MATERIAL AND METHODS

The experimental period was divided into two phases: field phase, held at Itu Farm, city of Itaqui, at the physiographic region called Fronteira Oeste (Western Boundary) of the state of Rio Grande do Sul; and carcasses analysis phase carried out in Mercosur Slaughterhouse S/A.

We used 68 Braford steers, from primiparous cows at three years of age, distributed according to prior management to which they were submitted along with their mothers: EW = early weaning - 30 calves weaned at an average age of 91 days, and CW

= conventional weaning - 38 calves weaned at an average age of 160 days.

Early weaning was performed on December 26th and conventional weaning on March 5th. Calves from both EW and CW were kept for ten days in a pen, right after the weaning, with temporary-grazing of three hours / day from the fourth day on. After the period of pen, calves, in a single lot, were kept grazing on millet *(Pennisetum americanum).* In April, the animals grazed on Brachiaria brizantha cv. Marandu pasture. During the post-weaning period until May 10th, the animals were supplemented with 18% crude protein and 75% TDN, composed of soybean meal, soybean hulls, wheat bran, rice bran, salt, limestone and minerals in the amount of 1% of body weight.

From May 10th until November 15th, calves grazed on oat *(Avena strigosa)* and ryegrass *(Lolium multiflorum* Lam), and also received 0.5% of body weight / day of soybean seed coat from June to October. In the second summer (December 1st to March 10th) steers were kept on pasture and finished on millet *(Pennisetum americanum).*

Throughout the experimental period, the animals received the same management and health conditions. Castration was performed at eight months of age. Slaughter occurred in two stages, according to the degree of finishing of the steers, visually determined by evaluating the body condition score (BCS), following the method described by Lowman *et al.* (1973), with assigned values from 1 to 5, where 1 = thin and 5 = fat. Farm weight was obtained at early morning hours before departure. In the slaughterhouse, the steers underwent a 13-hour fasting. When the animals left for slaughter, they were classified according to their farm weight as light (≤ 350 kg), medium (351-370 kg) and heavy (≥ 371 kg).

After the slaughter, carcasses were identified, weighed and refrigerated for 24 hours at -2°C. After this time, another weighing was carried out and hot and cold carcass yield and thawing loss were determined. Hot and cold carcass yields were determined by dividing their weights by the animals´slaughter weight, multiplying it by 100 to get the value in percentage. Thawing loss, also expressed as a percentage, was determined by carcass weight loss during cooling, comparing the weights of hot and cold carcass.

After the cooling period, the following measurements were performed: carcass length, taken from the anterior edge of the pubic bone to the cranial-medial edge of the first rib; leg length, of the pubic bone and the tibial-tarsal articulation; cushion thickness between the lateral and medial surface of the upper portion, measured with a compass; arm length, measured from the radiocarpial joint to the end of the olecranon; and arm perimeter. The left and right half-carcasses were divided into forequarter – which includes neck, shoulder, arm and five ribs – and hindquarter, between the posterior regions of the carcass and the sidecut, separated from the forequarter between the fifth and sixth ribs (MULLER , 1987).

Carcasses were evaluated as to conformation, following a scale of 1 to 18 points described by MULLER (1987). The conformation is a subjective assessment of muscular expression of the carcass, which takes into account mainly the muscular covering of the sidecut, where the muscles of greatest commercial value are. The measurement of subcutaneous fat thickness was carried out on the 12th rib, and value adjustment was made when it did not represent the actual carcass fat coverage. The percentages of the forequarter and hindquarter cuts were weighed and determined (including sawcut and sidecut) in cold carcasses.

The experimental design was completely randomized with unequal number of replications per treatment, because calves were the offspring of cows from herds under different weaning ages prior to the birth of the animals. Thus, it would not be possible to determine an equal number of replications. The results were submitted to analysis of variance and F test, using the following mathematical model:

$$Y_{ijkl} = \mu + ID_i + PA_j + ID*PA_{ij} + \Sigma_{ij}$$

where: Y_{ijkl} = dependent variables, μ = mean of all observations; ID_i = effect of weaning age of order i, being 1 (early weaning) and 2 (conventional weaning); PA_j = effect of slaughter weight of order j, being 1 (light), 2 (medium) and 3 (heavy); $ID * PA_{ij}$ = effect of interaction between weaning age order i and slaughter weight of order j, and Σ_{ij} = residual error.

We also calculated the correlation coefficients between the dependent variables within the treatments and a probability of significant correlation at 5% by t test was verified. Analyses were performed with the Proc GLM procedure of SAS statistical software, version 6.8 (SAS, 1997), adopting a 5% maximum significance level .

RESULTS AND DISCUSSION

The results are presented and discussed separately for the effects of weaning age and slaughter weight, because no significant interaction (P> 0.05) was determined between them. There were no differences in slaughter weight and hot and cold carcass weight between the two weaning groups (P> 0.05; Table 1).

The quantitative characteristics of beef carcasses, i.e muscle, fat and skeleton development, are affected mainly by the slaughter weight of animals. Thus, the similarity observed in carcass characteristics is explained by the animals ´development (DI MARCO, 1998; VAZ *et al.*, 2008).

TABLE 1 – Mean body weight at slaughter of steers weaned early and at conventional age, weight and yield of hot and cold carcass and thawing loss

	Early wening	Conventional weaning	CV (%)	P < F
Slaughter weight, kg	360.0	359.2	3.12	0.7762
Hot carcass weight, kg	193.0	193.2	3.34	0.9347
Cold carcass weight, kg	188.6	188.5	3.31	0.9731
Hot carcass yield, %	53.76	53.84	2.14	0.7919
Cold carcass yield, %	52.45	52.54	1.99	0.7327
Thawing loss, %	2.31	2.39	0.82	0.6794

LOBATO *et al.* (2007) also noted similarities in slaughter weight (408.5 and 411.2 kg) and hot carcass weight (219.1 and 219.6 kg) of steers weaned at 70 or 180 days of age and slaughtered at two years of age. Likewise, RESTLE *et al.* (1999d) and ALMEIDA *et al.* (2003) found no differences in slaughter weight, carcass weight and hot carcass yield of steers slaughtered at 24 months of age, weaned at different ages.

In the analysis of Braford calves weaned at 72 or at 210 days of age, RESTLE *et al.* (1999c) also reported similarities in slaughter weights and carcass characteristics of steers.The authors state that the lowest weight at the time of early weaning can be minimized with better nutrition after weaning, according to GRIMES & TURNER (1999).

By analyzing calves weaned at 100 and 180 days of age, all of them slaughtered when aged 420 days, PÖTTER & LOBATO (2003) found lower slaughter and cold carcass weights in early weaned steers, because of dietary restrictions to which they were submitted after weaning, due to weather conditions. However, steers weaned at 100 days showed higher carcass yield compared to steers weaned at 180 days. These results, added to the ones of the present study, showed to be possible to obtain adequate development and, consequently, higher slaughter and carcass weights from animals weaned early, since they do not suffer severe environment restrictions.

ROSE (2006) observed lower slaughter weights for Aberdeen Angus steers submitted to severe food shortages during the growing phases, although they presented better performance during the feedlot, which resulted in lower carcass weights for animals in restricted growing. This fact is critical for the amount paid to the producer by the slaughterhouse, because, for pricing, the slaughterhouse evaluates the value of the purchased product and of the operational costs (COSTA *et* *al.*(2002).

By analyzing, at 550 days of age, the carcass traits of heifers weaned at 100 or 180 days of age, using an ultrasound device, POTER *et al.* (2004) found no differences in the area of *Longissimus dorsi* and fat thickness.They concluded that the interruption of breastfeeding at 100 days of age did not affect muscle development nor the amount of meat in the carcass.

MEYER *et al.* (2005) found a higher carcass weight in animals weaned at 90 days, compared to calves weaned at 174 days of age, but noted that there was a trend of the later to compensate for differences in body weight and body fat levels presented at six months of age.

The similarity observed in hot carcass yield remained in cold carcass yield due to the similarity (P> 0.05) in thawing loss of carcasses of 2.31% and 2.39% for the conventional and early weaning, respectively (Table 1).

Analysing weaning at 72 and 210 days old, RESTLE *et al.* (1999c) found higher thawing loss values, 3.37% and 3.24% respectively.This result can be attributed not only to variations in fat cover, but also to the different characteristics of the cooling, among slaughterhouse sites as well as among the chambers of the same slaughterhouse (RESTLE *et al.* 1999c). DI MARCO (1998) states that thawing loss is determined by the fat cover over the carcass, which did not add differences between the treatments compared in this study (Table 2).

The values obtained for fat thickness, conformation and carcass metric measurements, shown in Table 2, support the results presented in Table 1 and are indicative of the similarity of the animals´growth.

Several studies, evaluating fat cover thickness on the carcasses of cattle slaughtered at 24 months of age (RESTLE, 1999d; LOBATO *et al.*, 2007) and at 14 months of age (RESTLE *et al.*, 1999a, c; PÖTTER & LOBATO, 2003) showed this characteristic is not influenced by the weaning age of the animal, but by the diet composition to which the animals are submitted in the finishing phase. GRIMES & TURNER, (1999) confined animals until they reached 8.9 mm fat thickness on the 12th rib, and verified calves weaned at 110 days were eleven days younger at slaughter than calves weaned at 220 days of age.

TABLE 2 – Means of carcass measurements, conformation and subcutaneous fat thickness of steers submitted to early or conventional weaning

	Early weaning	Conventional weaning	CV (%)	P < F
Fat thickness, mm	4.23	4.40	31.73	0.7001
Carcass length, cm	123.30	122.48	5.07	0.6000
Leg length, cm	68.33	68.24	3.01	0.8519
Cushion thickness, cm	22.56	22.68	4.91	0.6465
Arm length, cm	37.77	37.46	6.45	0.6140
Arm perimeter, cm	33.10	32.75	4.70	0.3728
Conformation[1]	11.10	11.09	8.48	0.9392

[1] Points 10 = good less; 11 = good typical; 12 = good more (Muller, 1987).

The carcass characteristics, arm and leg length, which reflect the carcass bone development, did not differ (P> 0.05) between treatments. The same was observed for the muscularity characteristics of the members, cushion thickness and arm perimeter (Table 2). The conformation was classified as "typical good" (MULLER, 1987) both to early weaning and conventional weaning (P> 0.05), with very similar values (11.10 and 11.09 points respectively). Similarity between the metric measurements values of the carcass of Braford steers have been reported earlier by RESTLE *et al.* (1999a, c).

Similar percentages were determined for fore and hindquarter – 37.4% and 62.6% for EW and 38.0% and 62.3% for CW (P> 0.05), respectively – as well as for sawcut + sidecut weight or yield (P> 0.05, Table 3).

ALBOSPINO & Lobato (1994) also found no significant difference in percentage of the three commercial cuts. However, in Braford males slaughtered at 14 months old, RESTLE *et al.* (1999c) observed a higher percentage of sidecut when weaning occurred at 72 days (12.8%) compared to Braford males weaned at 210 days of age (12.0%).These authors associate this result to food management in the period between the two weaning ages. As the animals weaned at 210 days were fed a diet based on the mothers´milk production, calves weaned at 72 days were fed in confinement, which may have led to an accumulation of fat in the sidecut region, because these characteristics had significant correlations to animals weaned at 72 days.

TABLE 3 – Weight means and percentage of carcass commercial cuts of steers submitted to early or conventional weaning

	Early weaning	Conventional weaning	CV (%)	P < F
Forequarter, kg	70.7	71.4	4.45	0.3610
Forequarter, %	37.4	38.0	3.68	0.5450
Sawcut + Sidecut, kg	117.8	117.6	4.53	0.8892
Sawcut + Sidecut, %	62.6	62.3	2.48	0.5036

However, with Charolais x Nellore steers weaned at 90 or 210 days of age and finished on pasture at 24 months of age, RESTLE *et al.* (1999d) found no differences between the proportion of commercial cuts and measurements of carcass development.The percentages for the forequarter, sawcut and sidecut were, respectively, 36.7%; 12.5% and 50.8% in calves weaned at 90 days , and 36.9%; 12.5% and 50.6% in those weaned at 210 days of age.

From both the data observed in this study and the studies reviewed, it can be stated that the management of early weaning in itself does not change the growth characteristics of carcasses, provided that the animal nutrition plan is adequate for the calf´s normal growth after weaning. In studies that measured milk yield of beef cows kept on natural pasture with different forage offers, TABLES & LOBATO (1997) and FAGUNDES *et al.* (2004) found daily production from 5.0 to 6.5 liters / day, respectively, wiht a decrease after the fourth month of lactation.

FLUHARTY *et al.* (2000) conducted two experiments to examine the effect of different diets on early-weaned Angus calves. In the first study, besides the weaning ages, the authors compared feeding strategies *(ad libitum* or programmed) and protein levels (100% or 120% of requirements). They observed more weight gain in calves weaned at an average age of 103 days. These animals, therefore, reached slaughter weight earlier, compared to calves weaned at 203 days old. This effect was also observed in calves fed *ad libitum* (394 against 409 days).

In the second experiment, FLUHARTY *et al.* (2000) used *creep feeding* prior to weaning, and calves weaned at 93 days were heavier at 210 days than those kept with the cow.The authors concluded, then, that high concentrate levels after weaning accelerate the deposition of fat in the carcass and the animals´growth. Thus better carcass classification is obtained and there is a nutritional alternative in cases of natural pasture limitation.

The slaughter and hot carcass weights were significantly correlated with most variables studied, but thawing loss, arm circumference, conformation and fat thickness. There was no significant correlation between the carcass and cushion thickness and arm perimeter (Table 4).

DI MARCO (1998) verified a correlation among cold carcass weight, conformation and fat thickness; result which was not observed in this work. Conformation and fat thickness were not correlated (P> 0.05) with any of the variables studied. However, the percentage of forequarter was correlated with almost all variables, similar to what was recorded for the slaughter and carcass weights (Table 4).

In this study, weight assessments were carried out by joining the commercial cuts (side and sawcut), because it corresponded to the packaging and shipping process used by the slaughterhouse Mercosur. The correlation between percentage of sidecut + sawcut and fat thickness was low (r = 0.13, P> 0.05), in disagreement with other studies that found a high correlation between the percentage of sawcut and fat deposition on carcass. The highest correlations are related to cold carcass weight (Table 4).

By analyzing the correlations within treatments, RESTLE *et al.* (1999d) found high correlation between slaughter weight and hot carcass weight (r = 0.94), and between carcass weight and carcass length (r = 0.91) in animals weaned at 210 days old. In the same study, considering the animals weaned at 90 days of age, the following significant correlations were verified: weight and carcass length with hot carcass yield; conformation with carcass weight and yield, leg length and arm length and perimeter.

TABLE 4 – Pearson´s correlation coefficients above the diagonal among the carcass variables studied in steers submitted to early or conventional weaning and level of significance below the diagonal

	SW	HCW	HCY	CCW	CCY	TL	CL	LL	CT	AL	AP	C	FT	F	H+S
Slaughter weight (SW)		0.9157	-0.172	0.9305	-0.151	0.0993	0.5681	0.4487	0.4635	0.5749	0.2257	0.0640	0.036	0.8784	0.7446
Hot carcass weight (HCW)	0.01		-0.089	0.9081	-0.092	-0.068	0.3683	0.4088	0.5233	0.3976	0.2053	0.0923	0.1073	0.8175	0.8957
Hot carcass yield (HCY)	NS	NS		-0.154	0.9127	-0.410	-0.309	-0.502	-0.009	-0.535	-0.080	0.0243	0.1090	-0.399	0.1077
Cold carcass weight (CCW)	0.01	0.01	NS		-0.100	0.0849	0.3713	0.4224	0.5289	0.4361	0.2256	0.0373	0.1115	0.8341	0.9008
Cold carcass yield (CCY)	NS	NS	0.01	NS		-0.033	-0.318	-0.506	0.0317	-0.486	-0.017	0.0849	0.1680	-0.360	0.1667
Thawing loss (TL)	NS	NS	0.01	NS	NS		0.0382	0.0895	0.0340	0.2483	0.1354	-0.05	0.038	0.1154	0.0392
Carcass length (CL)	0.01	0.01	0.01	0.01	0.01	NS		0.5213	0.054	0.6254	0.4647	0.050	-0.025	0.4301	0.2386
Leg length (LL)	0.01	0.01	0.01	0.01	0.01	NS	0.01		0.1795	0.862	0.2147	0.053	0.061	0.5675	0.2244
Cushion thickness (CT)	0.01	0.01	NS	0.01	NS	NS	NS	NS		0.180	0.1128	0.1614	0.087	0.4420	0.5681
Arm length (AL)	0.01	0.01	0.01	0.01	0.01	0.04	0.01	0.01	NS		0.3322	0.039	0.033	0.6063	0.2543
Arm perimeter (AP)	NS	NS	NS	NS	NS	NS	0.01	NS	NS	0.01		0.1147	-0.081	0.1523	0.2076
Conformation (C)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS		0.067	0.0307	0.1479
Fat thickness (FT)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS		0.029	0.1337
Forequarter (F)	0.01	0.01	0.01	0.01	0.01	NS	0.01	0.01	0.01	0.01	NS	NS	NS		0.5899
Hindquarter+sidecut (H+S)	0.01	0.01	NS	0.01	NS	NS	0.05	NS	0.01	0.03	NS	NS	NS	0.01	

The classification of the average weight of steers at slaughter of 338.7, 358.6 and 381.6 kg as light, medium or heavy (Table 5), respectively, gave linear increases in weights of hot and cold carcass, and the correlation between slaughter weight and hot and cold carcass weights was 0.9157 and 0.9305 (P <0.001), respectively (Table 4). This trend was observed by several authors by evaluating animals of different ages and sexes and under varied diets (RESTLE *et al.* 1997b, Costa *et al.* 2002; KUSS *et al.*, 2005).

TABLE 5 – Means for carcass quantitative characteristics of steers slaughtered with different weights

Characteristics	Slaughter weight		
	Light	Medium	Heavy
Slaughter weight, kg	338.7[c]	358.6[b]	381.6[a]
Hot carcass weight, kg	183.1[c]	193.7[b]	202.4[a]
Cold carcass weight, kg	179.0[c]	188.6[b]	198.0[a]
Hot carcass yield, %	54.05	54.01	53.85
Cold carcass yield, %	52.93	52.65	52.55
Thawing loss, %	2.26	2.63	2.17
Carcass length, cm	120.52[b]	122.70[ab]	125.44[a]
Leg length, cm	67.20[c]	68.40[b]	69.27[a]
Cushion thickness, cm	22.29[b]	22.33[ab]	23.23[a]
Arm length, cm	36.57	37.49	38.78
Arm perimeter, cm	32.68	33.07	33.02
Conformation[1]	10.82	11.34	11.12
Fat thickness, mm	3.99	4.39	4.54
Forequarter, kg	66.82[c]	71.31[b]	75.08[a]
Forequarter, %	37.32	37.82	37.92
Sawcut + Sidecut, kg	113.0[c]	117.1[b]	123.0[a]
Sawcut + Sidecut, %	62.68	62.18	62.08

[1] Points 10 = good less; 11 = good typical; 12 = good more (Muller, 1987).

There was no significant relationship between slaughter weight and hot and cold carcass weight, with average yields of 53.97% and 52.71%, respectively. Similar cold carcass yield of Red Angus bulls slaughtered at one year of age with different slaughter weights are reported by COSTA *et al.*(2002).

The thawing loss was similar for the three slaughter weights (P> 0.05). This variable represents the liquid loss of the carcass during cooling (LAWRIE, 1970). Fat cover protects the carcass, reducing the process of dehydration and weight loss during cooling (MULLER, 1987). Subcutaneous fat thickness was similar for the three slaughter weights (Table 5). Although it was not statistically significant (P> 0.05), the smallest thawing loss (2.17%) occurred in heavy animals, which also presented thicker fat thickness (4.54 mm).

Among the metric measures of the carcass, the variables arm length and perimeter were not affected by the slaughter weight of animals (P> 0.05), but the variables carcass length, leg length and cushion thickness became greater as the animals´s weight increased. Similar results are reported by RESTLE *et al.* (1997b), Costa *et al.* (2002) and KUSS *et al.* (2005), reflecting better development of animals. The greatest measures of carcass length and leg length demonstrate that animals with the highest slaughter weights had the best skeleton and musculature developement.

Cushion thickness, which is a measure of muscular expression of the carcass (MULLER, 1987), showed increasing response with the increase of slaughter weight. RESTLE *et al.* (1997b) and COSTA *et al.* (2002) observed a quadratic behavior in cushion thickness with the increase of slaughter weight of steers, by studying Charolais - breed which presents more muscles and later finishing (RESTLE *et al.*, 1999b), with slaughter weights of 420, 460 and 500 pounds - and with Red Angus, which is considered a more precocious breed (COSTA *et al.*, 2002), with weights of 340, 370, 400 and 430 kg, respectively.

The average conformation of the carcasses of 11.09 points produced by animals slaughtered in the three weight classes (P> 0.05) is classified as typical good (MULLER, 1987). By working with cull cows, KUSS *et al.* (2005) observed a linear conformation with the increase of slaughter weight. For these authors, the increase in the conformation was caused by the deposition of intermuscular and intramuscular fat, as well as by the accumulation of protein in the muscle, since the animals were in the compensatory gain phase when protein synthesis is superior to degradation (DI MARCO, 1998).

RESTLE *et al.* (1997b) found an increase in carcass conformation score of Charolais steers confined from 30 months of age and slaughtered at increasing ages and weights (420, 460 and 510 kg). However, in younger animals, as in the present study, ARBOITTE *et al.* (2004) and COSTA *et al.* (2002), studying the increase in slaughter weight of steers and young steers, respectively, did not find no significant changes in the carcass conformation as the slaughter weight increased.

The increase in slaughter weight resulted in increased absolute weight of forequarter and hindquarter + sidecut, but it did not alter the proportion of these cuts in relation to cold carcass weight. RESTLE *et al.* (1997b), COSTA *et al.* (2002) and ARBOITTE *et al.* (2004), studying the increase in slaughter weight of calves of different ages, found that the increase of slaughter weight produced larger increase of the forequarter percentage than of the sawcut percentage.

LOBATO & VAZ (2006) warned that livestock systems need to be analyzed in their complete context, including all categories of animals, not just the analysis and development of product at different stages of the production cycle. By increasing the size and weight of steers through the selection of breeding and mating of reproducers of bigger types or frames, bigger heifers and cows may be obtained. Thus, animals with delayed sexual precocity are selected, as well as the maintenance requirements of the growing herds are increased (JENKINS & WILLIANS, 1994; CUNDIFF *et al.*, 1998), which can affect herd fertility indexes (VAZ & LOBATO, 2006).

The main disadvantages of having big cows in growing herds, especially in limited forage conditions (TABLES & LOBATO, 1996; FAGUNDES *et al.*, 2004), are related to the increased age and weight at puberty of heifers (RESTLE *et al.* 1999e), longer time in termination of steers and more requirements by the cows. OLSON (1994), working with Brahman herds, identified small, medium and large cows and noted that the average age of puberty for heifers was 633 days. However, larger heifers had significantly later puberty (627 days) than medium (626 days) and small heifers (633 days). The author found pregnancy rates of 93.7%, 89.7% and 86.9%, respectively, for small, medium and large heifers at two years of age. However, the pregnancy repetition of primiparous cows was influenced by body size, being 74.9%, 51.8% and 34.5%, respectively.

In accordance with VAZ & LOBATO (2006), PÖTTER *et al.* (1998) and BERETTA *et al.* (2002), who emphasize the need to analyze the results obtained with different animal categories in complete life-cycle systems, RESTLE *et al.* (1999b) pointed out the importance of considering the salughter weight, related with reproduction indeces, in the complete production cycle, after studying the slaughter weight in the super-young steers production system. According to these authors, when the reproduction rate is low, the producer should seek the maximum weight in animals, because the production cost of the calf will be high. Conversely, when the reproduction rate is high, the cost of production of the calf will be lower, and the slaughter weight of animals may be lighter, since the profit of the system will be achieved with the amount of animals sold, thus the producer must seek production efficiency using younger animals.

CONCLUSION

The weaning of calves at 91 days of age does not alter the development, carcass characteristics and the yield of commercial cuts, enabling the production and slaughter of young animals, at 16 months of age, with minimum carcass weight (180 kg) and fat coverage (3.0 mm). For steers slaughtered at that age, the increase in slaughter weight results in increased carcass weight, due to the greater length of the hind limbs and of the carcass, but not to the finishing or conformation of the animals.

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