Archivos Latinoamericanos de Producción Animal. Volumen 24(3):2016

Performance of goats and sheep grazing in Brazilian semi-arid scrubland supplemented with feed-blocks

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Abstract The performance of four types of animals (two ovine and two caprine) was evaluated under grazing/browsing in Brazilian Caatinga scrubland, with *ad libitum* feed-block supplementation. Forty non-castrated males with an initial body weight of 19.3 ± 1.9 kg were used: 20 goats (10 Savanna x local undefined breed [LUB]) and 10 Boer x LUB and 20 sheep (10 Santa-Inês x local undefined hair sheep [LUHS]) breed and 10 Dorper x LUHS. The experimental design was completely randomized blocks with four treatments and ten replications. The genotypes were compared based on growth performance and carcass characteristics. The ½ Dorper sheep had a better productive performance than the ½ Santa-Inês sheep. For goats, the ½ Boer was superior to ½ Savanna in daily gain and final body weight (P>0.05). The ½ Dorper sheep gave the best carcass characteristics of all genotypes studied. In conclusion, the Dorper (sheep) and Boer (goats) are the genotypes recommended for crossing with local animals of undefined breeds to provide animals for finishing under grazing/browsing conditions in the Caatinga ecosystem of northeast Brazil with feed-block supplementation.

Key words: Caatinga, Carcass, Genotypes, Growth, Rangeland

Desempenho de cabras e ovelhas pastando no cerrado semi-árido brasileiro suplementado com blocos multinutricionais

Resumo Objetou-se avaliar o desempenho produtivo de quarto cruzamentos, sendo dois de caprinos e dois de ovinos suplementados *ad libitum* com blocos multinutricionais em sistema de pastoreio em pastagem nativa na Caatinga. Foram utilizados 40 animais não-castrados com peso inicial de 19.3± 1.9 kg, sendo 20 caprinos (10 ½ Savanna x ½ sem raca definida e 10 Boer x ½ sem raca definida) e 20 ovinos (10 ½ Santa Ines x ½ sem raca definida e 10 Dorper x sem raca definida). O delineamento utilizado foi o de blocos casualizados com quatro tratamentos e dez repetições. O ½ Dorper teve melhor desempenho produtivos que o ½ Santa-Inês. Para os caprinos o ½ Boer apresentou maior ganho de peso e peso final que o ½ Savanna (P>0.05). O ½ Dorper obtive a melhor carcaça entre os genótipos estudados. Se conclui que o Dorper para ovinos e o Boer para caprinos são os genótipos recomendados para cruza com animais sem raça definida quando o objetivo da criação e a terminação destes animais em sistema de pastoreio na Caatinga suplementados com blocos multinutricionais.

Palavras-chave: Caatinga, Carcaça, Crecimento, Genotipo, Pastagens

Introduction

The Caatinga ecosystem is a dry woodland, characterized by thorny and deciduous shrubs distributed in nearly 20% of Brazil's land area; nine states make up the geopolitical region commonly called the "Sertões". As this ecosystem has a limited availability of forage (400 kg dry matter year^{-1}), it is primarily used as rangeland by small ruminants, especially goats and sheep.

The seasonality of precipitation and drought conditions in the Caatinga results in an accentuated drop in the quantity and quality of the forage available for grazing. The ranchers often use feed

Recibido: 2015-10-30. Aceptado: 2016-03-10

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supplementation to promote animal performance and profitability of the livestock systems.

Supplemented feeding of animals in grazing systems, has been studied and techniques created or adapted for use in the Caatinga; among which is found the feed-block, a technology widely used by ranchers in the world's dry lands (Makkar, 2007)."

Most of the previous experiments with goats and sheep in Brazil were conducted with pure breeds; however, this scenario is contrary to the reality of the small family farmers, who generally cross pure males with females of local undefined breed (LUB) of goats and local undefined hair sheep (LUHS).

Another concern of Brazilian ranchers is to identify the genotypes of sheep and goats that will be most productive when animals are finished on native rangeland in the semi-arid region (Caatinga) of northeast Brazil. Currently, consensus does not exist between researchers and ranchers about which genotype is most efficient and productive. For example, some researchers and ranchers believe that native animals are more adapted to the region, and therefore more productive. Others believe that the exotic animals offer better phenotypic characteristics (size, weight, etc.) that will promote a better performance, especially in the finishing phase.

The present experiment evaluated the performance of two ovine and two caprine crossbred genotypes commonly utilized in Brazil and supplemented with feed block while grazing/ browsing under Brazilian Caatinga scrubland conditions.

Materials and Methods

The experiment was conducted from March to April 2014, in an area with vegetation characteristic of the Caatinga ecosystem, Paraiba State, northeast Brazil (Velloso *et al.* 2002). According to Köppen, this region is Bsh semiarid with the rainy season defined from January to June (Cunha *et al.* 2008). Precipitation during the experimental period totaled 33.8 mm and the average daily maximum and minimum temperatures were 27.5ºC and 21.3ºC.

The experimental area was rested for four years before the experiment. This site has as dominant vegetation shrubs/trees and annual forbs and grasses, including several species with forage value. The area was divided into four paddocks of 12.5 ha each, to be used in determining four experimental treatments. The paddock size was determined by the forage available and calculated to allow use of 60% of the initial forage available (Araujo Filho, 1987).

The forage available was measured three times during the experimental period (rainy, transition, and dry seasons) according to methodology described by Araujo Filho (1987), using for sampling an iron rectangle with 1.0 x 0.25 m dimensions. Samples were taken in transects of North South, East, and West directions starting at the central point of the paddock.

The vegetation samples were separated into shrubs (which we considered as forage up to 1.6 m in height), grasses and forbs. The collected fractions were dried and weighed to determine the forage dry matter production (DM kg ha^{-1}).

Another sample was collected and taken to the laboratory for determination of 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 Queiroz and Silva (2002).

The feed blocks had the following composition: 31% molasses, 5% urea, 18% ground corn, 4% soybean, 5% salt, 9% hydrated lime and 26% by-product malt. The procedure for the feed block manufacture was described by Allen (2007).

Forty non-castrated 5-mo old male animals were utilized: 20 goats and 20 sheep with initial body weight (BW) between 18 and 20 kg. The animals were distributed in the paddocks according to each treatment (genotype): T1 (½ Boer/½ LUB), T2 (½ Savana/½ LUB), T3 (½ Santa Inês/½ LUHS), and T4 (½ Dorper/½ LUHS). In each paddock water and a feed block were available to the animals.

Feed block intake was determined by weekly weighing of the blocks offered and their remnants.

On the initial day of the experiment the animals were weighed after a feed and water fast of 18 h, then placed in their respective paddocks by treatment. After 60 d, the animals were again fasted for 18 h and weighed prior to slaughter. The slaughtered animals were eviscerated to obtain the carcass (Cézar and Sousa, 2007). The carcass and the internal organs were weighed, measured for pH and then placed in a freezing chamber (4°C), where they remained suspended by the leg tendons for 24 h. The carcasses were then re-weighed and measured according to methodology described by Cézar and Sousa, (2007).

The carcasses were classified using methodology described by Cézar and Sousa, (2007). The scale used to evaluate conformation of the leg ranges from 1: super convex (very wide and muscular) to 5: sub-concave (not very muscular).

The area of the *Longissimus dorsi* (AOL) was measured according to methodology described by Moron-Fuenmayor and Clavero (1999). The carcasses were cut between the 12th and 13th rib and with a plastic template grid the area represented by one-tenth of a square inch (0.65 cm^2) was measured.

The quality characteristics marbling, color of the muscle and texture of the meat from the *Longissimus dorsi* muscle were measured according to Savel and Smith (2000). The determination of muscle quality depends in part on its color which is expressed on a scale from 1: dark purple to 8: very light cherry red. The scale-determining texture of muscle ranges from 1: very coarse to 7: very fine. Marbling is scaled from 1: practically none to 9: abundant.

The experiment was of complete randomized blocks design, including the four genotypes (treatments) with 10 replications (animals per treatment). The data were subjected to analysis of variance and the means were compared by Tukey test ($P<0.05$).

Results and Discussion

Table 1 shows the forage available during the experimental period. The difference between seasons was marked; during the rainy season there was 34% more forage available than in the dry season. Forage availability during the transitional period (intermediate-time between dry and rainy seasons) decreased gradually.

Araujo Filho and Carvalho (1997) reported Caatinga scrubland available forage figures of 1.905 kg ha^{-1} in the dry season and 3.598 kg ha^{-1} in the rainy season. The reason for those higher estimates was that those authors included the litter for calculating the biomass total.

Another contributing factor for this difference was a low level of precipitation during the present experiment, which was intended to be carried out during a drought year, defined as one in which the precipitation observed is 75% below the long-term average (SRM, 1989).

In Table 1 the forage available to goats and sheep is separated into three phenological phases. The biomass available per animal was greater than that required according to NRC (2007) for moderate daily weight gain of 0.65 kg DM d^{-1} for goats and 0.77 kg DM d^{-1} for sheep.

Despite a reasonable level of forage DM being available, there was insufficient nutrient availability. The protein content of the forage (Table 2) of 52.37 g kg^{-1} DM^{-1}, was not high enough to supply the daily nutritional requirement set by NRC (2007) for moderate weight gain in small ruminants of 18 kg BW as 78 g CP d^{-1} for sheep and 127 g CP d^{-1} for goats.

Animal species affected all of the performance characteristics (Table 3). The genotypes Dorper/LUHS and Boer/LUB reached a final BW higher than those of the other genotypes studied ($P<0.05$) due to both higher initial BW and greater rate of weight gain. Sousa *et al.* (2011) and Cartaxo and Souza. (2008) obtained similar results with animals in feedlots. The potential use of these crossbreeds in both extensive and intensive systems in the Caatinga is suggested.

The genotype Boer/LUB also showed the highest daily supplement intake and feed supplement/gain ratio ($P<0.05$). The results suggest

Table 1. Biomass total and biomass available per animal with contributing vegetative components* in the Caatinga ecosystem – Paraiba state – Brazil (kg DM ha^{-1}).

Season	Shrubs (kg)	(%)	Grass (kg)	(%)	Forbs (kg)	(%)	Total (kg)
			Dry matter available				
Rainy	91.27	8.9	159.54	15.7	765.10	75.3	1015.98
Transition	58.72	6.2	169.52	17.8	723.36	76.0	951.67
Dry	144.86	21.6	59.01	8.8	466.43	69.6	670.35
			Dry matter available per animal-day				
Rainy	0.24		0.43		2.052		2.724
Transition	0.13		0.40		1.680		2.205
Dry	0.29		0.12		0.66		1.343

* The methodology counted as forage available only plants with leaves located below 1.60 m height.

Table 2. Nutritional composition* by vegetation type (grass, forbs, and shrubs)** and of the supplemental feed blocks

Nutritional composition (g/kg)	DM	MM	OM	CP	NDF	ADF
Vegetation						
Grass	79.70	6.12	93.88	22.9	77.50	56.75
Forbs	74.80	4.16	95.84	43.6	76.00	61.03
Scrubs	57.68	5.31	94.69	90.6	55.91	42.65
Annual average	70.73	5.20	94.69	52.37	69.80	53.48
Feed blocks	909.3	708.1	2919	285.9	266.2	86.0

*Percentage in the dry matter
** The vegetation chemical composition represents the average of the whole grazed area.

that these animals spend less time grazing than those of the Santa Inês/LUHS, Dorpler/LUHS, and Savana/LUB genotypes.

Raising animals in grazing systems rather than feedlots is usually less expensive, but these savings can be reduced or disappear if the animals spend too much time feeding on the supplement (Silva *et al*, 1998)

Dantas *et al.* (2008), evaluated the performance of Santa Inês sheep with three levels of grain supplementation (0.5, 1.0 and 1.5% of BW daily) and obtained lower daily gains than in the present study, regardless of the level of supplementation.

There is scarce information about Boer goat performance in grazing systems, especially in rangelands. Silva *et al.* (1998) reported a final BW of 26.97 kg with grain supplementation (using 1% of BW daily) in the Caatinga grazing system. However, the forage available at the site of that study was inferior to that observed in the present case.

The results of the aforementioned studies, suggest that the feed blocks are better than traditional supplementation (ground grains) for small ruminants in the Caatinga, considering that they do not allow excessive daily intake of the feed supplement and because they release nutrients in smaller intakes over the full day.

There were no differences among genotypes in pH and temperature in the muscle at the time of slaughter (P>0.05) (Table 4). These results are similar to those reported by Bonagurio *et al.* (2003) for Santa Inês sheep, by Costa *et al.*, (2012) for Dorper x Santa Inês sheep, and by Madruga *et al.* (2005) for Boer goats.

The pH of the carcasses of all genotypes was 5.99 or below, indicating a favorable range to promote the

Table 3. Performance of sheep and goats by genotype under a grazing/browsing system supplemented with feed blocks in the Caatinga ecosystem – Brazil.

	Sheep		Goats	
	½ Santa Inês	½ Dorper	½ Savana	½ Boer
Initial BW (kg)	17.80	19.35	17.65	19.25
Final BW (kg)	26.16 bc	29.94 a	23.78 c	27.24 ab
Total weight gain (kg)	**8.36 b**	**10.29 a**	**6.28 c**	**7.99 b**
Daily gain (g)	100 b	133 a	81 c	103 b
Daily supplement intake (g)	239.91 bc	151.6 a	188.6 b	281.5 c
Feed supplement: gain (ratio)	2.39 b	1.13 a	2.32 b	2.73 c

Means followed by the same letters are not significantly different (P≤0.05).

Table 4. pH and muscle temperature at slaughter and of the chilled carcass of sheep and goats of four genotypes under a grazing/browsing system supplemented with feed blocks in the Caatinga ecosystem - Brazil.

	Sheep		Goats	
	½ Santa Inês	½ Dorper	½ Savana	½ Boer
At slaughter				
pH	6.62	6.71	6.91	6.86
Temperature (º C)	32.2	34.4	32.1	32.0
Carcass				
pH	5.75	5.8	5.73	5.91
Temperature (º C)	6.2 c	4.8 a	5.5 ab	5.1 bc

a, b, c, Means followed by the same letters are not significantly different (P≤0.05).

calpain and cathepsin activities, resulting in better meat taste. Hoffman and Wiklund (2006) affirm that several factors can influence the carcass pH, including the genotype and diet. However, neither of these two factors affected the pH of the carcasses in the present study (P>0.05).

The carcasses (Table 4) of the genotypes Dorper/LUHS and Savana/LUB showed the lowest temperatures when evaluated after chilling. It is noteworthy that the rate of reduction of temperature in the carcass can result in sensible differences in the color, texture and succulence of the meat (Bressan *et al.*, 2004).

Table 5 shows the carcass characteristics of sheep and goats of the four genotypes studied. For most of the variables under study, the Dorper/LUHS showed a better performance than the other genotypes. However, only the empty body weight, hot and cold carcass weights, and rib eye area were statistically different (P<0.05). Weights of the empty body and cold carcass of Boer/LUB and Dorper/LUHS were statically similar (P>0.05).

A greater total loss of weight in the carcass (Table 5) of the Dorper/LUHS could be caused by a low proportion of accumulated, fat covering the carcass. Sobrinho *et al.* (2010) affirm that the fat covering provides protection to the carcass during the freezing period, reducing the loss of water.

Generally, the sheep had larger loin eye area than the goats (P< 0.05) (Table 5), which confirms the report by Sen *et al.* (2004), that goat carcasses have a lower proportion of superior meat cuts (Premier) than do sheep. The current environment of the meat trade for small ruminants in Brazil encourages producers to produce premium grade meat including special cuts. This is a factor to consider when establishing a system of meat production.

Table 6 shows the carcass classification of the sheep and goats under a grazing/browsing system

Table 5. Carcass characteristics of sheep and goats of four genotypes under a grazing/browsing system supplemented with feed blocks in the Caatinga ecosystem - Brazil.

Item	Sheep		Goats	
	½ Santa Inês	½ Dorper	½ Savana	½ Boer
Empty body weight (kg)	23.76 bc	27.37 a	21.43 c	24.60 ab
Hot carcass wt (kg)	11.77 bc	14.18 a	12.61 ab	10.84 b
Carcass dressing (%)	55.00	53.85	55.54	54.73
Cold carcass wt, (kg)	11.61 bc	13.57 a	10.58 c	12.33 ab
Cold carcass yield (%)	44.41	45.16	44.36	45.24
Cooling loss (kg)	0.16	0.61	0.26	0.28
Total Loss (%)	1.31	3.59	2.42	2.21
Real yield (%)	45.00	47.15	45.46	46.27
Biological yield (%)	49.53	51.57	50.44	54.24
Commercial yield (%)	44.41	45.16	44.36	45.24
Loin eye area (cm^2)	12.09 ab	14.12 a	10.09 b	9.86 b

a, b, c Means followed by the same letters are not significantly different (P≤0.05).

supplemented with feed blocks in the Caatinga ecosystem--Brazil. The two sheep genotypes gave superior results to those of the goats in carcass conformation, dressing yield and muscle texture quality (P<0.05). There are few published reports comparing carcass classification between these two species of small ruminants. However, Casey (1992) demonstrates that African native goat kids have a total fat content in the carcass higher than that of African native sheep.

Pereira (1996) stated that local Brazilian goats usually have a higher proportion of bone in the carcass than Brazilian native lambs.

The genotype Dorper/LUHS was superior to the other three (P>0.05) in carcass conformation, dressing yield, kidney fat, and meat marbling (Table 6), but was similar to the Boer/LUB in fat thickness and grade (GR). This latter result contradicts the findings of Sousa *et al.*, (2011) and Tshabalala *et al.*, (2003), that sheep have higher fat thickness in the carcass than goats.

Fat accumulation can be considered from two perspectives. For Costa *et al.*, (2012) an excessive fat proportion in the carcass is not a characteristic desired by consumers. In contrast, Silva *et al.* (1998) affirm that a high fat content in the body favors the survival of animals during long drought periods of poor nutrition. Crossbred animals of the type studied could produce small ruminant meat of a quality suitable for meat boutiques in Brazil.

Table 6. Carcass classification of sheep and goats of four genotypes under grazing/browsing system supplemented with feed blocks in the Caatinga ecosystem - Brazil

	Sheep		Goats	
Item	½ Santa Inês	½ Dorper	½ Savana	½ Boer
Carcass conformation	2.4 b	3.67 a	1.85 c	2.13 bc
Dressing yield	2.25 b	3.33 a	1.10 c	1.26 c
kidney fat	1.51 b	2.33 a	1.18 c	1.65 b
Fat thickness, mm	1.00 b	1.83 a	1.51 a	1.61 a
Muscle texture	4.48 a	4.56 a	4.14 b	4.25 b
Meat marbling	0.51 bc	1.27 a	0.22 c	0.85 b
Meat color	4.25	4.31	4.28	4.12
GR	6.61 b	9.01 a	6.82 b	8.41 a

a,b, c,Means followed by the same letters are not significantly different (P≤0.05).

Conclusion

The Dorper (sheep) and Boer (goats) are the genotypes recommended for crossing with animals of local undefined breeds for meat production with finishing under grazing/browsing with feed block supplementation in the Caatinga ecosystem of northeastern Brazil.

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