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Commercial cuts and carcass characteristics of sheep and goats supplemented with multinutritional blocks

Cortes comerciales y característica de la canal de borregos y cabritos suplementados con bloques multinutricionales

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ABSTRACT:

Objective. Aimed to identify the weight and yield of the commercial cuts, muscularity, and adiposity in the carcasses of sheep and goats grazing in the Caatinga supplemented with different sources of supplementations; these include feed-blocks. **Material and methods.** Sixty non-castrated males an initial average body weight of 18.63 ± 1.93 kg were used: 30 goats and 30 sheep all animals did not have a defined breed standard (WDBS). The experimental design used was entirely randomized (DIC), in factorial scheme 3x2 (three types of supplementation: mineral salt, MBs and MBs + buffel hay, and two species: sheep and goats) and 10 replications. Animals were raised in a rangeland grazing system in an area with vegetation characteristic of Caatinga ecosystem under three types of supplementation: 1: only mineral salt; 2: Feed blocks (MBs); and 3: MBs + buffel hay There were measured the

weight, yield and the components of left half-part of carcass of lambs and kids. **Results.** The sheep were superior to goats in carcass conformation, loin-eye area, index of muscularity of the leg and compactness index of the leg while the goats were superior to sheep in leg muscles weight. **Conclusions.** Sheep and Goats, when fed with supplementation of pasture feeding blocks in the Caatinga ecosystem; Supplementation with mineral salt and Multinutritional Blocks with and without Buffel can be used to improve herds in the caatinga, with similar results among the three. Sheep show more adiposity of meat than goats, in contrast, goats have higher musculature than sheep when fed with feed blocks.

KEYWORDS: Caatinga, carcass yield, extensive management system, feed supplementation, small ruminants.

RESUMEN:

Objetivo. Con el objetivo de identificar el peso y rendimiento de los cortes comerciales, musculatura y adiposidad en las canales de borregos y cabritos pastando en la Caatinga suplementado con diferentes fuentes de suplementos; Estos incluyen bloques de alimentación. **Materiales y métodos.** Se utilizaron 60 machos no castrados con un peso corporal medio inicial de $18,63 \pm 1,93$ kg: 30 borregos y 30 cabritos, todos los animales no tenían un estándar de raza definido (WDDBS). El diseño experimental utilizado fue totalmente al azar (DIC), en esquema factorial 3x2 (tres tipos de suplementación: sal mineral, MBs y MBs + heno buffel, y dos especies: borregos y cabritos) y 10 repeticiones. Los animales fueron criados en un sistema de pastoreo de pastizales en un área con vegetación característica del ecosistema de Caatinga bajo tres tipos de suplementación: 1: sal mineral solamente; 2: Bloques de alimentación (MBs); Y 3: MBs + heno buffel Se midió el peso, el rendimiento y los componentes de la mitad izquierda de la carcasa de corderos y cabritos. **Resultados.** Las cordeiros fueron superiores a las cabritos en conformación de carcasas, área de lomo, índice de musculatura de la pierna y índice de compacidad de la pierna mientras que las cabritos fueron superiores a las cordeiros en el peso de los músculos de las piernas. **Conclusión.** Cordeiros y cabritos, cuando se alimentan con suplementos de bloques de alimentación de pasto en el ecosistema de Caatinga; La suplementación con sal mineral y Bloques Multinutritivos con y sin Buffel puede ser utilizada para mejorar los rebaños en la caatinga, con resultados similares entre los tres. Las cordeiros muestran más adiposidad de carne que las cabritos, en contraste, las cabritos tienen mayor musculatura que las cordeiros cuando se alimentan con bloques de alimentación.

PALABRAS CLAVE: Caatinga, pequeños rumiantes, producción en agostadero, rendimiento de la canal, suplementación alimentar.

INTRODUCTION

The large proportion of small ruminants in the semi-arid regions around the world is raised under extensive grazing system. In Brazil, the Caatinga dry shrubland is the main feeding source for small ruminants.

In the dry season the Caatinga ecosystem decreases the forage quantity and quality, for that reason, farmers frequently use feed-supplement for their animals, aiming to keep the production around the year.

Makkar et al (1) affirm that feed-supplementation is even more profitable, when carried out in extensive rangeland grazing system, once that, it could a supply source of nutrients, improving the size and quality of the carcasses.

The buffel grass (*Cenchrus ciliaris* L.), is largely cultivated in drylands of Northeastern of Brazil. The farmers commonly use areas with Buffel grass as a supplementary fiber (forage) source in the dry season.

Feed blocks arise as a feed-supplementation alternative to grazing systems, Cordão et al (2) advocate that one of advantages of feed-block are the use of different sources of protein and energy easily accessible for each region. According to Atti and Ben Salem (3), the economic evaluation of the diets may show that the use of feed blocks is more profitable than conventional feed supplementation in animals in lambs in grazing systems. Feed block technology has been used by small farmers in Africa, showing impressive results in milk and meat production (1). However, Kawas (4) support that better economic results are reached in animals under rangeland grazing systems where the feed block increases the digestibility of low-quality forage and release an extra input of energy in the diet.

Santos and Tozzetti (5) affirm that physical and chemical characteristics of feed-supplementation promote differences in growth rate and quality of carcass tissues. Thus, to study the effect of different feed sources in the growth and development of animals become an important information in order to increase the efficiency of system of production.

To Hashimoto et al (6) know the growth rate of tissues and the regions that compose the carcass enable us to determine with high precision the best time for slaughter, favoring the standardization and quality of meat product.

Several factors can affect carcass yield, especially food, which unquestionably, is one of the most important. The Carcass study is an assessment of the parameters related to objective measures and subjective in relation to it and must be linked to aspects and attributes inherent to the edible portion (7).

Therefore, this research aimed to identify the weight and yield of the commercial cuts, muscularity, and adiposity in the carcasses of sheep and goats grazing in the Caatinga supplemented with different sources of supplementations; these include feed-blocks.

MATERIAL AND METHODS

Location. The experiment was carried out in the Pendência Experimental Station, research unit part of the EMEPA-PB (Agricultural Research Corporation of the state of the Paraíba (EMEPA-PB) located in the semiarid region of the state of Paraíba.

Experimental site. The research site was situated in an area with vegetation characteristic of the Caatinga ecosystem (8). The site was rested during four years before the experiment. The area was divided into three paddocks of 12.5 ha each, which divided the three experimental treatments.

According to methodology described by Araújo Filho (8) the forage available was measured three times (previous, middle and final) during the experimental period, and then there were calculated the forage available per hectare (Kg of dry matter/ha-1), finally the kilograms of forage available per animal per hectare (kg dry matter M-1/ kg of live weight-1) (Table 1).

TABLE 1.

Table 1. Availability of dry matter per hectare and by unit of animal weight in the herbaceous and shrubby-arboreal lawyers, grasses and dicotyledonous plants present in the three paddocks in an area of Caatinga grazed by sheep and goats supplemented with feed blocks

Supplem. *	kg of DM/ha				kg of DM/kg of LW animal			
	ST	GRA	DIC	Total	ST	GRA	DIC	Total
Mineral salt	121.35	138.22	803.86	1063.43	0.264	0.323	1.875	2.463
MBs	83.97	124.75	548.46	757.18	0.192	0.318	1.301	1.812
MBs+ buffel hay	86.89	123.82	606.68	817.39	0.207	0.300	1.225	1.998

*Supplementation; MBs = Feed blocks; ST = Shrubby and Tree stratum; GRA = Grasses; DIC = Dicotyledonous plants.

At the same time, another sample was collected and conducted to the laboratory for chemical composition: Mineral Matter (MM), organic matter (OM), crude protein (CP), neutral detergent fiber (NDF) and acid detergent fiber (ADF) according to methodology described by Detmann et al (9) (Table 2).

TABLE 2. Chemical composition (g/kg) of forage available in the experimental area in the Caatinga ecosystem grazed by sheep and goats supplemented with feed blocks

Item ^a	Vegetable component							Supplements	
	GRA	DIC	PER	CAT	MAR	MOF	JUR	MBs	Hay Buffel
DMb	797.0	747.9	381.5	512.8	508.8	248.5	614.0	909.3	943.8
MMc	61.2	41.6	77.6	45.2	58.0	80.2	32.9	291.9	69.5
OMc	938.7	958.3	922.4	954.7	941.9	919.8	967.0	708.1	930.5
CPc	22.9	43.6	103.8	105.9	141.4	148.5	91.6	285.9	39.7
FNDc	775.0	759.9	387.5	390.1	559.5	335.3	554.5	266.2	702.3
FADc	567.5	610.2	289.0	304.0	430.3	250.6	430.5	86.0	389.7

aGRA = Grass; DIC = Dicotyledoneous plants; PER = Pereiro (*Aspidosperma pyriforme* Mart.); CAT = Catingueira (*Poincianella pyramidalis* Tul. L.P. Queiroz); MAR = Marmeleiro (*Croton blanchetii* Anus Baill); MOF = Mofumbo (*Combretum leprosum* Mart); JUR = Jurema preta (*Mimosa tenuiflora* (Willd.) Poir); MBs = Feed blocks; DM = Dry matter; MM = Mineral matter; OM = Organic matter; CP = Crude protein; NDF = Fiber in neutral detergent; ADF = Fiber in acid detergent. b(g/kg MN). c(g/kg MS).

Treatments. The experiment consisted of 3 treatments according to type of supplementation: 1) mix of mineral salt, 2) feed block and 3) Feed blocks + buffel hay.

There was utilized a commercial mix mineral salt specific for small ruminants. The feed blocks were manufactured with the following ingredients: 25% molasses, 5% urea, 24% corn grounded, 24% soybean meal, 5% salt and 10% hydrated lime. The procedure for the feed block manufacture is described by Allen (10).

Animals. 60 animals were used, being 30 sheep and 30 goats, without a defined breed standard (WDBS), non-castrated males, with an average of four-month-old and initial body weight of 18.63±1.93 kg. Previous the experiment, the research protocol was submitted and approved by the ethics committee 30-2013. The animals were identified and separated equality in three groups. Each group was conditioned in the paddocks with vegetation characteristic of Caatinga ecosystem. Each paddock suited 20 animals (10 sheep and 10 goats), with a shelter with free access to water and each treatment the respective supplement.

Animal performance. The animal performance was measured during to 108 days, preceded by 14 days of adaptation to the diet. At the end of the experimental period, the animals were submitted to 18 hours of water and food fasting, then stunned, suspended by their back legs and slaughtered bleeding from the jugular vein and carotid artery, skinned and eviscerated, thus obtained the carcass. All carcasses were stored and transported to a freezer room at 4°C, where they remained hanging by the leg tendons for 24 hours.

Carcass evaluation. After this period, the carcasses were subjectively evaluated and classified by means of scores, varying from 1 to 5, in respect of their conformation (bad, reasonable, good, very good and excellent) and finishing (very lean, lean, average, fat and very fat), as well as from 1 to 3, and the pelvic-renal fat coverage (little, medium, great amount). Posteriorly, this fat was removed and weighed to obtain its absolute and relative weight in relation to the empty body weight, following the methodology described by Cezar and Sousa (11).

Still in the left half carcass, was carried out a transversal cut between the 12th and 13th ribs, exposing the transversal section of the Longissimus dorsi muscle. Posteriorly, it was placed over the the surface of this transversal section, a transparent film, on which was delineated with a pen, the contour of the previously

mentioned muscle, for the determination of the loin-eye area (LEA). For this purpose, were obtained, using a ruler, the maximum width (A) and the maximum depth (B), to be applied in the formula: $LEA = (A/2 \times B/2) \times \pi$. The subcutaneous fat thickness (SFT) was also measured, in the dorso-central point of the exposed surface and the GR measure, on the 12th rib, on the point of 11 cm of distance from the medium line of the loin, both with a caliper.

The half carcass was sectioned in five commercial cuts to evaluate the regional composition of the carcass: neck, shoulder, ribs, loin and leg, and calculated the percentual ratio between the weight and reconstituted carcass. The leg was weighed and measured, for the determination of the leg compactness index (LCI = weight of the leg/length of the leg). Then the leg was frozen so as to, posteriorly, indirectly estimate the tissue composition of the carcass by its dissection into bones, muscles, and fat. From these weights the relations muscle:bone (RMB) and muscle:fat (RMF) were determined. Then, the muscularity index of the leg was calculated, using the formula $MIL = []/FL$, where MW corresponds to the sum of the weights of the five muscles that involve the femur (MW), the biceps gluteus, semimembranosus, semitendinosus, femoral quadriceps, and adductor. While the FL referred to the femur length (11).

Experimental design. The experimental design used was entirely randomized (DIC), in factorial scheme 3x2 (three types of supplementation: mineral salt, MBs and MBs + buffel hay, and two species: sheep and goats) and 10 replications. The data were submitted to variance analysis and the means were compared by Tukey's test at 5% of probability, using the statistical, computational software SAS.

RESULTS

Performance. The weight of half ½ carcass and loin were affected according to type of supplementation ($p < 0.05$), however, to other cuts the supplementation did not promote statistical differences. Regarding the animal species, differences were observed for the weight of shoulder, ribs, percentages of the leg, loin, shoulder, and ribs (Table 3).

TABLE 3.

Table 3. Reconstituted weight of the left half carcass and yield of the commercial cuts of sheep and goats consuming different feed supplements in grazing system in the Caatinga rangeland

Variables*	Supplementations			Pb	Species		Pb
	Mineral Salt	FBa	FBa + buffel hay		Sheep	Goats	
½ Carc. g	6395.1 A	5713.4B	5747.0AB	0.02	5842.7a	6060.9a	0.33
Leg. g	1856.9 A	1673.1 A	1679.1A	0.03	1749.3a	1723.4a	0.69
Leg. %	29.07A	29.28A	29.33A	0.80	29.99a	28.47b	<0.01
Loin, g	724.3A	632.5 AB	612.0B	0.02	677.3a	635.2a	0.23
Loin, %	11.35A	11.05A	10.65A	0.44	11.55a	10.48b	0.02
Shoulder, g	1223.1 A	1105.9 A	1129.9A	0.05	1090.1b	1215.8a	<0.01
Shoulder, %	19.16A	19.38A	19.67A	0.11	18.70b	20.11a	<0.01
Neck, g	928.9A	814.2A	845.6A	0.05	862.8a	863.0a	0.99
Neck, %	14.50A	14.28A	14.68A	0.61	14.78a	14.19a	0.07
Ribs, g	1661.9 A	1487.7 A	1480.4A	0.06	1463.1b	1623.5a	0.02
Ribs, %	25.89A	25.99A	25.65A	0.79	24.96b	26.73a	<0.01

aFB = Feed blocks. bDifferent letters, upper case for supplementation types and lower case for the species, on the same line mean statistical differences between the treatments by the Tukey's test at 5% of probability. *Half carcass

The weight of the ½ carcass was superior to animals that consumed only mineral salt as feed supplement (p<0.05), than those that consumed only feed blocks. Not statistical differences were observed between animals that consumed mineral salt and those that consumed feed blocks + buffel hay.

For the cuts, only the weight of loin (g) showed to be different according to type of supplementation, being superior to animals supplemented with mineral salt when compared those that consumed FB + buffel hay. The other cuts were not affected by the type of supplementation.

The sheep were superior to goats in leg and loin percentages; whereas the goats showed a larger shoulder and ribs than sheep (p<0.05) (Table 3). The sheep showed larger leg and loin than goats. These results indicate that sheep obtained better carcasses when raised in grazing system in the Caatinga ecosystem. According to Cezar and Sousa (13), the leg and loin are the most value commercial meat cuts.

Carcass muscularity components. The muscularity variables are showed in the Table 4. The supplementation did not affect the carcass compactness index and weight of the leg muscles (p>0.05). However, differences in the conformation for LEA, MIL, CIL and LMW% were observed between species (Table 4).

TABLE 4.

Table 4. Quantitative characteristics of the muscularity of the carcass of sheep and goats consuming different feed supplements in grazing system in the Caatinga rangeland

Variables	Supplementations			Pb	Species		Pb
	Mineral Salt	FBa	FB + buffel hay		Mineral Salt	FB	
Conf	2.50A	2.26A	2.17A	0.06	2.80a	1.82b	<0.01
CCI, kg/cm	0.198A	0.181 AB	0.180B	0.02	0.186a	0.186a	0.93
LEA, cm ²	8.321A	7.426A	7.391A	0.09	8.268a	7.157b	0.01
MIL	0.33A	0.32A	0.31A	0.16	0.33a	0.31b	<0.01
LCI, cm/cm	0.32A	0.33A	0.32A	0.30	0.35a	0.30b	<0.01
RLW, g	1706.6 A	1533.7 A	1539.9A	0.05	1590.8 a	1595.9 a	0.93
LMW, g	1163.7 A	1031.3 B	1042.8AB	0.03	1060.8 a	1097.7 a	0.41
LMW, %	68.24A	67.12A	67.56A	0.23	66.62b	68.66a	<0.01
BW, g	367.9A	338.2A	344.4A	0.08	351.0a	349.3a	0.88
BW, %	21.64A	22.25A	22.53A	0.34	22.26a	22.02a	0.62
M:B	3.165A	3.045A	3.031A	0.33	3.022a	3.139a	0.15
M:F:B	3.523A	3.408A	3.350A	0.34	3.413a	3.441a	0.77

aConf. = Conformation; CCI = Carcass compactness index; LEA = Loin-eye area; MIL = Muscular index of the leg; LCI = Leg compactness index; RLW = Reconstituted leg weight; LMW = Leg muscle weight; BW = Bone weight; M:B = Muscle:bone relation; M:F:B = Muscle:Fat:Bone relation; FB = Feed blocks. bDifferent letters, upper case for the types of supplementation and lower-case for the species, on the same line mean statistical differences between the treatments by Turkey's test at 5% of probability.

The type of supplementation did not affect the conformation of carcass. Therefore, animals supplemented with mineral salt, FBs or FBs + buffel hay, acquired the same musculature. The CCI was highest for animals supplemented with mineral salt and lowest for animals that consumed FBs + buffel hay. This atypical results may be attributed the high availability of forage during to experiment.

Observing by animal species, the sheep surpassed the goats regarding the conformation, LEA, MIL and LCI, while the goats were superior in percentual of LMW (Table 3).

Carcass adiposity components. There were observed that the type of feed supplementation did not promote differences between in most of aspects related with the carcass adiposity ($p>0.05$) (Table 5).

TABLE 5.

Table 5. Quantitative characteristics of the adiposity of the carcass of sheep and goats consuming different feed supplements in grazing system in the Caatinga rangeland

Variables	Supplementations			Pb	Species		Pb
	Mineral Salt	MBsa	MBsa + buffel hay		Mineral Salt	MBsa	
GRM, mm	6.43A	5.80A	5.81A	0.17	6.25a	5.77a	0.13
PRFS	1.46A	1.45A	1.45A	0.98	1.45a	1.45a	0.96
Renal Fat, g	81.90A	69.50A	77.20A	0.69	72.00a	80.40a	0.48
Renal Fat, %	0.35A	0.33A	0.38A	0.78	0.33a	0.38a	0.36
Inguinal Fat, g	32.20A	32.00A	26.40A	0.54	34.60a	25.80a	0.07
Inguinal Fat, %	0.13A	0.15A	0.13A	0.66	0.15a	0.12a	0.11
Sub. Fat, g	64.6A	58.8A	50.0A	0.10	68.26a	47.33b	<0.01
Sub. Fat, %	3.756A	3.815A	3.220A	0.19	4.208a	2.986b	<0.01
Inter. Fat, g	67.7A	63.8A	59.4A	0.46	69.53a	57.73b	0.03
Inter. Fat, %	3.882A	4.100A	3.850A	0.67	4.321a	3.567b	<0.01

aGRM = Grade Rule Measure; PRFS = Pelvic-renal fat score; Sub. Fat = Subcutaneous fat; Inter. Fat = Intermuscular Fat; MBs = Feed blocks.
 bDifferent letters, upper case for the supplementation types, and lower-case for species, on the same line mean statistical differences between the treatments by Tukey's test at 5% of probability.

There were interactions among the variables studied (Table 6). The interaction occurred to SFT, pelvic fat (g and %), total leg fat (g and %), and the relation muscle:fat. Indicating, that the supplements interfered in the animal species in these factors.

TABLE 6

Table 6. Unfolding of the interaction of the quantitative characteristics of the carcass's adiposity of sheep and goats consuming different feed supplements in grazing system in the Caatinga rangeland

Species	Supplementations			Pb
	Mineral Salt	MBsa	MBsa + buffel hay	
	Finishing			
Sheep	3.18Aa	3.13Aa	2.52Ba	0.002
Goats	1.57Ab	1.55Ab	1.61Ab	
	Subcutaneous fat thickness (SFT), mm			
Sheep	1.09Aa	1.07Aa	0.70Ba	0.003
Goats	0.70Ab	0.66Ab	0.79Aa	
	Pelvic fat, g			
Sheep	16.40Aa	9.40Aa	5.40Ba	0.021
Goats	8.40Aa	10.60Aa	10.80Aa	
	Pelvic fat, %			
Sheep	0.06Aa	0.04Aa	0.02Aa	0.043
Goats	0.03Aa	0.05Aa	0.05Aa	
	Total leg fat, g			
Sheep	156.4Aa	148.4Aa	108.6Aa	0.042
Goats	108.2Ab	96.80Bb	110.2Aa	
	Total leg fat, %			
Sheep	8.91Aa	9.46Aa	7.18Ba	0.010
Goats	6.36Ab	6.33Ab	6.96Aa	
	Muscle: Fat relation, g:g			
Sheep	7.84Ab	7.21Ab	9.58Aa	0.030
Goats	11.37Aa	11.14Aa	10.30Aa	
aMBs = Feed blocks. bDifferent letters, upper case on the same line for the types of supplementations and lower case in the same column for species, mean statistical differences between the treatments by Turkey's test at 5% of probability.				

The finishing, the SFT, pelvic fat (g) and total leg fat (%) did not have influence of the type of supplementation, with a lower average for sheep supplemented with FBs + buffel hay. To animal species, sheep obtained a better finishing than goats in the three supplementations.

The same pattern the supplementation did not promote differences in the muscle:fat ratio.

DISCUSSION

The values observed for the weight of the ½ carcass in this study agree with the reported by Carvalho Júnior et al (12) when studying the effect of the supplementation in the characteristics of the carcass of goats finished off in shrubland grazing system, feed supplemented based on 1% of body weight.

In concordance with our results, Hashimoto et al (6) reported similar weight and yield of the lambs finished in grazing system and feed supplemented with soybean pellets at 1% of body weight.

The values for carcass conformation observed in this study corroborated with those reported by Sousa et al (14), where sheep showed better carcass than goats grazing in the Caatinga. Also, Sousa et al (14) reported that sheep had more proportion of meat in the carcass than goats. According to Álvarez et al (15), the carcasses with high conformation scores are more valued by consumers, which means better price and appreciation in the market.

However, a higher percentage of leg muscles for goats represents a heavier carcass and with more muscles, as found by Sousa et al (14), who observed the superiority of goats about sheep regarding the muscle percentage, and reported that the goats presented a greater muscularity in comparison the sheep.

According to Louvandini et al (16), the nutrition is the key-point for obtaining of carcass more uniform in goats and sheep, which is a mandatory factor to improve the market value of this product to attract consumers.

Contrarily the results obtained in our research, Sen et al (17), stated that sheep tend to obtain a better fat coverage than goats. Sen et al (17) also reported that the carcass of goat is leaner when compared with the carcass of sheep. The fact that becomes an advantage for the sheep, as according to Rosa et al (18), the fat is the tissue with the most variability in the animal, either in quantitative terms or by its distribution and fundamental biological function of energy storage for periods of food scarcity. However, there are controversies,

Osório et al (19) affirmed that fat increase the conformation improves and the edible portion (muscle:fat ratio) might not be the one desired by the consumer, as excess fat is undesirable. It is uneconomical for the producers to accumulate fat in the animal body, once that, it is necessary more kilos calories in the diet than to produce muscle. According to Santos et al (20), the currently market demands a product with a maximum muscle production (edible fraction) and a reasonable quantity of fat that not affect the organoleptic properties of the meat.

Differently of the results reported in this research, Osório et al (19) stated that edible portion of the meat is composed of muscle and meat and the determination of the optimal time for slaughter of animals must be the one in which there is a proportion of fat adequate for the consumer's preference.

In conclusion, sheep and goats, when fed with supplementation of pasture feeding blocks in the Caatinga ecosystem, present weights and cuts of meat adequate to Brazilian commercial requirements; Supplementation with mineral salt and Multinutritional Blocks with and without Buffel can be used to improve herds in the caatinga, with similar results among the three. Sheep show more adiposity of meat than goats, in contrast, goats have higher musculature than sheep when fed with feed blocks in pasture grass in the Caatinga ecosystem.

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