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Carcass traits of goats finished with different levels of concentrate supplementation and kept on caatinga enriched with *Urochloa trichopus*

Características de carcaça de caprinos terminados com diferentes níveis de suplementação concentrada e mantidos em caatinga enriquecida com Urochloa trichopus

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Abstract
The objective of this study was to evaluate the carcass traits of crossbred F1 goats (Boer x non-descript breed) finished on thinned caatinga pasture enriched with signal grass (*Urochloa trichopus* Stapf.), and receiving supplementation. Twenty-four crossbred F1 goats with 27.00 ± 3.32 kg body weight were used. The supplement was designed to meet the nutritional requirements and animals receiving the highest supplementation level could gain 150g per day. For data analysis, a completely randomized design was adopted, with four treatments (supplementation levels of 0.0%; 0.5%; 1.0% and 1.5% body weight) and six replications (animals). Data were subjected to analysis of variance and regression. Supplementation resulted in an increasing linear effect for slaughter weight, hot carcass weight, cold carcass weight, empty body weight, hot carcass yield and cold carcass yield; and a quadratic effect for biological yield. Weight loss by cooling was not influenced by supplementation. For the results of subjective evaluations, only conformation was influenced by supplementation (P<0.05). For morphometry, a positive linear effect of supplementation was found for thorax perimeter, croup perimeter, croup width, thorax width. The level of supplementation caused a positive linear effect on the weight of most non-edible carcass components, and there was no influence of supplementation on most variables for yield. It can be concluded that increasing levels of supplementation up to 1.5% body weight for F1 goats (Boer x non-descript breed) kept on caatinga pasture results in higher carcass weight and yield.
Keywords: Boer; carcass conformation; carcass quality; native pasture; pasture supplementation

Resumo
Objetivou-se avaliar as características de carcaça de caprinos mestiços F1 (Bôer x sem padrão de raça definida) terminados em pastagem de caatinga raleada e enriquecida com capim corrente (*Urochloa trichopus* Stapf.), submetidos a suplementação. Foram utilizados 24 caprinos mestiços com peso vivo 27,00 ± 3,32 kg. O suplemento foi elaborado de modo a atender as exigências nutricionais para que os animais do maior nível de suplementação obtivessem um ganho de 150 g diário. Para a análise dos dados foi adotado o delineamento inteiramente casualizado, com quatro tratamentos (níveis de suplementação de 0,0%; 0,5%; 1,0% e 1,5% do peso vivo) e seis repetições (animais). Os dados foram submetidos a análises de variância e de regressão. Observou-se que a suplementação proporcionou efeito linear crescente para o peso ao abate, peso de carcaça quente, peso de carcaça fria, peso de corpo vazio, rendimento de carcaça quente e rendimento de carcaça fria; efeito quadrático para o rendimento biológico. A perda de peso por resfriamento não sofreu influência da suplementação. Para os resultados das avaliações subjetivas apenas a conformação sofreu influência da suplementação (P<0,05). Para a morfometria observou-se efeito linear positivo da suplementação para o perímetro do tórax, perímetro da garupa, largura da garupa, largura do tórax. O nível de suplementação proporcionou efeito linear e positivo sobre o peso da maioria dos não componentes comestíveis da carcaça, sendo que para o rendimento não foi observado influência da suplementação para a maioria das variáveis. Conclui-se que o uso crescente de suplementação até o nível de 1,5% do peso vivo para caprinos F1 (Boer x sem padrão de raça definida) mantidos em pastagem de caatinga resulta em maiores pesos e rendimentos de carcaças.
Palavras-chave: Boer; conformação de carcaça; qualidade de carcaça; pasto nativo; suplementação em pastejo

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Introduction

Agricultural production in the Northeast has an important socioeconomic role, since family farming is predominant in the context of the region. However, there are limitations, as it depends on the availability of pastures, which in turn depends mainly on rainfall, as well as on the awareness of the producer, since it is known that many producers still do not have a professional animal husbandry, which requires technical assistance, rigorous care, with concrete objectives for goat production.

The Brazilian Northeast presents a range of characteristic eco-climates and generalized semiarid areas, with dominant aspects being the long and frequent periods of drought. In this context, goat farming is highlighted, as these animals are highly adaptable to the environment provided by the semiarid conditions of the region(25).

Along with cultural and socioeconomic importance, goats have stood out for having excellent quality meat, which increases their consumption due to the increase in national demand for low-fat meat(15), which also occurs in developed countries(23). Besides the carcass, parts of the viscera are used, which is a common practice in the Northeast region, making goat farming more valued. In addition to quality, an alternative for the development of goat farming in northeastern Brazil, aiming to increase herd productivity, has been the importation of specialized breeds. Among these, the Boer breed is highlighted, where the F1 of the cross with the non-descript breed is able to obtain high and favorable yield for the production chain(27).

For that, livestock production depends on improvements in the production system, mainly in the Northeast region, then, in the search to minimize the effects of the climate on livestock farming. Pereira Filho et al.(24) stated that technicians, researchers and producers have been looking for alternatives to improve the productivity of goats in the semiarid region, but two points are described as obstacles: the first is the low weight gain and the long time required for animals raised on grazing in the caatinga to reach the weight required by the consumer market; the second refers to the high cost of confinement, especially with concentrates. Finally, the authors suggest that supplementation of goats raised on caatinga pasture may be an alternative to overcome these obstacles.

Paula, Ferreira and Veras(22) reported that in semiarid regions, pastures are impacted in different ways and, in order to provide a good performance to the animals, adequate food intake is necessary, and that this can only be achieved by animal feed supplementation.

Pinto et al.(33) affirm that Caatinga plants have the potential to feed ruminants, improving the carcass traits under grazing in managed caatinga, providing an adequate supply of forage during the rainy season. In this sense, enrichment of the caatinga is an alternative that improves forage quality, which, according to Pereira Filho et al.(24), consists of intensive thinning, in order to leave about 15% soil covered with woody vegetation and then the introduction of exotic and/or native forage species is carried out, with the objective of increasing the production and availability of grazable dry matter, as well as improving the carrying capacity, with emphasis on signal grass, used by animals and which has been the object of evaluation in the semiarid region.

Thus, the objective of this study was to evaluate the effect of supplementation on carcass traits of crossbred F1 goats (Boer x non-descript breed) finished on thinned caatinga and enriched with signal grass.

Material and methods

The experiment was conducted at Lameirão Farm, belonging to the Federal University of Campina Grande, Rural Health and Technology Center, located at the geographical coordinates 7° 02' 56.8″ S and 37° 29' 36.2″ W, in the municipality of Santa Teresinha, state of Paraíba. The vegetation of the region has three distinct strata: arboreal, shrubby and herbaceous.

According to the Köppen climate classification, the climate of the region is As (tropical hot and humid with autumn-winter rains)(4). The annual average temperature is 28ºC, with maximum and minimum values around 35ºC and 22ºC, respectively. The average relative humidity in the region is 60%.

In the year of the experiment, cumulative rainfall volume was 690.9 mm. In the period before the experiment, rainfall volume was 396.4 mm, concentrated in the months of January and April, the latter registered the largest volume with 240.2 mm; during the experimental period, from May to October, the cumulative volume was of 178.6 mm(1).

The vegetation in the experimental area is at the early stage of secondary succession, and may present three distinct strata, arboreal, shrubby and herbaceous, with a great predominance of *Mimosa tenuiflora* (Willd.) Poir. and the presence of other woody species, such as *Croton sonderianus* Muell Arg., *Caesalpinia bracteosa* Tul, *Combretum leprosum* Mart and *Zizyphus joazeiro* Mart. In terms of the herbaceous stratum, the following stand out: *Urochloa plantaginea* and *Panicum* sp., *Aristida setifolia* H. B. K, *Digitaria* sp. and *Setaria* sp.; among the herbaceous dicots, there is a predominance of *Hyptis suaveolens* Point, *Senna obtusifolia*, *Stylozanthes* sp., *Sida cordifolia* and *Macroptilium lathyroides* L.

The vegetation of the experimental area was subjected to selective thinning, aiming at the partial removal of undesirable species, especially plants considered invasive, such as *Mimosa tenuiflora* (Willd.)

Poir. and *Croton sonderiamus* Mull. Arg., as well as the preservation of tree and/or shrub species considered to be endangered plants and those that remain green during the dry season, such as *Zizyphus joazeiro*.

A tree-shrub soil of between 15 and 20% was maintained, as indicated by Araújo Filho[6]. Caatinga enrichment was carried out in 2012 with the introduction of signal grass (*Urochloa trichopus*), in order to increase dry matter availability in the herbaceous stratum, increasing the level of diet selection by the animals.

Collections to determine the chemical composition of the herbaceous vegetation in the different evaluation periods (Table 1) were carried out as follows: 1st – before the start of grazing (May); 2nd – 30 days after the start of grazing (August); 3rd – 60 days after the start of grazing (September); 4th – the day after the animals leave (October).

Table 1. Chemical composition of vegetation in the different periods

Item	May			August			September			October	
	CC	Dic.	OG	CC	Dic.	Ser	CC	Dic.	Ser	Dic.	Ser
DM*	541.7	534.3	76.7	755.2	886.5	898.7	802.1	842.8	936.6	864.4	901.8
OM	915.7	938.8	936.5	905.7	952.2	966.3	915.3	952.4	963.7	962.7	969.0
MM	84.3	61.2	63.5	94.3	47.8	33.7	85.7	47.6	36.3	37.3	31.0
CP	94.1	88.7	63.5	78.8	73.1	36.9	57.8	57.6	33.9	56.6	29.0
NDFcp	615.4	488.3	654.8	671.2	645.8	786.6	698.8	711.7	805.2	665.1	824.4
ADFcp	402.5	402.7	415.3	433.6	555.0	689.6	467.3	554.1	692.9	504.9	714.7
HEM	212.9	85.6	239.5	183.6	90.8	97.0	231.5	167.6	112.3	160.2	109.7

CC: signal grass; Dic: dicots; OG: Other grasses; Ser: litter; DM: dry matter; OM: organic matter; MM: mineral matter; CP: crude protein; NDFcp: neutral detergente fiber corrected for ash and protein; ADFcp: acid detergent fiber corrected for ash and protein; HEM: hemicellulose. *g/kg natural matter.

To quantify the availability between collection periods (Table 2) and within each treatment (Table 3), the vegetation was cut close to the ground and separated into signal grass, herbaceous dicots, other grasses and litter, and weighed.

Table 2. Availability (kg DM ha^{-1}) of grass *Urochloa trichopus*, dicots, other grasses and litter in the different periods in 2013

Month	*Urochloa trichopus*	Dicots	Other grasses	Litter
May	144.20a	1.886a	149.47a	0.0c
August	27.19b	510b	0.0b	2.545a
September	21.51b	472b	0.0b	1.897b
October	13.28b	540b	0.0b	1.798b

Mean values followed by different letters in the same column are significantly different by Tukey's test (P<0.05).

Table 3. Availability (kg DM ha-1) of grass *Urochloa trichopus*, dicots, other grasses and litter within each treatment

Components	Supplementation level (% BW)				Equation	R^2
	0.0	0.5	1.0	1.5		
Urochloa trichopus	42.95	58.91	44.87	59.45	Y=51.55	0.003
Dicots	886	1.181	559	782	Y=0.85	0.01
Other grasses	0.0	15.73	83.39	50.35	Y=37.37	0.04
Litter	1.763	2.017	1.010	1.450	Y=1.56	0.04

All procedures for animal research were approved by the Internal Ethics Committee in Animal Experimentation of the Rural Health and Technology Center: Protocol 029/2012.

For the study, 24 male goats (F1 Boer x non-descript breed) were used, with 27.00 ± 3.32 kg average body weight (BW) and approximately 90 days of age. From the acquisition of the animals and during the experimental period, goats received all routine health treatments and control of endo- and ecto-parasites. All animals were individually identified, through a numbered collar. Animals were kept in an area (2.4 hectares) of thinned caatinga and enriched with *Urochloa trichopus* grass. This area was divided into four paddocks of 0.6 hectares each, with 6 goats in each paddock, with no rotation.

Animals were weighed, and randomly assigned to four treatments, with six replications each, with the control treatment receiving only mineral supplementation and the others, supplemented with 0.5; 1.0 and 1.5% BW concentrate supplement (ground corn and soybean meal). Paddocks were equipped with shelter for salt lickers and water troughs, in which complete mineral mixture and water were made available at will.

The feeding management consisted of goat grazing on caatinga pasture enriched with signal grass, from 8 to 16 hours, later housed in individual pens, equipped with feeders and drinkers, remaining in that place overnight, where they received concentrate supplementation with 80.14% ground corn grain and 19.86% soybean meal.

The supplement was prepared following the recommendations for nutritional requirements of small ruminants, according to the National Research Council[19], in order to meet the nutritional requirements for animals of the treatment with 1.5% supplementation to achieve an average weight gain of 150 grams per day.

Samples of signal grass were collected, as well as samples of other grasses (*Cyperus compressus*, *Axonopus purpusii* and *Aristida setifolia* H.B.K.), herbaceous dicots (*Stylosanthes captata*, *Centrosema brasilianum* Benth., *Phaseolus patyroides* L., *Ipomoea purpurea* Roth, *Sida spinosa* L., *Hyptis suaveolens* L. Poit, *Sida cordifolia* L., *Senna obtusifolia*, *Boerhavia diffusesa* L., *Lippia sidoides*, *Desmodium tortuosum* (Sw.) DC., *Turnera ulmifolia* L, *Floehlichia humboldtiana* and *Senna corymbosa*) and litter. Species of other grasses and herbaceous dicots were identified by frequency evaluations. Analyses were performed to determine dry matter (DM), crude protein (CP), neutral detergent fiber corrected for ash and protein (NDF), acid detergent fiber corrected for ash and protein (ADF) and Hemicellulose (HEM), which were analyzed according to Silva and Queiroz[28].

Litter was measured, as it becomes a significant part of the goat diet with approximation of the dry season[30].

To obtain the intake estimates (Table 4), the LIPE® marker was administered orally in the form of capsules at a dosage of 250 mg/animal, for an adaptation period of two days and five days for total collection of feces, according to Saliba et al.[29].

Table 4. Intake of concentrate and forage (g/kg) by supplemented goats on caatinga pasture enriched with signal grass

	Supplementation (% BW)				Equation	R^2
	0.0	0.5	1.0	1.5		
DMIConc (g/day)	0.00	136.00	299.42	458.00	Y=-7.26+307.48x	0.95
DMIvol (g/day)	494.73	426.21	447.41	429.14	Y=449.37	0.19
DMItot (g/day)	494.73	562.21	746.82	887.14	Y=468.45+272.37x	0.75
CTMS (%BW)	1.71	2.07	2.50	2.91	Y=1.70+0.80x	0.96
CMSvol (%BW)	1,71	1.57	1.50	1,41	Y=1.69-0.20x	0.63
DMI (g/kg$^{0.75}$)	39.70	47.16	58.32	68.15	Y=38.85+19.31	0.94

DMIConc(g/day) = dry matter intake of concentrate (grams/day), DMIvol(g/day) = dry matter intake of forage (grams/day), tot(g/day) = total dry matter intake (grams/day), CTMS(%BW) = total dry matter intake (% body weight), CMSvol (% BW) = forage dry matter intake (% body weight), DMI(g/kg$^{0.75}$) = dry matter intake (grams/kg metabolic weight).

Table 5. Intake of protein, neutral detergent fiber, digestibility of dry matter, protein and neutral detergent fiber according to supplementation levels

	Supplementation (% BW)				Equation	R^2
	0.0	0.5	1.0	1.5		
CPI (g/day)	30.16	47.75	75.20	99.46	Y= 27.84+47.07x	0.90
NDFI (g/day)	196.06	184.09	210.73	221.20	Y=187.70+20.41x	0.15
DMD (%)	62.45	69.73	74.72	78.10	Y=63.44+10.37x	0.96
CPD (%)	48.22	66.84	75.33	79.25	Y=48.44+42.54x-14.79x^2	0.94
NDFD (%)	19.25	24.46	25.52	29.10	Y=19.92+6.18x	0.34

CPI(g/day) = crude protein intake (grams/day), **NDFI (g/day) =** neutral detergent fiber intake (grams/day), **DMD (%) =** dry matter digestibility (%), **CPD (%) =** crude protein digestibility (%), **NDFD (%) =** neutral detergent fiber digestibility (%).

The intake of all nutrients was estimated according to the methodology of Saliba et al.[29] (Table 5).

After 69 experimental days, goats were fasted for solids for 16 h and for liquids for 12 h, weighted at the end of this period, obtaining the slaughter body weight (SBW). Animals were slaughtered by stunning and bleeding, followed by skinning and evisceration. Carcass was obtained after removing the head (section at the atlanto-occipital joint), the forelegs and hindlegs (sections at the carpal metacarpal and tarsal metatarsal joints, respectively), obtaining the hot carcass weight (HCW), following the methodology prescribed by Cezar and Sousa[12], as well as all carcass methodologies.

After obtaining the carcass weight, the hot carcass yield (HCY) was determined. Then, carcasses were kept in a cold chamber, at 4 ºC, for 24 hours, obtaining the cold carcass weight (CCW), cold carcass yield (CCY), biological yield (BY) and cooling losses (CL), all obtained according to the methodology described by Cezar and Sousa[12], using the equations:

$$HCY = (HCW/SBW) \times 100$$

$$BY = (HCW/EBW) \times 100$$

$$CCY = (CCW/SBW) \times 100$$

$$CL = HCW - (CCW/HCW) \times 100$$

After cooling, qualitative traits were determined by subjective evaluations of the carcasses: conformation, finishing and amount of pelvic-renal fat of the carcasses, according to the methodology described by Cezar and Sousa[12].

A cross section was made between the 12th and 13th ribs in the left half carcass, exposing the cross section of the Longissimus dorsi muscle, for evaluations of marbling, color, texture, assigning scores for marbling, ranging from one to five, with classification: (1) non-existent, (2) little, (3) good, (4) very much, and (5) excessive, according to Cezar and Sousa[12].

Texture was evaluated with scores ranging from one to five, following the classification: (1) very fine, (2) fine, (3) slightly coarse, (4) coarse, (5) very coarse. As for the color, meat were classified into (1) light pink, (2) pink, (3) light red, (4) red and (5) dark red, according to Cezar and Sousa[12].

Carcass conformation was evaluated by punctuating the anatomical regions: leg, croup, loin, shoulder and their muscular planes, and the carcass finishing considered the thickness and distribution of adipose planes in relation to the musculature, according to the categories and scores varying from one to five, following the classification: (1) bad, (2) fair, (3) good, (4) very good and (5) excellent, according to the methodology of Cezar and Sousa[12].

Weights and yields of non-edible components of the carcass were obtained, comprising the following organs: respiratory tract, heart, liver, spleen, kidney; empty viscera: rumen, reticulum, omasum and abomasum. The gastrointestinal tract (GIT) was weighed with all organs full, then all were emptied and individually weighed. The weights of all empty GIT viscera were added together to obtain the empty GIT weight.

For morphometric evaluation of the carcass, the following measurements were taken: external length of the carcass: distance from the cervical-thoracic joint to the 1st intercoccygeal joint; croup width (CW): maximum width between the trochanters of the femurs; croup perimeter: perimeter in the croup region, based on the trochanters of the femurs; thoracic perimeter: perimeter measured behind the shoulder; thoracic width: maximum width of the carcass at the level of the ribs, taken with a compass; thigh circumference: based on the middle part of the leg, above the femoro-tibial patellar joint); carcass internal length (CIL): distance between the anterior edge of the pubic bone and the anterior edge of the first rib at its midpoint; leg length (LL): distance between the greater trochanter of the femur and the edge of the tarsometatarsal joint; and, thoracic depth: distance between the sternum and the withers and, thoracic width. Length and perimeter measurements were taken with a measuring tape, and width measurements, with a caliper.

For data analysis, a completely randomized design was adopted, with four treatments (supplementation levels) and six replications (animals). Data were tested by analysis of variance and regression, always at the 5% probability level.

Results and Discussion

The increase in supplementation levels resulted in a greater supply of nutrients to the animals, as it increased the total dry matter intake (in % body weight), in the order of 17.4, 31.6 and 41.2%, for the supplementation levels of 0.5%; 1.0% and 1.5% (Table 4), respectively, in relation to the control group, indicating that the supplementation increased the animal intake, which could bring benefits in weight and carcass gain. There was also an increase in dry matter digestibility coefficients (62.40%; 69.70%, 74.70% and 78.00%, for the levels 0.0%; 0.5%; 1.0% and 1.5% (Table 5), respectively, resulting in an increase in total weight gain in the period, which was 2.53, 3.63, 5.71 and 6.78 kg, respectively. Silva et al.[35] evaluated the effect of feed supplementation on the performance of crossbred goats finished on caatinga pasture, showing that feed supplementation was positive for intake, dry matter digestibility, crude protein, resulting in a higher final body weight, total gain and average daily gain, with recommendation to use up to the level of 0.7% CP to avoid the substitution effect.

Supplementation provided an increasing linear effect for slaughter weight, hot carcass weight, cold carcass weight, empty body weight, hot carcass yield and cold carcass yield, and a quadratic effect for biological yield. Cooling weight loss was not influenced by supplementation (Table 6).

Soares et al.[30] evaluated the performance of sheep and goats finished on caatinga pasture enriched with buffel grass and supplemented with two types of supplementation (energy and protein-energy), and reported that the performance of these animals was favored by the supply of protein-energy supplementation, which showed higher total weight gain and higher hot and cold carcass weights and empty body weight, indicating the role of protein in the concentrate, meeting the protein deficiency of the pasture. In the study by Silva et al.[31] evaluating the carcass traits of non-descript breed goats, raised on caatinga pasture and supplemented with two types of hay: jitirana (*Merremia aegyptia*) or mororó (*Bauhinia cheilanta*), combined or not with cactus pear (*Nopalea cochenillifera* Salm Dick), and a treatment without supplementation (control). Feed supplementation with jitirana and mororó hays, and cactus pear did not improve performance and carcass traits of goats raised on caatinga pasture.

Table 6. Weight, yield and carcass quality parameters of F1 goats (Boer × non-descript breed) finished on native pasture with different levels of supplementation

Parameters	Supplementation (% BW) 0.0	0.5	1.0	1.5	Regresion equation	R^2	CV
Initial body weight[3]	26.70	26.01	26.43	26.51	-	-	-
Body weight at slaughter[3]	26.82	27.09	31.56	32.45	y = 4.27x + 26.28	0.32	12.37
Hot carcass weight[3]	10.63	11.66	13.86	14.96	y = 3.04x + 10.50	0.51	13.70
Cold carcass weight[3]	10.36	11.45	13.57	14.67	y = 3.01x + 10.25	0.51	13.91
Cooling losses[4]	2.57	1.81	2.12	1.97	y = 2.12	0.03	43.51
Empty body weight[3]	20.28	20.77	24.47	26.17	y = 4.28x + 19.72	0.41	13.00
Hot carcass yield	39.68	42.91	43.94	45.99	y = 3.99x + 40.13	0.57	4.71
Cold carcass yield[4]	38.66	42.27	43.00	45.10	y = 4.01x + 39.25	0.56	4.94
Biological yield[4]	52.36	56.06	56.65	57.07	$y = -3.28x^2+7.86x+ 52.51$	0.70	2.32

[3]kilogram; [4]percentage; dependent variable (y); independent variable – supplementation level (x); coefficient of determination (R^2); coefficient of variation (CV).

Carvalho Júnior et al.[11] obtained similar results when studied the effect of supplementation on the carcass traits of F1 Boer × non-descript breed goats (with 120 days of age and average weight of 15.52 kg) finished on native pasture. The same result was registered by Silva et al.[26], who studied the effects of supplementation levels (0.0; 0.4; 0.8 and 1.2% BW) on the carcass traits of crossbred goats finished in the caatinga.

For biological yield, a quadratic effect of supplementation was found, estimated by the regression equation, increasing up to the level of 1.13% BW supplementation.

According to Jochims et al.[17] and Biezus et al.[10], it may be associated with a possible substitution or additive effect of the intake of forage for the concentrate, or with the growth of organs and viscera (non-carcass components) in relation to the animal body growth due to the higher intake of dry matter.

Hot carcass yields were 39.68, 42.91, 43.94, 45.99% and cold carcass yields were 38.66; 42.27, 43.00 and 45.10% (Table 6), demonstrating the positive effect of supplementation, in which the energy and protein input guarantees higher carcass yield, which reflects in the higher commercial value in the sale of the product. Souza et al.[27] examined carcass traits of supplemented Canindé goats in the caatinga and Marques et al.[18], with Moxotó goats, in caatinga pasture, receiving food supplementation, conclude that supplementation improves carcass traits.

The hot and cold carcass weights were linear and positive with increasing supplementation level, thus showing the importance of supplementation and especially of native pasture in the local context. This because the availability and quality of the caatinga depends on the ambience as the set of factors with a direct influence on the zootechnical, physiological and behavioral indices of animals, including the climate provided by the semiarid region, which is quite inconsistent, where supplementation plays a key role in making ruminant farming a profitable activity.

The increase in the supplementation level increased nutrient intake and probably had an additive effect on intake, resulting in a positive effect of supplementation on carcass weights and yields. For the results of the subjective evaluations of carcass quality, no influence of supplementation was detected (P<0.05) for almost all the variables studied (Table 7), with the exception of conformation, showing that supplementation improved the distribution of muscle mass on the bone base[13].

However, conformation values were low for animals with half-blood Boer, as higher values are usually found for this variable when this breed is included in crossings. Factor that may be linked to poor pasture quality during the period studied.

Arruda Santos et al.[7] evaluated carcass traits of Anglo Nubian x Non-descript breed goats finished on caatinga pasture and receiving the same supplementation levels of the present study, and obtained a linear and positive effect of the diet on the finishing and conformation parameters. Oliveira et al.[20] evaluated the in vivo characteristics of body components of Angorá kids naturalized from the upper Camaquã in an extensive grazing system, and found no difference in carcass conformation of animals slaughtered at different ages (11-12 and 8-9 months) and weights (20.56 and 22.71 kg). The present study differs from these results, where the low pasture quality was determinant for the low-fat accumulation in the carcass, a factor that was not mentioned as a limiting factor by any of the cited authors.

Table 7. Subjective evaluation of the carcass and meat of F1 goats (Boer × non-descript breed) finished on native pasture with different levels of supplementation

	Supplementation level (% BW)				Regression equation	R^2	CV(%)
	0.0	0.5	1.0	1.5			
Conformation	2.10	2.22	2.55	2.55	Y = 2.10 + 0.34x	0.28	13.27
Finishing	2.33	2.28	2.33	2.40	Y = 2.31	0.14	6.99
Kidney fat	1.03	1.80	1.52	1.75	Y = 1.53	0.16	32.96
Color	3.78	3.58	3.90	3.87	Y = 3.78	0.02	11.12
Marbling	0.20	0.93	0.68	0.30	Y = 0.53	0.01	83.23
Texture	3.93	3.95	4.85	3.92	Y = 4.16	0.01	30.08

Bezerra et al.[9] obtained different results when evaluated the effect of three feeding managements (free grazing with supplementation; free grazing without supplementation; and restricted grazing) on non-descript breed goats on native pasture, with a positive effect for the treatment with greater availability of nutrients (free grazing with supplementation) in all morphometric parameters evaluated and common to those in the present study.

There was a positive linear effect of supplementation on thoracic perimeter, croup perimeter, croup width, thoracic width. Thus, diets with greater levels of supplementation (0.5, 1.0 and 1.5%) increased the weight of the animals with a greater deposition of muscle mass and fat in the body, and consequently, an increase in these morphometric measures. There was no effect for external carcass length, internal carcass length, leg length, thigh perimeter and thoracic depth (Table 8).

Table 8. Morphometric parameters of the carcass of F1 goats (Boer × non-descript breed) finished on native pasture with different levels of supplementation

	Supplementation (% BW)				Regression Equation	R^2	CV(%)
Variable (cm)	0.0	0.5	1.0	1.5			
External carcass length	50.17	47.83	50.17	49.58	y =49.44	0.01	4.84
Internal carcass length	63.00	59.17	62.00	61.00	y = 61.29	0.02	4.69
Leg length	35.83	39.70	37.40	39.87	y = 38.20	0.10	8.76
Thoracic perimeter	62.33	64.72	65.53	68.97	y = 4.14x + 62.28	0.36	4.93
Leg perimeter	34.33	35.17	37.50	36.55	Y = 35.89	0.14	7.27
Croup perimeter	48.23	50.38	52.08	54.65	y = 4.19x + 48.20	0.55	4.35
Croup width	19.60	19.58	20.12	21.42	y = 1.20x + 19.28	0.22	6.50
Thoracic width	15.20	15.83	16.83	16.58	y = 1.03x + 15.34	0.25	6.51
Thoracic depth	24.83	25.10	25.53	25.63	y = 25.28	0.05	6.01

Dependent variable (y); independent variable – supplementation level (x); coefficient of determination (R^2); coefficient of variation (CV).

Bezerra et al.[9] obtained different results when evaluated the effect of three feeding managements (free grazing with supplementation; free grazing without supplementation; and restricted grazing) on non-descript breed goats on native pasture, with a positive effect for the treatment with greater availability of nutrients (free grazing with supplementation) in all morphometric parameters evaluated and common to those in the present study.

Arruda Santos et al.[7] evaluated the morphometric characteristics of Anglo Nubian x non-descript breed goats with a mean initial age of 6 months and a mean initial weight of 18.75 kg, finished on caatinga pasture and receiving the same supplementation levels of this study, and found results similar to ours for croup perimeter and croup width, where the supplementation positively influenced the aforementioned variables, but there was no effect on the other variables. Importantly, in the same study, there was no difference in slaughter weight between the treatments, differing from this study, where there was an increase in this variable as the level of supplementation increased, a factor that may have influenced the increase of more measurements when comparing the two studies.

The results also showed a linear and positive effect for an important region of the carcass, the croup, where a greater regression coefficient was found for croup perimeter CP (4.190x), corroborating Araújo Filho et al.[5], who claimed that during the animal growth, there are changes in body measurements, and the meat animal breeds show a greater tendency for muscle development in the hind region, which is an important factor, since it is the region where the prime cuts are found.

Thus, given the fact that morphometry is a parameter that allows an objective evaluation of the carcass, these results show a variation in carcass quality when the supplementation level was increased, showing once again that the low pasture quality did not allow to obtain carcasses with higher attributes.

The supplementation level had a linear and positive effect on the weight of most non-edible carcass components, influencing the weight of the empty gastrointestinal tract, empty rumen, liver, heart, spleen and kidney (Table 9).

Table 9. Weight of non-edible carcass components of F1 goats (Boer × non-descript breed) finished on native pasture with different levels of supplementation

Variable (kg)	Supplementation (% BW)				Regression equation	R^2	CV(%)
	0.0	0.5	1.0	1.5			
Empty gastrointestinal tract	2.05	2.08	2.62	2.62	Y = 0.45x + 2.00	0.34	15.68
Empty rumen	0.52	0.58	0.70	0.64	Y = 92.67x + 542.17	0.22	16.51
Empty reticulum	0.09	0.08	0.10	0.11	Y = 95.83	0.11	21.83
Empty omasum	0.11	0.09	0.12	0.12	Y = 112.08	0.07	20.30
Empty abomasum	0.10	0.10	0.13	0.12	Y = 113.75	0.15	21.55
Liver	0.34	0.39	0.45	0.48	Y = 86.23x + 354.74	0.48	12.39
Respiratory tract	0.37	0.39	0.38	0.37	Y = 379.32	0.01	18.93
Heart	0.11	0.12	0.14	0.14	Y = 24.34x + 109.60	0.39	13.83
Spleen	0.03	0.03	0.03	0.04	Y = 4.87x +29.42	0.24	15.29
Kidney	0.06	0.08	0.07	0.08	Y = 0.01x + 0.07	0.22	14.92
Yield (%)							
Empty gastrointestinal tract	19.71	18.37	19.34	17.96	Y = 18.85	0.05	11.97
Empty rumen	5.04	5.10	5.19	4.42	Y = 4.94	0.10	12.47
Empty reticulum	0.88	0.74	0.74	0.73	Y = 0.77	0.15	16.63
Empty omasum	1.06	0.86	0.87	0.84	Y = -0.13x + 1.01	0.20	17.05
Empty abomasum	0.99	0.90	0.93	0.85	Y = 0.92	0.08	18.78
Liver	3.29	3.45	3.33	3.29	Y = 3.34	0.01	8.76
Respiratory tract	3.56	3.48	2.84	2.56	Y = -0.73x + 3.66	0.38	17.38
Heart	1.02	1.05	1.03	1.00	Y = 1.02	0.01	14.66
Spleen	0.28	0.28	0.26	0.26	Y = 0.27	0.07	15.29
Kidney	0.62	0.70	0.50	0.58	Y = 0.60	0.07	23.31

Dependent variable (y); independent variable – supplementation level (x); coefficient of determination (R^2); coefficient of variation (CV).

There was no effect of different supplementation levels on the empty reticulum, empty omasum, empty abomasum and respiratory tract. Bezerra et al.[8], evaluating non-carcass components of goats fed on caatinga pasture and Al-Owaimer et al.[3], in a study carried out in Saudi Arabia, with the objective of evaluating the growth of body components of native goats at different slaughter weights, observed that with increasing animal weight, heavier non-edible carcass components were obtained, confirming the mobilization of nutrients to these organs, a case that occurred partially in the present study. As in a research carried out by Souza et al.[32], when they observed differences in the gastrointestinal tract weight when cactus pear was included in the diet for lambs. This indicates that supplementation can have positive effects on digestion and consequent increase in food absorption, favoring a greater nutritional input.

As for the yield of non-carcass components, a linear and negative effect was found for the yield of the empty omasum and the respiratory tract, and the other organs were not influenced by supplementation considering their yields in relation to slaughter weight, showing that nutrient mobilization to these components was not proportional compared to the carcass, decreasing and/or maintaining their participation in percentage terms in relation to slaughter weight. Different results were obtained by Al-Owaimer et al.[3] and also by Ozcan et al.[21], who evaluated the carcass of goats native to Turkey at 4 months of age in semi-intensive and extensive systems, obtaining higher yields for respiratory tract and liver in animals kept in a system that provided concentrate (semi-intensive) when compared to the extensive system. Alexandre et al.[2] studied the effect of the food system (direct grazing, or confined and fed on forage) with supplementation on the production, carcass traits and composition of goats native to the Caribbean with an average weight between 20 and 21 kg, and reported no difference for weight and yield of the empty gastrointestinal tract, respiratory tract, kidney and heart.

The liver is used to measure the animal metabolic rate, with a linear and positive effect on weight and no effect of supplementation on yield, showing that the increase in the metabolic rate was not proportional, in percentage terms, to animal growth. Gebru[14] studied the effect of supplementation with two ingredients (alfalfa hay and sesame cake) on the carcass and non-carcass components of goats native to Ethiopia, with four supplementation levels for each ingredient (Alfalfa hay: 0.0 g; 105 g; 126 g and 147 g DM/goat/day and sesame cake: 0.0 g; 105 g; 84 g and 63 g DM/goat/day), and found a positive effect of supplementation with the two ingredients on liver weight and performance.

Conclusion

The use of concentrate supplementation for F1 goats (Boer x non-descript breed) kept on caatinga pasture in the enriched with signal grass resulted in higher carcass weight and yield, with the supplementation level of 1.5% showing the best results. As well as positively influencing most non- carcass components.

Conflict of interest

The authors declare no conflict of interest.

Authors' contributions

Conceptualization: J. F. P. Gama, J. M. Pereira Filho, G. V. do Nascimento; M. F. Cezar; *Methodology*: J. F. P. Gama, J. M. Pereira Filho, M. F. Cezar; *Investigation*: J. F. P. Gama, J. M. Pereira Filho, G. V. do Nascimento; *Data curation*: J. F. P. Gama, J. M. Pereira Filho; *Supervision*: J. M. Pereira Filho, M. F. Cezar; *Funding acquisition*: J. M. Pereira Filho, M. F. Cezar; *Project administration*: J. M. Pereira Filho, M. F. Cezar; *Formal Analysis*: J. M. Pereira Filho, J. F. P. Gama; *Writing (original draft)*: J. F. P. Gama, J. M. Pereira Filho, M. F. Cezar; *Writing (rewiew & editing)*: J. F. P. Gama, J. M. Pereira Filho, G. V. do Nascimento, S. Gonzaga Neto, R. M. dos S. Pessoa, J. M. de S. Ferreira, M. A. Cordão; *Resources*: J. M. Pereira Filho, M. F. Cezar; *Validation*: J. F. P. Gama, J. M. Pereira Filho, M. F. Cezar, S. Gonzaga Neto.

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