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The effect of supplementation on the tissue composition of the commercial cuts of cross-bred F1 (Boer × SPRD) finished in native pasture[1]

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ABSTRACT - The present study aimed to assess the effect of levels of supplementation with concentrate on the tissue composition of commercial cuts of goats finished in native pasture. It was used 24 non-castrated cross-bred F1 (Boer × SPRD) goats at the age of 120 days, with initial average body weight (BW) of 15.52 kg distributed in four levels of supplementation with concentrated feed (0.0; 0.5; 1.0 and 1.5% of body weight in dry matter) and slaughtered at 25.12 kg; 26.62 kg; 28.56 kg and 29.19 kg, respectively, corresponding to 218 days of life. The carcass was sectioned in the half, and from the left half of the carcass, the following cuts were separated: leg, loin, ribs, shoulder and neck, which were dissected into muscle, bone and fat, with the results expressed in weight and yield of the tissues in relation to the weight of the cut. Supplementation incresead the muscle weight, as well as the fat weight and yield and decreased the muscle:fat relationship; however there was no influence on the proportion of muscle in the five studied cuts. Therefore, in order to obtain better finished commercial meat cuts, supplementation of 1.0 and 1.5% of body weight is recommended. Nevertheless, supplementation is unnecessary for obtaining lighter meat cuts with a good proportion of muscle.

Key Words: fat weight, goats in grazing, muscle yield

Efeito da suplementação na composição tecidual dos cortes comerciais de caprinos mestiços F1 (Boer × SPRD) terminados em pastagem nativa

RESUMO - Com o objetivo de avaliar o efeito dos níveis de suplementação com concentrado na composição tecidual dos cortes comerciais de caprinos terminados em pastagem nativa utilizaram-se 24 animais, não-castrados, mestiços F1 (Boer × SPRD), com peso vivo (PV) médio inicial de 15,52 kg e 120 dias de idade, distribuídos em quatro níveis de suplementação com concentrado (0,0; 0,5; 1,0 e 1,5% do PV em matéria seca) e abatidos aos 25,12 g; 26,62; 28,56 e 29,19 kg, respectivamente, correspondentes a 218 dias de idade. A carcaça foi seccionada ao meio e da meia-carcaça esquerda, foram separados os cortes perna, lombo, costilhar, paleta e pescoço, os quais foram dissecados em músculo, osso e gordura e os resultados expressos em peso e em rendimento dos tecidos em relação ao peso do corte. A suplementação aumentou o peso de músculo e o peso e rendimento de gordura e reduziu a relação músculo:gordura, mas não influenciou a proporção de músculo dos cinco cortes. Assim, para obtenção de cortes comerciais de melhor acabamento, recomenda-se suplementação de 1,0 e 1,5% do PV, mas, se a finalidade for cortes mais leves e com boa proporção de músculo, a suplementação e desnecessária.

Palavras-chave: cabritos em pastejo, peso de gordura, rendimento de músculo

Introduction

In northeastern Brazil, the main source of food ofor goats is the caatinga, but irregular rainfall distribution and frequent rainless periods in the region tend to reduce the amount and quality of forage, affecting the productivity of the segment and, consequently, animal yield and carcass quality. Consequently, some pasture practices, such as supplementation of animals in grazing pasture with protein concentrate, use of silage and hay can be adopted in order to maximize forage in high tide periods, so that optimize the production system at this time of the year. Among many alternatives to develop goat for slaughter in *Brazilian Semiarid Northeas*t, the supplementation of concentrate for animals finished on pasture may increase production and improve the quality of the carcass and meat.

Carcass segmentation in commercial portions or cuts of different sizes is called carcass regional composition. It is aimed to obtain different prices for the different carcass parts, allowing a more rational use of the carcass, thus

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avoiding waste (Cezar & Sousa, 2007). In turn, tissue composition comprises the weights and proportions of muscular, fat and bone tissues of the carcass.

The knowledge of tissue composition of different carcass cuts particularly muscle and fat, makes it possible to assess some qualitative aspects of the meat and facilitate its commercialization, because carcasses and cuts of well-formed tissues are more likely to please consumers, who would be more willing to pay a higher price for them (Monte et al., 2007).

Research providing more information on the tissue composition of carcass cuts of goats finished in native pasture are of great importance, since there are scarce studies about the tissue composition of carcass cuts in cross-bred F1 (Boer with females of non defined racial standard - SPRD). These might contribute to the economic sustainability of the activity, because carcass of younger animals could be obtained without the high costs of confinement and a better quality product would increase the consumption of goat meat. For this reason, we aimed to assess the effect of levels of concentrate supplementation levels on the tissue composition of cuts (leg, loin, ribs, shoulder and neck) of cross-bred F1 (Boer × SPRD) goats finished in native pasture.

Material and Methods

The experiment was carried out at the "Nupeárido" farm of the Universidade Federal de Campina Grande, Patos, Paraíba, Brazil. The study began in May 2007 and ended in August 2007, and the grazing period comprised 98 days. The climate of the region is classified as hot and dry, characterized by two well-defined seasons, a rainy season from January to May, and a dry season from June to December, with average annual rainfalls of 500 mm, temperature of 28.5ºC, relative humidity of 61%, and altitude of 300 meters.

It was used twenty-four non-castrated cross-bred F1 (Boer × SPRD) goats at 120 days of age, with initial average body weight (BW) of 15.52 kg. The animals were fed on a continuous grazing system from 8:00 a.m. to 4:00 p.m., and afterwards they were taken to their stalls for supplementation with increasing levels of concentrate (0.0; 0.5; 1.0 and 1.5% of BW in dry matter) in individual cages equipped with troughs and drinking vessels.

The supplement diet was composed of ground corn (53.21%), wheat meal (24.43%), cotton cake (13.61%), soybean meal (3.76%), soybean oil (1.75%), calcitic limestone (1.5%) and mineral core for goats (1.74%), and it was balanced according to AFRC (1998) recommendations so that the highest supplementation level provided a daily weight gain of 200 g per animal.

Following the finishing period, the animals were submitted to 24 and 16 hours of fasting (restriction of solid and liquid food, respectively), and then they were weighed to obtain the body weight at slaughter. The average age of the animals was 218 days and they were slaughtered with a body weight of 25.12 kg; 26.62 kg; 28.56 kg and 29.19 kg for the respective following supplementation levels: 0.0; 0.5; 1.0 and 1.5% of body weight in dry matter. Slaughter was performed by stunning and bleeding, followed by flaying and removal of viscera.

The carcass was obtained after skinning, detachment of head, viscera and anterior and posterior paws at the level of carpometacarpal and tarsometatarsal joints. The carcasses were maintained in cold chamber for 24 hours, at a 3-5ºC, and they were then sectioned in two half-carcasses. The left half-carcasses were divided into five commercial meat cuts: leg, loin, ribs, shoulder and neck. The obtained cuts were frozen at -20ºC, then defrozen and dissected into muscle, bone and fat, and the results were expressed in absolute weight and in relation to the cut weight, according to the methodology described by Osório et al. (1998), Yáñez et al. (2006) and Cezar & Sousa (2007).

The design was completely randomized, with four treatments and six replicates. Variance and regression analyses were performed by using the SAS program (1999), for all the study variables concerning to the level of supplementation.

Results and Discussion

The increase in supplementation levels had a positive effect ($P<0.05$) on muscle weight in the five cuts, but it did not influence ($P>0.05$) yield (Table 1). The linear growth ($P<0.05$) of the muscle weights in the studied meat cuts clearly reflected the greatest percentage of weight of these meat cuts, because the muscle is a tissue that follows the development of the meat cut and reduces the growth speed when the animals gain fat weight (Rosa et al., 2005).

The supplementation levels had a positive linear effect ($P<0.05$) on the weight of the leg and on the shoulder bone (Table 2), but a negative effect on the shoulder yield. The supplementation levels had no influence on the other cuts.

The yield of shoulder bone of F1 (Boer × SPRD) goats showed a negative behavior of the supplementation, being different from the other analyzed cuts, indicating that the different parts of the carcass had disproportional growth rates, thus confirming the early development of

Table 1 - Weights and yields of commercial meat cuts of goats finished in pasture with different supplementation levels

Cut (g)	Level of supplementation (%) of LW				Regression	r^2	CV (%)
	0.0	0.5	1.0	1.5			
Leg	983.29	969.36	1261.53	1140.60	$\hat{Y}$=972.93+147.06X	0.36	15.55
Loin	394.06	375.56	460.41	486.50	$\hat{Y}$=376.61+70.24X	0.25	20.14
Ribs	622.84	624.46	810.22	744.95	$\hat{Y}$=617.04+106.95X	0.32	17.89
Shoulder	654.91	644.95	827.76	794.04	$\hat{Y}$=640.85+116.28X	0.34	16.65
Neck	270.77	273.13	369.68	396.11	$\hat{Y}$=257.74+92.56X	0.33	27.28
Cuts (%)							
Leg	70.38	70.03	71.55	69.39	$\hat{Y}$=70.52	0.09	3.74
Loin	68.90	66.40	64.00	65.95	$\hat{Y}$=66.52	0.15	6.80
Ribs	60.23	61,13	58.49	57.95	$\hat{Y}$=59.52	0.11	6.48
Shoulder	67.04	66.32	66.07	66.45	$\hat{Y}$=66.51	0.01	4.26
Neck	63.32	63.79	62.33	61.45	$\hat{Y}$=62.76	0.05	6.67

$\hat{Y}$= dependent variable and X = independent variable (supplementation level).
r^2 = coefficient of determination; CV = coefficient of variation.

bone tissue (Osório et al., 2001) and of the cut (Furusho-Garcia et al., 2006), and also corroborating the assertions by Costa et al. (1999) in which as the animal grows, muscle and fat deposition is accelerated, leading to the reduction of bone growth.

There was a positive linear effect ($P<0.05$) of the supplementation in weights and yields of the total fat in all the cuts, in the yield of subcutaneous leg fat, in the yield of intermuscular rib and neck fat (Table 3).

The F1 (Boer × SPRD) goats were well fed, which probably increased the adipose tissue, reflecting the increased yield, because diets enriched with supplements determine a greater availability of energy and they favor adipose tissue growth (Sousa, 1993). Consequently, it is important to establish the correct level of concentrate supplementation to obtain a proper distribution of body fat, since, according to Warmington & Kirton (1990), this distribution may be influenced by nutritional management of goats.

One important aspect is the increase of weight, fat yield, and intermuscular yield as a result of supplementation, which does not affect subcutaneous fat in the loin and in the rib cuts. This is probably related to the pace of growth of adipose tissue, confirming that the growth of intermuscular fat occurs earlier than the growth of subcutaneous fat, which was found by Pereira Filho et al. (2008) in F1 Boer × Saanen goats, and by Yáñez et al. (2009) for Saanen goats. The referred characteristic becomes more apparent because the body areas of these meat cuts have a late growth compared to the body ends which include the leg, shoulder and neck cuts, corroborating the assertions by Pereira Filho et al. (2005), according to whom, in the beginning of the life of the animal, fat is deposited in the cavities, particularly around the viscera, kidneys and between the muscles.

Except for the legs, the other assessed cuts maintained a lower level in subcutaneous fat yield compared to that of the intermuscular yield, when the supplementation levels were increased. Concerning to the leg, the results may indicate a desirable market product, once the subcutaneous fat ensures proper storage of the product in the cold storage facilities, which in turn, adds value to

Table 2 - Weights and yields of the bone in commercial meat cuts of goats finished in pasture with different supplementation levels

Cut (g)	Level of supplementation (% BW)				Regression	r^2	CV (%)
	0.0	0.5	1.0	1.5			
Leg	359.54	329.29	397.19	410.44	$\hat{Y}$=343.03+41.91X	0.31	13.47
Loin	108.52	99.40	140.64	132.10	$\hat{Y}$=118.82	0.19	30.91
Ribs	276.40	280.61	327.54	326.88	$\hat{Y}$=300.72	0.15	20.88
Shoulder	237.08	227.18	274.43	266.35	$\hat{Y}$=231.38+25.86X	0.34	11.61
Neck	119.04	110.86	150.03	149.14	$\hat{Y}$=130.97	0.21	27.45
Cuts (%)							
Leg	25.72	24.19	22.76	25.09	$\hat{Y}$=24.56	0.21	9.32
Loin	18.46	17.83	19.35	17.54	$\hat{Y}$=18.26	0.03	19.80
Ribs	26.60	27.71	23.34	25.42	$\hat{Y}$=25.90	0.22	12.18
Shoulder	24.40	23.54	22.05	22.53	$\hat{Y}$=24.23-1.43X	0.21	8.25
Neck	27.66	27.07	24.84	23.62	$\hat{Y}$=25.91	0.15	16.60

$\hat{Y}$= dependent variable and X= independent variable (level of supplementation).
r^2 = coefficient of determination; CV = coefficient of variation.

these meat cuts, particularly first-class cuts (Huidobro & Cañeque, 1994). In their study of Saanen goats with a body weight of kg, Yáñez et al. (2009) noticed late growth of adipose tissue in the leg, although the intermuscular fat had grown earlier than subcutaneous fat, corroborating the findings obtained for F1 (Boer × SPRD) goats with body weights from 25 to 30 kg.

No influence of the supplementation levels (P>0.05) for the muscle-bone relationship variable were found in the cuts shown in Table 4; however, supplementation linearly decreased (P<0.05) the muscle-fat relationship of commercial cuts.

The fact that the muscle-bone relationship was not influenced by the levels of supplementation can probably be explained by the fact that the muscle and bone tissues have grown proportionally with the increase in the concentrate levels, which was not found by Clementino et al. (2007) who observed a linear growing behavior (P<0.05) of muscle-bone relationship in the leg of cross-bred (Dorper × Santa Inês) goats with initial weight of 17.1 kg, fed different levels of concentrate supplementation (30, 45, 60 and 75%) and slaughtered at the following weights: 21.68; 24.03; 25.55 and 27.30 kg when they were at 141 days of age.

However, the muscle-fat relationship in the cuts decreased as the supplementation increased, which was somewhat expected, because the animals gain weight throughout the finishing period, and there is an alteration in the composition of this weight gain, that is, the predominant muscular growth from the beginning is changed due to the greater retention of adipose tissue, in accordance with Pinheiro et al. (2007) who found that the increased weight of animals causes the variation in the muscle, bone and fat proportions, reducing the muscle-fat relationship. Another explanation for this fact can be associated to replacement effect:replacement of consumption of large volumes with the consumption of concentrate, and according to Carvalho Jr. et al. (2009), these animals had the greatest replacement of consumption of dry matter with the consumption of concentrate when the level of supplementation was 0.74% of body weight, corroborating Hodgson (1990), who affirmed that this effect can be caused by the fact the consumption of forage is more influenced by behavioral attitudes than by nutritional limitations, because when a readily assimilable source of food is available as concentrate, the animals spend less energy in pasture activities consequently reducing the consumption of forage.

Table 3 - Weights and yields of fat of commercial cuts of goats finished in pasture with different supplementation levels

Cut	Level of supplementation (% BW)				Regression	r^2	CV (%)
	0.0	0.5	1.0	1.5			
Total fat (g) = subcutaneous fat + intermuscular fat							
Leg	54.08	67.01	99.70	92.64	$\hat{Y}$=55.67+29.34X	0.41	31.89
Loin	73.08	89.33	123.31	123.67	$\hat{Y}$=74.16+36.84X	0.35	32.95
Ribs	138.42	117.79	250.55	217.08	$\hat{Y}$=126.19+70.73X	0.49	33.50
Shoulder	83.53	98.43	149.46	134.52	$\hat{Y}$=85.28+40.17X	0.38	32.43
Neck	38.93	38.51	77.72	97.66	$\hat{Y}$=31.67+42.23X	0.54	41.68
Total fat (%)							
Leg	3.88	4.83	5.67	5.51	$\hat{Y}$=4.08+1.15X	0.27	26.37
Loin	12.62	15.75	16.64	16.50	$\hat{Y}$=13.40+2.55X	0.28	19.35
Ribs	13.16	11.16	18.17	16.62	$\hat{Y}$=12.23+3.29X	0.36	26.54
Shoulder	8.55	10.12	11.87	11.00	$\hat{Y}$=8.95+1.82X	0.23	23.95
Neck	9.00	9.14	12.82	14.91	$\hat{Y}$=8.33+4.20X	0.44	27.65
Subcutaneous fat (%)							
Leg	2.15	2.86	3.80	3.18	$\hat{Y}$=2.36+0.80X	0.33	31.17
Loin	4.02	3.88	4.00	4.96	$\hat{Y}$=4.22	0.05	46.06
Ribs	2.60	2.01	2.57	2.87	$\hat{Y}$=2.52	0.06	52.74
Shoulder	1.97	3.62	3.70	3.38	$\hat{Y}$=3.10	0.20	50.95
Neck	1.06	1.06	1.22	1.42	$\hat{Y}$=1.18	0.08	45.66
Intermuscular fat (%)							
Leg	1.72	1.98	1.87	2.32	$\hat{Y}$=1.96	0.16	28.11
Loin	8.60	11.86	12.63	11.53	$\hat{Y}$=10.99	0.27	25.81
Ribs	10.55	9.14	15.59	13.75	$\hat{Y}$=9.88+3.05X	0.36	29.65
Shoulder	6.57	6.50	8.16	7.62	$\hat{Y}$=7.15	0.16	23.33
Neck	7.94	8.07	11.60	13.49	$\hat{Y}$=7.32+3.96X	0.41	30.93

$\hat{Y}$= dependent variable and X= independent variable (supplementation level).
r^2 = coefficient of determination; CV = coefficient of variation.

Table 4 - Relationships of tissues of commercial cuts in goats finished in pasture with different levels of supplementation

RM:O (g/g)	Level of supplementation (% BW)				Regression	r^2	CV (%)
	0.0	0.5	1.0	1.5			
Leg	2.75	2.98	3.17	2.79	$\hat{Y}$=2.90	0.17	13.44
Loin	4.16	3.96	3.32	3.81	$\hat{Y}$=3.85	0.05	34.43
Ribs	2.28	2.22	2.59	2.33	$\hat{Y}$=2.34	0.10	18.04
Shoulder	2.76	2.83	3.03	2.97	$\hat{Y}$=2.88	0.10	11.73
Neck	2.38	2.41	2.60	2.69	$\hat{Y}$=2.51	0.05	24.62
RM:G (g/g)							
Leg	19.69	16.28	12.87	13.28	$\hat{Y}$=19.03-4.55X	0.27	31.78
Loin	5.92	4.27	4.05	4.08	$\hat{Y}$=5.50-1.18X	0.29	29.32
Ribs	5.32	5.89	3.41	3.60	$\hat{Y}$=5.67-1.46X	0.28	39.38
Shoulder	8.18	6.90	5.86	6.41	$\hat{Y}$=7.84-1.27X	0.22	25.90
Neck	8.10	7.40	5.31	4.15	$\hat{Y}$=8.32-2.76X	0.40	34.06

$\hat{Y}$= dependent variable and X= independent variable (level of supplementation).
r^2 = coefficient of determination; CV = coefficient of variation.
RM:O = muscle-bone relationship; RM:G = muscle-fat relationship.

In their study on the feeding behavior of these animals, Lira (2008) observed that increase in the concentrate levels (0.0; 0.5; 1.0 and 1.5% BW) caused the reduction in the grazing period (411.9; 406.6; 392.7 and 343.1 minutes, respectively), with decreased consumption of dry matter volume up to 0.80% level of supplementation (Carvalho Jr. et al., 2009).

The muscle is the most important tissue in commercial cuts, because it is appreciated by consumers at most, and a first-class cut must present, according to Carvalho et al. (2006), maximum amount of muscle, minimum amount of bone and optimal amount of fat, which varies according to the preference of the consumer. In the present study, considering the five assessed cuts, it was found that the lowest percentage of muscle occurred in the ribs (59.52%), and the highest occurred in the leg (70.52%). These findings can be associated to three aspects: first, the effect of supplementation in pasture, which aimed to provide the correct levels of nutrients to native pasture; second, adaptability and rusticity characteristics of without racial defined standard in semi-arid conditions, and third, the fact that the Boer can transmit their meat production characteristics to the offspring (Erasmus, 2000), which might explain why these cross-bred F1 (Boer × SPRD) goats had cuts with good tissular distribution, with emphasis on the good distribution of muscular mass, not only for the first-class, but also for the second-class cuts.

Conclusions

Supplementation to cross-bred F1 (Boer × SPRD) goats finished in native pasture makes it possible to obtain commercial cuts with greater muscular and fat weights, increased fat yield and decreased muscle-fat relationship yield, which however do not change the muscle proportion, indicating that supplementation of concentrate at levels 1.0 and 1.5% of body weight is recommended to obtain better finished commercial meat cuts. However, supplementation is unnecessary for obtaining lighter meat cuts with a good proportion of muscle.

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