Revista Brasileira de Zootecnia
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ISSN 1806-9290
www.sbz.org.br

R. Bras. Zootec., v.40, n.12, p.2886-2893, 2011

Pattern of tissue deposition, gain and body composition of Nellore, F_1 Simmental × Nellore and F_1 Angus × Nellore steers fed at maintenance or *ad libitum* with two levels of concentrate in the diet[1]

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ABSTRACT - Sixty 18-month-old steers (20 Nellore, 20 F_1 Simmental × Nellore and 20 F_1 Angus × Nellore with average body weight of 265.6±6.4 kg; 325.3±4.7 kg and 324.6±6.0 kg, respectively) were used. The effects of feeding regime and genetic group on physical carcass composition, empty body composition, composition of the gain, as well as the pattern of tissue deposition were evaluated in this trial. The interaction between genetic group and feeding regime was not significant for any variable evaluated. Animals fed at the maintenance level produced carcass with larger proportions of bones and muscle than the animals fed *ad libitum* and Nellore animals had larger muscle portion and smaller adipose tissue portion on the carcass than the crossbred animals. Nellore animals and those fed at maintenance had smaller amount of total fat in the carcass than the crossbred animals and those fed *ad libitum*, respectively. Fat was deposited more pronouncedly in the intermuscular depot, followed by the visceral depot. The rate of deposition of the carcass tissues was smaller in the Nellore animals and in the animals fed the diet with concentrate allowance equivalent to 1% body weight (except for subcutaneous fat tissue), when compared with the crossbred animals and those fed the diet with 2% BW on concentrate, respectively. The rate of fat deposition on the visceral depot was larger in the F_1 Angus × Nellore animals and on those fed the 2% of BW of concentrate diet when compared with F_1 Simmental × Nellore animals and those fed the diet with the lowest concentrate allowance (1% BW).

Key Words: empty body gain, physical gain composition, visceral fat

Introduction

Recently, the Brazilian beef industry has invested in technology to improve its quality, mainly of beef destined to exportation, leading the professionals in the related area to improve their knowledge of how to increase productivity and profitability in beef production systems. Thus, strategies of production such as the use of feedlot prior to the harvesting and crossbreeding have been used in order to improve the gain rate and the carcass traits (Preston, 1998).

Factors such as age of the animal, gender, feeding regime and genetic type can affect the physical composition of the carcass as well as its growth rate. Among these factors, the genetic type and feed system can be easily manipulated in order to improve the productivity (Owens, 1995).

The corporal structure of the animals determines the rates of body weight gain, fat deposition in different portions of the body and the energy required for maintenance. Animals with different frame sizes such as Nellore, Angus and Simmental present different finishing time when submitted to the same feeding system. Thus, as the genetic type and feeding regime may affect the composition of the carcass, investigations about strategies to reduce costs of production by manipulating the genetic type and diets are needed.

Tissue growth is allometric, where the time to reach the plateau of growth differs between different types of tissues. As such, since the bone, muscle and adipose tissue follow this order, it would be possible to maximize the muscular gain and allow the least deposition of fat without compromising beef quality, thus minimizing the feed costs.

In this context, this study was carried out aiming to evaluate the influence of feeding regime on the pattern of tissue deposition and carcass and empty body gain composition of Nellore, F_1 Simmental × Nellore and F_1 Angus × Nellore cattle.

Material and Methods

This experiment was conducted in the Laboratório Animal of the Departmento de Zootecnia of Universidade Federal de Viçosa (UFV), in Viçosa-MG, from May to September of 2007. Forty-eight steers with average age of 18 months (16 Nellore, 16 F_1 Simmental × Nellore, 16 F_1

Received June 15, 2009 and accepted July 28, 2011.
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Angus × Nellore) were used. The average body weight (BW) was 265.6±6.4 kg; 325.3±4.7 kg and 324.6±6.0 kg for Nellore, F_1 Simmental × Nellore and F_1 Angus × Nellore, respectively, for the analysis using animals fed *ad libitum* and at maintenance. For the analysis where animals fed at maintenance were not used, the average initial BW was 267.17±4.6 kg; 325.63±3.9 kg and 321.63±6.7 kg, for Nellore, F_1 Simmental × Nellore and F_1 Angus × Nellore animals, respectively.

Cattle were submitted to 30 days of adaptation to the experiment conditions and 14 days of adaptation to the experimental diets prior the beginning of the 84 days of experiment. During the adaptation period, cattle were fed diet composed of 55% roughage (corn silage) and 45% concentrate. Concentrate was formulated using corn meal, soybean meal, cotton seed, soybean hull, urea and mineral mixture (12.5% crude protein). After the adaptation period, four animals from each genetic group were randomly selected to compose the reference group and slaughtered in order to determine the initial empty body weight (EBWi).

After the slaughter of the reference group, six animals of each genetic group that were assigned to receive concentrate at levels of 2% of body weight (BW) were fed concentrate at 1.5% BW for 7 days and fed concentrate at 2% BW for 7 days for adaptation to experimental diets. Six animals of each genetic group assigned to receive concentrate at 1% of BW and four animals assigned to be fed at maintenance were fed their treatment diets (Table 1) after the 30 days of adaptations to the experimental conditions.

Animals were confined to individual stalls with feeders and drinkers and a total area of 30 m^2, from which 8 m^2 were covered with asbestos tiles. After analyzing the available ingredients, the diets were formulated to be isonitrogenous with 12.5% crude protein (CP). The animal feed intake was estimated as suggested by Valadares Filho et al. (2006) and the macro and micro minerals requirements were adjusted according to the NRC (1996). Diets were fed as total mixed ration (roughage + concentrate) and cattle were fed twice daily (at 06h30 and 15h30) allowing for up to 5-10% of orts. Animals assigned to be fed at maintenance were fed once a day with the same diet of those fed concentrate at 1% BW. At the first experimental period cattle fed at maintenance were fed concentrate levels at 1.2% of BW. However, due to a gain of weight observed in those animals, they were fed concentrate levels at 1% of BW after the second experimental period.

At the end of the trial the animals were weighed after a 16-h solid fast and harvested at the slaughter facility Universidade Federal de Viçosa. Cattle were slaughtered by cerebral concussion followed by jugular and carotid venesection by the Normative Instruction no.3 of 01/13/2000 (Technical Regulation of Methods for Humane Slaughtering of Livestock).

Table 1 - Proportion of ingredients and chemical composition of experimental concentrates and diets

Ingredient	1% BW		2% BW	
	Concentrate	Diet	Concentrate	Diet
	Proportion			
Corn silage		58.70		24.84
Cotton seed	12.28	5.07	12.07	9.07
Soybean hull	26.93	11.12	26.66	20.04
Urea	3.17	1.31	1.06	0.80
Ammonium sulphate	0.35	0.14	0.21	0.16
Corn	52.43	21.65	55.07	41.39
Soybean meal	2.02	0.83	2.09	1.57
Mineral mixture[1]	0.69	0.29	0.70	0.52
Salt	0.69	0.29	0.70	0.52
Potassium chloride	0.35	0.14	0.35	0.26
Magnesium oxide	0.32	0.13	0.32	0.24
Sodium bicarbonate	0.64	0.26	0.64	0.48
Limestone	0.14	0.06	0.14	0.11
Dry matter	-	53.97	-	74.29
Organic matter	95.72	94.31	95.70	95.11
Crude protein	20.69	12.73	14.96	13.02
Ether extract	4.01	3.09	4.06	3.66
NDFap	41.18	45.84	35.51	38.89
Non fiber carbohydrates	52.39	41.96	48.21	44.83
Total digestible nutrients	-	70.50	-	70.27
Digestible energy	-	3.11	-	3.10
Metabolizable energy	-	2.54	-	2.54
Phosphorus	0.56	0.44	0.57	0.52
Calcium	0.67	0.49	0.67	0.59
Magnesium	0.35	0.21	0.36	0.30
Sodium	0.55	0.31	0.55	0.45
Potassium	0.95	1.14	0.96	1.04

[1] Composition: Ca – 24,0%; P – 17.4%; Co – 100.0 ppm; Cu – 1,250.0 ppm; Fe – 1,795.0 ppm; Mn – 2,000.0 ppm; Se – 15.0 ppm; Zn – 5,270.0 ppm; I – 90.0 ppm.
NDFap = neutral detergent fiber corrected for ashes and proteins.

After slaughtering, the gastrointestinal tract of each animal was emptied and, together with the other organs, was washed, weighed, and added to the remaining body parts (carcass, head, skin, tail, legs, and blood) to determine the empty body weight (EBW). The relationship obtained between EBW and body weight (BW) of the reference animals slaughtered at the beginning of the experiment was used to estimate EBW of the animals that remained in the experiment. After the slaughter, each carcass was split into identical longitudinal halves and chilled at 0 °C for 24 hours. After chilling, the right half of the carcass was dissected into bone, muscle and fat. The fat tissue were subdivided into subcutaneous and intermuscular fat, and weighed separately.

The experiment was conducted under a completely randomized design in a 3 × 3 factorial arrangement. Treatments consisted of 3 genetic types (Nellore; F_1 Simmental × Nellore; F_1 Angus × Nellore) and 3 feeding regimes (cattle fed at maintenance and *ad libitum* with concentrate levels of 1 or 2% of BW) with six replicates in each of *ad libitum* levels and four replicates in the group of animals fed at maintenance.

The physical composition of the carcass and EBW, composition of gain and deposition rates were analyzed using SAS version 9.1 (SAS Institute, Inc, 2000). Data of animals fed *ad libitum* and at maintenance were analyzed as a completely randomized design in 3 × 3 factorial arrangements, and 3 × 2 factorial arrangement when data of animals fed *ad libitum* were analyzed separately. The variables were compared by contrast with significance considered at P<0.05.

Results and Discussion

Animals fed at maintenance possessed carcass with greater proportion (P<0.05) of muscular and bone tissues and lower proportion (P<0.05) of fat tissue than animals fed *ad libitum*. Cattle fed concentrate at 2% of BW had similar proportion (P>0.05) of muscle, and fat in the carcass to those fed concentrate at 1% of BW (Table 2).

The muscular tissue represents 40% of the body mass and varies from 53% to 64% of carcass weight (Paulino et al., 2005). The muscle:fat ratio decreases with the increase of the weight at slaughter since there is F_1 Angus × Nellore inversion on the intensity of deposition of these tissues in the carcass (Arboitte et al., 2004).

At the beginning of the trial, F_1 Angus × Nellore animals had average age of 18 months. However, since the maximum growth of bone tissue occurs between six to eight months of age, it was expected that growing animals would have lower proportion of bone compared with the other tissues of the carcass than animals fed at maintenance.

The lower proportion of fat compared with muscular tissue on carcass from animals fed at maintenance is explained by the restriction of the energy availability, which in this case, is used mostly for the vital functions. Thus, in animals fed at maintenance, the muscle:fat ratio would not differ as the animal ages, as there is a reduced deposition of fat and the carcass presents greater proportion of muscle.

The decrease in the muscle growth rate during the puberty may occur due a resource restrictions (space, nutrients and growth factors) and accumulation of inhibitor factors (Owens et al., 1993). This would explain the fact that animals fed at levels above the maintenance, even with different levels of concentrate, did not present differences in carcass muscle percentage. Nonetheless, animals fed concentrate at 2% of BW had greater amount of total fat. According to Owens et al., (1993) the excess of nutrients can be converted into lipids, excreted or catabolized.

Silveira et al. (2009) did not find differences in the carcass composition of animals fed diets with different energy densities above the maintenance level, attributing the lack of differences to the slaughter weight, as it is highly correlated to the quantitative characteristics of the carcass.

Nellore animals has greater proportion (P<0.05) of muscle and lower proportion (P<0.05) of total and intermuscular fat than F_1 Simmental × Nellore and F_1 Angus × Nellore animals. However, no differences were observed (P>0.05) for the proportion of bones and subcutaneous fat among the genetic types (Table 3).

The proportion of adipose tissue varies inversely to muscle deposition (Berg & Buterfield, 1976), and is affected by age, gender, genetic type and nutritional status of the animals. This association was observed in this trial where cattle fed at maintenance, as well as Nellore animals, presented greater proportion of muscle and lower proportion of fat compared with animals fed *ad libitum* and crossbred cattle, respectively.

The increase in muscular mass through the growing phase is determined by the balance between synthesis and degradation of proteins. Mili and micro calpains are the main endogenous proteases responsible for protein degradation, which is specifically inhibited by the calpastatin. Therefore, the balance between calpastatin and calpains determines the muscular growth (Goll et al., 1989). Zebu cattle present greater levels of calpastatin (Koohmaraie, 1992) as well as

Table 2 - Means and coefficient of variation (CV) of carcass physical composition of animals fed concentrate 1% and 2% of body weight and at maintenance

Item	Feeding regime			P-value		CV (%)
	Ad libitum		Maintenance			
	1% BW	2% BW	Maintenance	Maintenance × *Ad libitum*	1% × 2%	
Muscle	60.68	60.31	65.11	<0.0001	0.6275	3.8
Bones	15.26	15.19	19.70	<0.0001	0.8475	6.0
Subcutaneous fat	7.52	7.63	6.77	<0.0001	0.5828	17.5
Intermuscular fat	15.39	16.37	11.20	<0.0001	0.1218	12.6
Total fat	22.91	24.00	17.97	<0.0001	0.1611	11.7

lower levels of mili-calpain. The lower protein degradation in Zebu animals might explain the greater proportion of muscles in these animals compared with crossbred animals.

In addition, considering the influence of BW on body composition, since the proportion of fat increases as the BW increases (Goulart et al., 2008), the higher proportion of muscle and lower proportion of fat in carcass of Nellore animals may have occurred due to their lower weight at slaughter compared with crossbred animals.

Goulart et al. (2008) found a greater proportion of bones on carcass of crossbred animals compared with purebred animals.

The percentage of fat deposition in relation to the empty body weight (EBW) was not affected (P>0.05) by the *ad libitum* feeding regime, while the mesenteric fat had greater deposition in relation to EBW in animals fed concentrate at 2% of BW. Animals fed at maintenance had lower (P<0.05) amount of body fat compared with animals fed *ad libitum*. Cattle fed concentrate at 2% had greater (P<0.05) amount of body fat than those fed concentrate at 1% of BW (Table 4).

According to Ferreira et al. (2000), visceral fat deposition means waste of energy, as there is F_1 Angus × Nellore increase in maintenance requirements due to the increase in the metabolism activity in this adipose tissue. In addition, there is a reduction in carcass yield in relation to BW since these fat depots are located in non-carcass tissues.

Visceral fat is not constant through the life of the animal, with mobilization and deposition occurring through the growth phase of the animal, which might explain the similar proportion of visceral fat in relation to total fat among animals fed at maintenance and *ad libitum*. As previously discussed, animals fed at maintenance present different ways to retain energy, where the deposition of lipid in adipocytes that have already reached their hyperplasic development seems to be one of the main ways to retain energy.

Even though animals fed concentrate at 2% of BW had 6 kg more fat than animals fed concentrate at 1% of BW, no differences were observed (P>0.05) on the pattern of fat deposition in the body. Thus, it can be inferred that feeding animals with concentrate levels at 1% of BW represents greater economic availability, as those animals presented similar proportion of muscle and 6.17 mm of rib fat thickness.

Nellore animals had lower proportion (P<0.05) of intramuscular fat and greater proportion (P<0.05) of mesenteric fat in relation to the total amount of fat than crossbred animals. F_1 Angus × Nellore animals had greater

Table 3 - Means and coefficient of variation (CV) of carcass physical composition of Nellore (NE), F_1 Angus × Nellore (AN) and F_1 Simmental Nellore (SN) animals

Item	Genetic type			P-value		CV (%)
	NE	SN	AN	NE × Crossbred	SN × AN	
Muscle	62.74	60.80	61.41	0.0393	0.3796	3.8
Bone	16.66	16.17	16.21	0.1360	0.7000	6.0
Subcutaneous fat	6.24	6.74	7.22	0.0572	0.3488	17.5
Intermuscular fat	13.71	15.71	14.71	0.0085	0.1155	12.6
Total fat	19.94	22.45	21.93	0.0051	0.4614	11.7

Table 4 - Partition of the main body fat depositions in relation to the total deposition and in relation to the empty body weight in animals fed concentrate at 1% or 2% of body weight and fed at maintenance

Item	Feeding regime			P-value		CV (%)
	Ad libitum		Maintenance			
	1% BW	2% BW	Maintenance	Maintenance × *ad libitum*	1% × 2%	
	Fat deposition in relation to total amount of fat (%)					
Total (kg)	54.89	61.33	26.86	<0.0001	0.0097	13.6
Subcutaneous fat	18.26	17.53	15.03	0.0012	0.3634	13.5
Intermuscular fat	37.03	37.15	42.52	<0.0001	0.9026	7.3
Mesenteric fat	30.60	31.35	30.70	0.7350	0.3486	7.7
Perirenal fat	14.03	13.92	11.64	0.0004	0.8470	12.7
	Fat deposition in relation to the empty body weight (%)					
Subcutaneous fat	2.51	2.86	0.95	<0.0001	0.0859	26.4
Intermuscular fat	5.18	6.03	2.66	<0.0001	0.3810	23.0
Mesenteric fat	4.26	5.04	1.93	<0.0001	0.0144	22.9
Perirenal fat	1.96	2.29	0.75	<0.0001	0.0525	27.7

CV = coefficient of variation.

proportion (P<0.05) of perirenal fat than F_1 Simmental × Nellore animals. The percentage of fat deposition in relation to EBW was not affected (P>0.05) by genetic type (Table 5).

Fat deposition typically follows the order in which perirenal fat is deposited first, followed by intermuscular, subcutaneous and finally by the intramuscular fat. The increase in the amount of body fat occurs after birth by hyperplasia and hypertrophy. In the finishing phase, lipocytes that have been developed earlier (intermuscular, perirenal and mesenteric) complete their hyperplasic development and become depots for fat. However, subcutaneous and intramuscular deposits continue to produce new adipocytes, as they accumulate fat (Sainz & Hastings, 2000).

Berg & Walters (1983) reported that the distribution of the fat in the body is related to local pressure that occurs as the fat deposition occurs during the animal growth. Thus, the fat deposited early in the body cavity and between muscles finds only a little resistance. After it reaches the maximum resistance, the excess of energy that is absorbed by the animal would be stored as subcutaneous fat. In this case, the subcutaneous fat would be under different pressure against the fat deposition in different parts of the body, where the lower pressure would be observed in the hind and forequarter, allowing the early deposition of subcutaneous fat in these areas.

Animals from all genetic types and feeding regimes had greater deposition of intermuscular and mesenteric fat, respectively. Di Marco (1998) reported that, quantitatively, the intermuscular fat deposition is important for the yield of the cuts, but does not increase the carcass finishing score. Thus, the deposition of intermuscular fat is not seen as F_1 Angus × Nellore advantage, since it is difficult to be trimmed without damaging the integrity of commercial cuts. In addition, the reduction of subcutaneous fat deposition seems to increase the deposition of intermuscular fat.

The greater amount of mesenteric fat in Nellore animals and of perirenal fat in F_1 Angus × Nellore animals would explain the lower growth of these animals compared with crossbred and F_1 Simmental × Nellore animals, respectively, as the fat deposition of fat around organs and viscera occurs with the reduction of BW gain (Paulino et al., 2009).

Nellore cattle had lower amount of body fat than crossbred animals, which may have happened because these animals were in a growth phase during the trial, in which the protein deposition is more intense, while the crossbred animals were already in a finishing phase.

The daily deposition of muscle, bones, intermuscular and total fat in the carcass were greater (P<0.05) for animals fed concentrate at 2% of BW compared with those fed concentrate at 1% of BW. No differences were observed (P>0.05) for the daily deposition of subcutaneous fat among animals fed concentrate at different levels (Table 6).

The greater tissue deposition on animals fed concentrate at 2% of BW addressed the greater carcass gain in these animals (0.850 g/day) compared with animals fed concentrate at 1% of BW (0.720 d/day). The efficiency of carcass deposition was greater in animals fed concentrate at 2% of BW (0.364) than those fed concentrate at 1% of BW (0.324).

The lack of differences in subcutaneous fat deposition between treatments with different levels of concentrate may be explained by the difference in energy intake, which was greater in animals fed concentrate at 2% of BW and probably used mostly for the deposition of intermuscular fat.

Nellore animals had lower deposition (P<0.05) of muscle, bones, subcutaneous, intermuscular and total fat on carcass. F_1 Angus × Nellore animals had greater (P<0.05)

Table 5 - Partition between the main body fat depositions in relation to total deposition and in relation to empty body weight in Nellore (NE), F_1 Simmental × Nellore (SN) and F_1 Nellore × Angus (AN) animals

Item	Genetic type			P-value		CV (%)
		Crossbred				
	NE	SN	AN	NE × Crossbred	SN × AN	
	Fat deposition in relation to total amount of fat (%)					
Total (kg)	39.77	51.81	51.51	<0.0001	0.9060	13.6
Subcutaneous fat	16.85	16.20	17.77	0.8611	0.0824	13.5
Intermuscular fat	37.63	40.59	38.48	0.0408	0.0518	7.3
Mesenteric fat	32.57	30.43	29.64	0.0016	0.3702	7.7
Perirenal fat	12.86	12.69	14.03	0.3692	0.0448	12.7
	Fat deposition in relation to the empty body weight (%)					
Subcutaneous fat	1.94	1.99	2.39	0.1865	0.0740	26.4
Intermuscular fat	4.31	4.69	4.87	0.1906	0.6539	23.0
Mesenteric fat	3.76	3.57	3.89	0.9154	0.3432	22.9
Perirenal fat	1.60	1.53	1.87	0.5357	0.0634	27.7

CV = coefficient of variation.

subcutaneous fat deposition than F_1 Simmental × Nellore animals (Table 7).

The lower tissue deposition in Nellore animals addressed the lower carcass gain in these animals (0.640) compared with the crossbred animals (0.860). Crossbred animals had greater gain probably due to the heterosis effect (Teixeira & Albuquerque, 2005). It can be inferred that Nellore cattle need more time at the feedlot to reach the slaughter weight and adequate finishing score due to their lower muscle growth rate (Bianchini, 2005) compared with the other genetic types evaluated in this trial.

British breeds reach the growth precocity earlier than continental breeds, which might explain the greater subcutaneous fat deposition in F_1 Angus × Nellore animals. However, F_1 Simmental × Nellore animals presented greater tendency for muscle deposition.

Cattle fed at maintenance had lower (P<0.05) amount and increasing rate of visceral fat (perirenal + mesenteric fat) than animals fed *ad libitum*. Similarly, the percentage of organs and viscera was lower (P<0.05) in animals fed at maintenance compared with those fed *ad libitum*. The amount of mesenteric fat was greater (P<0.05) for animals fed concentrate at 2% of BW than those fed concentrate at 1% of BW. However, similar values (P>0.05) of perirenal fat deposition were observed among treatments of concentrate levels. Similarly, no differences were found (P>0.05) in the proportion of visceral fat in relation to the EBW and the weight of organs and viscera among animals fed different levels of concentrate (Table 8).

The lower amount of visceral fat and percentage of organs and viscera in animals fed at maintenance can be explained by the fact that those animals were not in a growing phase, which allows their physiological adjustment in order to reduce their energy requirements. Several studies have reported the importance of the evaluation of non-carcass components, due to its relationship with the energy requirements of the animals, mainly from animals fed at maintenance (Owens et al., 1993).

According to Reynolds et al. (1992), the gastrointestinal tract and the liver are responsible for 40 – 45% of the basal energy metabolism of the bovine under normal conditions, presenting a metabolism up to six times more intense than

Table 6 - Tissue deposition and physical composition of carcass gain of animals fed concentrate at 1% and 2% of body weight (BW)

Item	Feeding regime		P-value	CV (%)
	Ad libitum			
	1% BW	2% BW	1% × 2%	
	Deposition rate of carcass tissue (g/day)			
Muscle	200.89	246.50	0.0524	30.3
Bones	33.06	48.09	0.0561	52.0
Subcutaneous fat	74.98	83.54	0.2232	26.1
Intermuscular fat	117.44	141.89	0.0303	24.9
Total fat	192.42	225.43	0.0417	22.3
	Physical composition of carcass gain (%)			
Muscle	47.92	47.83	0.9129	14.0
Fat	44.97	43.96	0.7656	17.5
Bones	7.11	8.31	0.3314	40.4

CV = coefficient of variation.

Table 7 - Tissue deposition and physical composition of carcass gain of Nellore (NE), F_1 Simmental × Nellore (SN) and F_1 Angus × Nellore (AN) cattle

Item	Genetic type			P-value		CV (%)
	NE	SN	AN	NE × Crossbred	SN × AN	
	Deposition rate of carcass tissue (g/day)					
Muscle	152.08	261.11	257.90	<0.0001	0.9025	30.3
Bones	29.18	55.58	33.18	0.0890	0.0150	52.0
Subcutaneous fat	65.37	76.67	95.74	0.0078	0.0311	26.1
Intramuscular fat	103.19	143.91	141.90	0.0016	0.8797	24.9
Total fat	168.55	220.58	237.64	0.0009	0.3765	22.3
	Physical composition of carcass gain (%)					
Muscle	45.99	48.59	48.43	0.3650	0.9538	14.0
Fat	47.45	41.25	45.57	0.2145	0.1845	17.5
Bones	6.57	10.17	6.01	0.2429	0.0031	40.4

CV = coefficient of variation.

the whole body. Thus, it is common to see feed restricted animals with lower proportion of gastrointestinal tract and liver in relation to EBW as an F_1 Angus × Nellore alternative to reduce the use of energy.

Animals fed diets with high proportion of roughage may present greater BW and size of gastrointestinal tract compared with those fed high concentrate diets (Véras et al., 2001). However, no differences were observed (P>0.05) among cattle fed *ad libitum* with diets containing different levels of concentrate, which might be explained by the high digestibility of corn silage which was the rough source used in this trial.

Animals from Nellore group possessed lower (P<0.05) percentage of organs and viscera than crossbred animals. Animals from F_1 Angus × Nellore group had greater daily deposition (P<0.05) of perirenal fat than animals from F_1 Simmental × Nellore group (Table 9).

The composition of empty body is important to determine the nutritional requirements of the animal, where differences on the composition of the empty body weight gain may explain the greater energy requirement for early finish animals (NRC, 2000).

Zebu cattle (including Nellore breed) were selected to be adapted to adverse environmental conditions (mainly to the exposition to a low availability of food), which can benefit cattle with low maintenance requirements.

Ferrell et al. (1976) reported that differences in net energy requirements for maintenance between genetic types may be explained by differences in size of internal organs, which are larger in Taurine animals compared with Zebu animals. Organs and viscera have high metabolic rates and are consequently highly responsive to challenges in nutrient intakes (Ferrel, 1988). Differences between purebred and crossbred animals would also be explained by the difference in nutrient utilization between breeds.

As the animals were slaughtered after the same period at the feedlot and the perirenal fat is the first that starts the deposition, it would be expected that early-finished animals such as F_1 Angus × Nellore cattle have greater daily deposition of perirenal fat, since these values were obtained by dividing the total deposition by the number of days at feedlot.

Table 8 - Tissue deposition in the empty body weight (EBW) in animals fed at maintenance or fed concentrate at 1% and 2 % of body weight (BW)

Item[1]	Feeding regime			P-value		CV (%)
	Ad libitum		Maintenance			
	1% BW	2% PC	Maintenance	Maintenance × *Ad libitum*	1% × 2%	
	Fat deposition pattern (g/day) and % of non-carcass components in the final EBW					
PFDR	57.11	65.31	8.51	<0.0001	0.0932	29.8
%PF	1.96	2.29	0.75	<0.0001	0.0525	27.7
MFDR	108.70	131.46	16.94	<0.0001	0.0108	27.1
%MF	4.26	5.04	1.93	<0.0001	0.0144	22.9
%O+V	16.06	16.36	13.63	<0.0001	0.1660	4.2

[1] EBWG = empty body weight gain; PFDR = perirenal fat deposition rate; % PF = percentage of perirenal fat; MFDR = mesenteric fat deposition rate; % MF = percentage of mesenteric fat; %O+V = percentage of organs and viscera.
CV = coefficient of variation.

Table 9 - Tissue deposition in the empty body weight (EBW) of Nellore (NE), F_1 Simmental × Nellore (SN) and F_1 Nellore × Angus (AN)

Item[1]	Genetic type			P-value		CV (%)
	NE	SN	AN	NE × Crossbred	SN × AN	
	Fat deposition pattern (g/day) and % of non-carcass components in the final EBW					
PFDR	42.58	42.61	58.92	0.0756	0.0047	29.8
%PF	1.60	1.53	1.87	0.5357	0.0634	27.7
MFDR	85.44	94.9	102.54	0.1118	0.4905	27.1
% FA	3.76	3.57	3.89	0.9154	0.3432	22.9
% O+V	15.25	15.58	15.85	0.0111	0.4512	4.2

[1] PFDR = perirenal fat deposition rate; % PF = percentage of perirenal fat; MFDR = mesenteric fat deposition rate; % FA = percentage of mesenteric fat; % O+V = percentage of organs and viscera.
CV = coefficient of variation.

Conclusions

Nellore animals have greater proportion of muscles and lower proportion of adipose tissue in the carcass than crossbred animals. High concentrate levels increase the fatness of the carcass. The intermuscular fat depot is primarily used by the animal, followed by the mesenteric fat. The tissue deposition rate in Nellore cattle is lower than in crossbred cattle. F_1 Angus × Nellore animals present greater increasing rates of subcutaneous fat than F_1 Simmental × Nellore cattle. The *ad libitum* regime does not affect the weight of organs or viscera. Nellore cattle have lower percentage of organs and viscera than crossbred animals.

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