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Carcass characteristics of small and medium-frame Aberdeen Angus young steers

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ABSTRACT. Carcass characteristics of small and medium-frame Aberdeen Angus young steers, finished in feedlot and slaughtered with similar subcutaneous fat thickness are evaluated. The average age and live weight at the start of feedlot were respectively 298 days and 202 kg. The steers were confined during 158 days, and slaughtered with average subcutaneous fat thickness of 6.4 mm. The feed consisted of sorghum silage and concentrate at 60:40 ratio of dry matter during the first 63 days and 50:50 afterward. The frame was calculated by formula $F = -11.548 + (0.4878xh) - (0.0289xID) + (0.0000146xID^2) + (0.0000759xIDxh)$, where h is the height and ID the age, in days. Steers with medium frame showed superiority in important marketing aspects such as warm ($p < 0.0001$) and cold carcass ($p < 0.0001$) weights. Muscularity measurements such as *longissimus dorsi* area in relation to cold carcass ($p = 0.0477$) and empty body ($p = 0.0419$) weights were lower for medium-frame steers. Carcass conformation, *longissimus dorsi* area and cushion thickness were similar in both frame. The commercial cuts, forequarter ($p < 0.001$), flank ($p = 0.009$) and saw cut ($p = 0.0003$) in kg were higher for medium-frame steers. Saw cut decreased 0.18% with an increase in frame ($p = 0.0404$). Weight of the carcass tissues increased with the steers frame, whereas the percentage of muscle tissue decreased 0.57% ($p = 0.0410$).

Keywords: height, age, cold carcass, commercial cuts, conformation, empty body.

Características da carcaça de novilhos super jovens Aberdeen Angus de biótipos pequeno e médio

RESUMO. Avaliaram-se as características da carcaça de novilhos Aberdeen Angus super jovens de biótipos pequeno e médio, terminados em confinamento e abatidos com semelhante espessura de gordura subcutânea. A idade e o peso vivo médio de ingresso no confinamento foram de 298 dias e 202 kg. Os animais foram confinados durante 158 dias, abatidos com espessura de gordura subcutânea média de 6,4 mm. A alimentação foi composta por silagem de sorgo e concentrado, na razão volumoso:concentrado de 60:40 na matéria seca, nos primeiros 63 dias e após, 50:50 até o abate. O biótipo foi calculado utilizando a fórmula $B = -11,548 + (0,4878xh) - (0,0289xID) + (0,0000146xID^2) + (0,0000759xhxID)$, em que h representou a altura e o ID idade em dias. Novilhos com biótipo médio apresentaram superioridade nos aspectos importantes de comercialização, como o peso de carcaça quente ($p < 0,0001$) e fria ($p < 0,0001$). As medidas de musculosidade da carcaça como a área de *longissimus dorsi* em relação ao peso de carcaça fria ($p = 0,0477$) e de corpo vazio (0,0419) foram menores nos novilhos de biótipo médio. A conformação da carcaça, área de *longissimus dorsi* em cm^2 e espessura de coxão foram semelhantes entre os biótipos. Os cortes comerciais, dianteiro ($p < 0,0001$), costilhar ($p = 0,009$) e traseiro especial ($p = 0,0003$) em kg foram superiores nos de biótipo médio. Em percentagem, o corte traseiro diminuiu 0,18% com o aumento no biótipo ($p = 0,0404$). Em peso, os tecidos constituintes da carcaça aumentaram com o biótipo do novilho, já quanto à percentagem o tecido muscular apresentou queda de 0,57% ($p = 0,0410$).

Palavras-chave: altura, idade, carcaça fria, cortes comerciais, conformação, corpo vazio.

Introduction

The inclusion of abattoirs and producers within the production chain is mandatory so that the requirements of beef consumer could be satisfied. Improvement in beef quality and more efficient production undergo processes such as the slaughtering of less than two-year-old animals, coupled to the cattle frame, which may also affect beef quality.

Aberdeen Angus steers are characterized by early fat deposition and excellent biological efficiency, both of which satisfy the producers' needs. Further, they provide tender beef required by the consumer market (COSTA et al., 2002a).

Santini et al. (2006) reported three different frame in Aberdeen Angus steers, or rather, small-frame with 1 to 2 marks; medium-frame with 4 to 5 marks and big-size with over 6 marks. The direct relationship between biotypes and production efficiency in steers has incorporated characteristics associated with animal size in improvement programs (ROSO; FRIES, 1995). Rump height has been the most preferred as the most practical within the context of other measurements.

Whereas large-frame animals are generally heavy at any age with a great amount of lean beef and late developing, the smaller ones are lighter, with early development and greater fat deposition (DI MARCO et al., 2007). Studies are based on different weights at slaughter (COSTA et al., 2002a) within different food conditions (BRONDANI et al., 2004; VAZ et al., 2008).

The characteristics of very young Aberdeen Angus young steers with small and medium-frame slaughtered with the same carcass fitness are evaluated.

Material and methods

The experiment was undertaken between 15th July and 20th December with eight small frame Aberdeen Angus steers and ten medium frame ones from 13 farms.

Steers' initial mean age was 298 days and main live weights at confinement were 178 ± 6.65 and 221 ± 5.95 respectively for small and medium frame steers. Animals were confined during 158 days and slaughtered with an average age of 456 days and mean weight of 397 ± 0.12 and 455 ± 7.68, respectively, and 6.39 ± 1.53 mm subcutaneous fat thickness.

Feed consisted of sorghum hybrid AG2005E silage, with 55% grains in the silaged green mass, and commercial concentrate. During the first 63 days diet supplied contained 11.2% crude protein, 36.1% fiber in neutral detergent, 68.2% total digestible nutrients and 2.32% ethereal extract. From this period to slaughter time, diet contained 12% crude protein, 35.75% fiber in neutral detergent, 68.5% total digestible nutrients and 2.35% ethereal extract.

Diet was supplied in the morning, once a day, at 60:40 roughage:concentrate during the first 63 days and at 50:50 till slaughter. Feed wastes of the previous day were removed before the daily supply, and weighed to determine feed intake. Feed supply was calculated at 8% above voluntary intake and regulated according to intake of the previous day.

At the start of the experiment frame was calculated according to formula:

$$F = -11.548+0.4878xhx0.0289xID+0.0000146xID^2+ +0.0000759xhxID$$

where:

F = frame; h = height in inches; ID = age in days (DI MARCO et al., 2007; ARBOITTE et al., 2011). Height measurements were taken above sacral tuberosity up to the front of the hooves in contact with the ground, with metric tape, at the start and finish of the experiment. Animals were weighed every 21 days after a 14h-fast in solid meals and liquid.

Heifers were slaughtered by brain concussion and severing of the jugular vein. Weight of empty carcass, warm and cold carcass, chilling loss, warm and cold carcass yield, measurement in cm of carcass, leg and forearm length, cushion thickness of chilled carcass, amount of muscles, bone and fat, determination of *longissimus dorsi* muscle area and thickness of subcutaneous fat, carcass conformation, physiological maturation and participation of the three main commercial cuts: flank, forequarter, hindquarter were calculated, following Arboitte et al. (2005).

Carcass capacity was determined by dividing the weight of the warm carcass by its length. Rump size was calculated by multiplying cushion thickness by two.

Dry matter, crude protein, ethereal extract rates were determined following AOAC methodology (AOAC, 1984) and fiber rate in neutral detergent according to Van Soest and Wine (1967). Experimental design was randomized and steers were classified into small and medium frame in which each animal was an experimental unit.

Data underwent variance analysis with test F (SAS, 2000) and Pearson's correlation between variables was also calculated.

Statistical model was $Y_i=\mu+f_i+e_{i;}$
where:

Y_{ij}= dependent variables; μ = mean of rates; f_i = effect of the $_i$ th biotype, 1 – small size and 2 – medium size; e_i = randomized error associated with each rate.

Regression analysis (SAS, 2000) was undertaken in the dependent variables which were significant by Anova. Coefficients of determination of regression equations were transformed through methodology {sum of total corrected regression squares / (sum of total corrected regression squares+sum of error squares of variance analysis)} (ARBOITTE et al., 2011).

Results and discussion

There were differences ($p = 0.0002$) in the initial weight of steers with 178.50 and 221.10 kg respectively for the small and medium frame (Table 1). When regression equation is used to evaluate the initial weight, there was an increase of 25.94 kg with regard to the initial weight in the steers frame ($\hat{y}=107.87+250.04B$; $R^2=0.3825$). Santini et al. (2006) also reported differences ($p < 0.05$) in the initial weight of Aberdeen Angus steers with regard to the small (159 kg) and big (193 kg) frame. According to Di Marco et al. (2007), the initial weight did not affect the determination of the animals' frame.

Medium-frame steers had a final weight ($\hat{y} = 308.14+32.07B$; $R^2 = 0.3520$; $p = 0.0001$) higher than that of small-frame ones. Rates 454.80 and 396.62 kg were respectively influenced by the highest initial weight. Di Marco et al. (2007) reported that same age animals and with bigger frame had a greater body weight. This fact was also corroborated by Santini et al. (2006) with small and big Angus steers slaughtered with the same carcass finish.

Initial age and age at slaughter were similar ($p = 0.1395$ and $p = 0.5212$) respectively for small and medium fame in the variables inserted in the equation by Di Marco et al. (2007) to determine the frame. Height is the most influential variable (DI MARCO et al., 2007), whereas the mean initial rates ($p = 0.0003$) classified the animals in small (3.01 marks) and medium (4.07 marks) frame.

Height gain was similar ($p = 0.6427$) among the small and medium-frame, with a mean rate of 9.28 cm, which characterized a similar bone growth among the frame under analysis.

From the economical point of view, steers' weight gain is highly relevant due to the direct effect in net yield and positive relationship with the efficiency of weight gain and commercial value (DI MARCO et al., 2007). There was no difference ($p = 0.1570$) in mean daily weight gain with regard to the mean rate 1.43 kg day^{-1}. Similarity in mean daily weight gain among different steer frame has been reported by Tatum et al. (1988).

Santini et al. (2006) reported a difference ($p < 0.05$) in weight gain in favor of large-frame steers (1.06 kg) when compared to small-frame ones (0.89 kg). Weight gain in favor of large-frame animals, at the same nutrition level, is due to the fact that they are prepared for muscle production which contains water and low fats and thus require less energy amounts (BERG; BUTTERFIELD, 1976).

Empty carcass weight is relevant for abattoirs since it represents the commercial tissues which make up the animal. Medium-frame steers had a high empty carcass weight ($\hat{y} = 255.07 + 30.74B$; $R^2 = 0.4827$; $p < 0.0001$), which comprises a 30.74 kg increase as steers go up one mark in their frame. Weight of empty carcass and slaughter weight failed to influence ($p = 0.9251$) the relationship (mean rate 0.86) between the variables for small and medium-frame steers.

Medium-frame reached a higher warm carcass weight ($\hat{y} = 153.91 + 21.09B$; $R^2 = 0.4886$; $p < 0.0001$) when compared to rates of small-frame which reached a weight of 214.97 kg (Table 2). This rate is below that required by abattoirs so that carcass devaluation would not occur. Since the Aberdeen Angus race has a high potential for the production of very young steers, knowledge on the steer's frame is important, especially those classified as small-frame as Santini et al. (2006) report.

Table 1. Adjusted means, standard error for initial weight, slaughter and empty carcass, initial and final height, gain of height during experiment, initial age and at slaughter, mean daily weight gain of small and medium frame Aberdeen Angus steers.

Variable	Frame		Regression equation	Significance
	Small	Medium		
Initial weight (kg)	178.50 ± 6.65	221.10 ± 5.95	$\hat{y}$ =107.87 + 250.04B	0.0002
Weight at slaughter (kg)	396.62 ± 0.12	454.80 ± 7.68	$\hat{y}$ =308.14 + 32.07B	0.0001
Initial height (cm)	110.00 ± 1.00	116.20 ± 0.90	$\hat{y}$ =93.68 + 5.25B	0.0003
Height at slaughter (cm)	119.50 ± 0.85	125.30 ± 0.76	$\hat{y}$ =108.54 + 3.89B	0.0001
Height gain (cm)	9.50 ± 0.63	9.10 ± 0.56	$\hat{y}$ =9.28 ± 1.74	0.6427
Initial age (days)	287.37 ± 9.86	309.90 ± 8.37	$\hat{y}$ =298.22 ± 27.55	0.1395
Age at slaughter (days)	452.12 ± 9.86	460.80 ± 8.82	$\hat{y}$ =456.94 ± 27.41	0.5212
Weight of empty carcass (kg)	342.93 ± 5.37	393.22 ± 5.69	$\hat{y}$ =255.07 + 30.74B	<0.0001
MDWG (kg)[1]	1.38 ± 0.05	1.48 ± 0.04	$\hat{y}$ =1.43 ± 0.14	0.1570
Ratio ECW:WS[2]	0.87 ± 0.010	0.86 ± 0.008	$\hat{y}$ =0.86 ± 0.03	0.9251

[1]MDWG –mean daily weight gain in kg. [2]ECW:WS – ratio empty carcass weight:weight at slaughter.

Table 2. Mean rates, standard deviant and significance of weight, warn and cold carcass yield, chilling loss, thickness of subcutaneous fat of small and medium-frame Aberdeen Angus steers.

Variable	Frame		Regression equation	Significance
	Small	Medium		
Weight of warn carcass (kg)	214.97 ± 4.64	248.09 ± 4.15	ŷ =153.91 + 21.09B	<0.0001
Weight of cold carcass (kg)	210.39 ± 4.62	243.13 ± 4.13	ŷ =150.29 + 20.78B	<0.0001
YWC (%)[1]	54.29 ± 0.66	54.54 ± 0.59	ŷ =54.43 ± 1.80	0.7853
YCC (%)[2]	53.13 ± 0.65	53.44 ± 0.58	ŷ =53.31 ± 1.78	0.7247
Chilling loss (%)	2.14 ± 0.04	2.01 ± 0.04	ŷ =2.06 ± 0.13	0.0521
TSF (mm)[3]	6.00 ± 0.54	6.70 ± 0.48	ŷ =6.39 ± 1.53	0.3500

[1]YWC – yield of warm carcass; [2]YCC – yield of cold carcass; [3]TSF – thickness of subcutaneous fat.

Difference in warm carcass weight with the same finish degree, or rather, by the same thickness of subcutaneous fat (p = 0.3500) among frame is correlated with the steers' difference in height (r = 0.73696; p = 0.0005). This fact is corroborated by Di Marco et al. (2007) who reported that large-fame steers were prone to a higher weight at slaughter and greater carcass weight. According to Dolezal et al. (1993), the frame affects weight at slaughter and carcass weight. This fact is more consistent among small and large-frame steers than between medium-sized ones and others.

Warm carcass yield did not differ (p = 0.7853) among the frame under analysis with rates at 54.29 and 54.54% for small and medium-frame steers respectively. A similar result was obtained (p > 0.05) with rates 56.70 and 57.35% respectively, reported by Santini et al (2006). Carcass yields above 50% provide a higher price to the producer in steer commercialization and thus a great advantage when very young animals with adequate fat thickness on carcass are concerned.

Medium-frame steers had a high cold carcass weight (ŷ = 150.29 + 20.78B; R^2 = 0.4831; p < 0.0001) although cold carcass yield was similar (p = 0.7247) among small and medium-frame steers, with rates 53.13 and 53.44%, respectively. Dolezal et al. (1993), who reported a lower (p < 0.05) cold carcass yield (61.5%) for small-fame steers, registered a similar cold carcass yield (p > 0.05) among big-frame (63.2%) and small-frame (62.6%) animals.

Weight loss during chilling reported in small and medium-frame carcass of steers were similar (p = 0.0523), with rates 2.14 and 2.01% respectively. Brondani et al. (2004) reported that in very young steers the rate of chilling loss reached 1.98%, with carcasses featuring subcutaneous fat thickness 3.62 mm. However, Santini et al. (2006) registered higher percentages in chilling loss with rates 4.07 and 4.15% for small and large-frame steers.

Subcutaneous fat thickness was similar (p = 0.3500) for the two frame under analysis, with rates 6.00 and 6.70 mm respectively for the small and medium-frame. Optimized rates for the internal market provided a good liquid retention in the carcass with a homogenous fat distribution in first rate commercial cuts and good visual aspects of the carcass.

Tatum et al. (1986b) reported rates 2.6; 2.4 and 2.2 mm respectively for small, medium and big frame, and thus a similarity in the fat thickness among steers of different frame. On the other hand, Camfield et al. (1997) reported differences (p < 0.05) in subcutaneous fat thickness between medium and big-frame steers with rates 5.4 and 4.4 mm.

When Santini et al. (2006) measured subcutaneous fat in small and big-frame steers by ultrasound, they reported similarity in the rates (6.91 and 6.42 mm respectively). When slaughtered, their subcutaneous fat thickness rates were 5.77 and 4.87 mm (p > 0.05) respectively. Small frame steers are prone to be lighter at slaughter with greater fat deposits (DI MARCO et al., 2007).

Carcass conformation (Table 3) and the subjective evaluation of the muscle are relevant for the commercial aspect of the above due to the hindquarter muscle hypertrophy, or rather, the region of cuts with the greatest commercial value. The muscle development of the shoulder-blade and forearm are also evaluated.

Table 3. Mean rates, standard deviant and conformation significance, physiological maturity, carcass, leg and forearm length, cushion thickness, compactness, *longissimus dorsi* area in cm^2, weight of cold and empty carcass of small and medium frame Aberdeen Angus steers.

Variables	Frame		Regression equation	Significance
	Small	Medium		
Conformation (marks)[1]	10.00 ± 0.40	10.40 ± 0.36	ŷ =10.22 ± 1.11	0.4660
Physiological maturity (marks)[2]	13.75 ± 0.16	13.80 ± 0.14	ŷ =13.78 ± 0.43	0.8138
Length of carcass (cm)	122.06 ± 1.09	126.15 ± 0.98	ŷ =116.04 + 2.20B	0.0133
Length of leg (cm)	64.97 ± 1.00	67.50 ± 0.89	ŷ =66.38 ± 3.03	0.0782
Length of forearm (cm)	36.00 ± 0.38	37.90 ± 0.34	ŷ =32.19 + 1.29B	0.0020
Cushion thickness (cm)	20.00 ± 0.59	20.75 ± 0.53	ŷ =20.42 ± 1.66	0.3578
Compactness (kg cm^{-2})	1.76 ± 0.03	1.97 ± 0.03	ŷ =1.37 + 0.13B	0.0004
LDA $(cm)^2$ [3]	60.29 ± 2.49	61.60 ± 2.23	ŷ =61.02 ± 6.87	0.6999

[1]scale from 1 to 18 marks: 8 = regular, 9 = regular plus; 10 = good minus; [2]scale 15 to 13 animals aged less than 2.5 years; 12 to 10 animals aged between 2.5 and 4.0 years; [3]LDA - *longissimus dorsi* area.

Conformation rates were similar ($p = 0.4660$), mean 10.22 marks, classified as 'good minus', mean similar to that registered by Costa et al. (2002b) and less than that reported by Brondani et al. (2004) with very young Aberdeen Angus steers.

Due to similarity in age at slaughter (457 days, Table 2), there was no difference ($p = 0.8138$) in physiological maturity. Carcasses were thus ranked at an age below 2.5 years, in which cartilages are in the endochondral and intra-membrane process and in the process of thorax and lumbar vertebrates in the sacral vertebrates and in the sternum bone.

Carcass length increased by 1.93 cm with an increase in the steers' frame ($\hat{y} = 116.04 + 2.20B$; $R^2 = 0.1786$; $p = 0.0133$). Mean rates for small and medium frame steers were 122.06 and 126.15 cm respectively, with rates higher than 103.68 and 115.10 cm reported by Santini et al. (2006), respectively, in small and large frame steers.

Carcass length, positively correlated to rump height ($r = 0.6477$; $p = 0.0039$), showed that through an increase in frame the animals became longilinear. Carcass length also showed a correlationship between warm carcass weight ($r = 0.65084$; $p = 0.00034$) and mean daily weight gain ($r = 0.75772$; $p = 0.0003$). When correlations between carcass length and muscle percentage are analyzed ($r = -0.52938$; $p = 0.0239$), the longilinear animals had a lesser proportion of this carcass factor.

Mean rate of carcass length, 124.33 cm in current experiment, was higher than 116 cm reported by Brondani et al. (2004) in young steers Aberdeen Angus steers. Equation ($\hat{y} = 85.48 + 0.084$xweight at slaughter), suggested by Costa et al. (2002b) showed that small and medium frame steers had lower rates, 3.26 and 2.47 cm, for carcass length than those reported in current study. The above reveals the importance of frame inclusion to adequate data.

Carcass leg length was similar ($p = 0.0782$) between small and medium frame steers and did not follow height trends (Table 1). The measurement was used to calculate the steers' frame classification. However, the correlation ($r = 0.38425$) between the leg length and final height of the steers was not relevant ($p = 0.1154$) due to the exclusion of the calf (tibia and fibula bones) which were not measured at slaughter.

The carcass's forearm length increased 1.12 cm for each increase mark in the steers' frame ($\hat{y} = 32.19 + 1.29B$; $R^2 = 0.4008$; $p = 0.0020$) with rates 36.00 and 37.90 cm respectively in small and medium frame steers. The variable was correlated to the leg length ($r = 0.50219$; $p = 0.0337$) and to the final height of the steer ($r = 0.78661$; $p = 0.0001$).

Cushion thickness reveals the proportion value of the carcass's different muscles since the cushion is the thickest part of the animal, made up of the greatest muscle mass, and thus beef quantity. It is a measure that foregrounds the conformation by which abattoirs classify the carcasses.

Cushion thickness in the carcass of small and medium-frame young steers Aberdeen Angus was similar ($p = 0.3578$) with mean rate 20.42 cm. These results contradict those by Di Marco et al. (2007) who reported that big frame animals had large carcass muscularity, but coincide with research results by Tatum et al. (1986a, 1988) who registered that different frame steers had similar carcass muscularity rates.

Carcass capacity characteristics increased 0.13 kg cm^{-2} ($\hat{y} = 1.37 + 0.13B$; $R^2 = 0.4607$; $p = 0.0004$) with an increase in the steer's frame. This fact was expected since high rates actually mean a greater quantity of carcass cuts. When Alberti et al. (2008) evaluated the compactness of 365-day-old steers, they found that Angus steers had a rate of 2.6 kg cm^{-2}. According to these authors, compactness is a complementary measurement in carcass ranking which may be a help in comparing steers with different frame.

The FRame under analysis were similar ($p = 0.6999$) with regard to the *longissimus dorsi* area, featuring a mean rate of 61.02 cm^2. Similarity ($p > 0.05$) between the *longissimus dorsi* area in British and Continental crossbreed steers, slaughtered with medium (74.61 cm^2) and big (79.56 cm^2) frame, was been reported by Camfield et al. (1997). Santini et al. (2006) registered non-significant rates ($p > 0.05$) with regard to the *longissimus dorsi* area, measured by ultrasound, in Aberdeen Angus steers with small (51.39 cm^2) and big (60.97 cm^2) frame. The authors have also verified that after slaughter the *longissimus dorsi* areas were respectively 59.39 and 76.51 cm^2 ($p < 0.05$).

Within the context of most cattle slaughtered in Brazil, steers under analysis are differentiated by age at slaughter and by their British origin which, due to their early development and in spite of being very young, may demonstrate a type of finish (subcutaneous fat) proper to the carcass, as has been reported in current experiment (Table 2).

The weight of the hindquarter cut (Table 4) increased 9.64 kg ($\hat{y} = 74.02 + 9.64B$; $R^2 = 0.5667$; $p = 0.0003$) proportionately to the steers' frame. Rates of hindquarter weight were 102.92 and 116.25 kg respectively for small and medium size frame. The hindquarter is the most rated part of the carcass since it contains the most commercialized beef cuts. In the case, the commercialization of medium frame steer carcass is highly preferable since it has a mean increase of 13.33 kg when compared to that of the small-frame.

Table 4. Mean rates, standard deviant and significance of hindquarter, forequarter, flank, muscle, fat, bone in kg and percentage, ratio between muscle:bone and eatable section of small and medium-frame Aberdeen Angus steers.

Variable	Frame		Regression equation	Significance
	Small	Medium		
Hindquarter (kg)	102.92 ± 2.13	116.25 ± 1.91	ŷ =74.02 + 9.64B	0.0003
Hindquarter (%)	48.93 ± 0.40	47.83 ± 0.33	ŷ =49.00 - 0.18B	0.0404
Forequarter (kg)	77.10 ± 1.72	90.36 ± 1.54	ŷ =54.93 + 7.84B	<0.0001
Forequarter (%)	36.64 ± 0.26	37.18 ± 0.23	ŷ =36.94 ± 0.77	0.1442
Flank (kg)	30.37 ± 1.13	36.52 ± 1.01	ŷ =21.33 + 3.31B	0.0009
Flank (%)	14.42 ± 0.24	14.99 ± 0.21	ŷ =14.74 ± 0.71	0.0933
Muscle (kg)	128.16 ± 3.10	141.81 ± 2.77	ŷ =94.36 + 10.99B	0.0047
Muscle (%)	60.93 ± 0.87	58.34 ± 0.77	ŷ =61.63 - 0.57B	0.0410
Fat (kg)	52.79 ± 1.61	57.29 ± 1.44	ŷ =55.29 ± 4.97	0.0530
Fat (%)	26.31 ± 0.80	28.56 ± 0.72	ŷ =27.56 ± 2.48	0.0529
Bone (kg)	24.51 ± 0.40	24.93 ± 0.36	ŷ =24.74 ± 1.13	0.4450
Bone (%)	12.22 ± 0.20	12.43 ± 0.18	ŷ =12.33± 0.56	0.4434
Ratio muscle:bone	5.23 ± 0.18	5.71 ± 0.16	ŷ =5.50 ± 0.54	0.0585
Eatable section	7.39 ± 0.20	8.02 ± 0.18	ŷ =6.11 + 0.43B	0.0330

An analysis of the hindquarter percentage, adjusted to the weight of cold carcass, shows that rates decreased 0.18% ($\hat{y}$ = 49.00 - 0.18B; R^2 = 0.0119; p = 0.0404) according to the frame increase in mark. Rates close to 48.56% by Brondani et al. (2004) and to 47.45% by Vaz et al. (2008) were reported. Difference ($p < 0.05$) in the hindquarter was reported by Santini et al. (2006) in the carcass of small and big frame Aberdeen Angus steers, with 48.72 and 47.41%, respectively.

Forequarter weight increased 7.84 kg ($\hat{y}$ = 54.93 + 7.84B; R^2 = 0.4435; $p < 0.0001$) with frame increase. With regard to its participation in meat cuts, the forequarter had a similar rate (p = 0.1442) between small and medium frame steers. Mean rate was 36.94%, close to 36.76% reported by Costa et al. (2002a) and below the 38.82% yield registered by Brondani et al. (2004).

Flank weight was higher ($\hat{y}$ = 21.33 + 3.31B; R^2 = 0.2764; p = 0.0090) in the carcass of medium-frame steers, with 36.52 kg, when compared to rate of small-frame ones, with 30.37 kg. Flank percentage was not influenced (p = 0.0933) by the animal's frame, with mean rate 14.74%.

The participation of the hindquarter was negatively influenced by the forequarter (r = -0.80309; $p < 0.0001$) and flank (r = -0.76645; p = 0.0002) participation increase. The above shows the relevance of frame that produce higher participation of hindquarters where the meaty cuts with high commercial value may be found.

Carcass ranking comprises muscle, bone and fat quantities (DI MARCO et al., 2007). Great quantities of muscle and sufficient fat quantities, with small bone amounts are preferred since they are expected by consumers. Muscle amount in the carcass increased 10.99 kg ($\hat{y}$ = 94.36 + 10.99B; R^2 = 0.4911; p = 0.0047) when the steer's frame increased, with 128.16 and 141.81 kg respectively for small and medium frame. Differences ($p < 0.05$) in muscle quantity in the carcass was registered by Tatum et al. (1988) and Dolezal et al. (1993), with 71.4 and 146.5 kg in small-frame steers; 89.3 and 172.2 kg in medium-frame steers; 106.6 and 208.7 kg for big-frame steers.

According to Di Marco et al. (2007), big-frame steers mature at a later period and may cause high participation in muscle to the detriment of fat participation in the carcass. The same authors report that steers of the same height may differ considerably in muscle and fat accumulation. This fact implies different body compositions which may be potentialized in the same race steers or in genetic groups with different frame.

Muscle proportion was higher in small-frame steers ($\hat{y}$ = 61.63 - 0.57B; R^2 = 0.0215; p = 0.0410), or rather, a decrease by 0.57% for each mark in frame increase. This fact contradicts results by Tatum et al. (1986b) who reported higher ($p < 0.005$) muscle participation in big-frame steers' muscle (64,4%) when compared to medium (61.0%) and small (58.8%) frame ones.

Weight of fat in the carcass is similar (p = 0.053) among the frame under analysis, with mean rate 55.29 kg. Dolezal et al. (1993) reported greater ($p < 0.05$) fat amounts in the big frame steers' carcass (128.2 kg) when compared to those in medium (107.1) and small-frame one (92.2 kg). When fat proportion in the carcass is taken into consideration, the frame studied were similar (p = 0.4949), with mean rate 25.41%, lower than 32.5% given by Dolezal et al. (1993). This fact enhances that animals' finish condition amounted to 13.3mm, higher than the rate 6.51 mm in current experiment.

Animals with higher fat percentages in the carcass have less muscle participation. This is verified by the correlation between these factors ($r = -0.93106$; $p < 0.0001$). Correlations between muscle and hindquarter ($r = 0.91528$; $p < 0.0001$), forequarter ($r = 0.78502$; $p = 0.0001$) and flank ($r = 0.79751$; $p < 0.0001$) weights and the correlation between fat weight and forequarter ($r = 0.5459$; $p = 0.0193$) and flank ($r = 0.52745$; $p = 0.0245$) weights indicate that the weight of the above cuts depend on these tissues.

The ratio muscle:bone was similar ($p = 0.0585$) in the frame under analysis and show a mean rate 5.50%, above the rates 3.50 and 3.72% reported by Tatum et al. (1988) and Dolezal et al. (1993) respectively. Ratio muscle:bone was mainly influenced by muscle weight ($r = 0.89601$; $p < 0.0001$) which was better correlated than with the bone weight ($r = -0.56402$; $p = 0.0148$).

The eatable proportion, or rather, the sum of the muscle and fat participation in the carcass, increased 0.43% ($\hat{y} = 6.11 + 0.43B$; $R^2 = 0.2274$; $p = 0.0330$) with the fame increase of the very young Aberdeen Angus steers, with rates 7.96 and 8.10% respectively for small and medium-frame steers. High eatable participation of medium-frame steers provided them with a better choice in production to the detriment of the small-frame one.

Meat quality and the quality of the eatable portion are relevant factors to evaluate carcass ranking. Relative emphasis should be given to the quantity and quality of muscle and fat since they may be altered according to consumers' requirements. Currently consumers prefer carcass with the quality provided by young age (tenderness) and finish (fat), registered in British cattle races such as the Aberdeen Angus steers.

Conclusion

Medium frame of Aberdeen Angus steers provided better characteristics in initial and final weight, empty carcass and warm and cold carcass, less chilling loss, increase in CUT weights of the hindquarters, forequarters and flank, and in the eatable proportion of the carcass. Small-frame steers provided a higher percentage of hindquarter cuts and carcass muscularity, such as the *longissimus dorsi* area, when compared to cold carcass and empty carcass weight.

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