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Evaluation of production systems and economic analysis of baby goats raised in the semiarid region of Paraíba

Avaliação de sistemas de produção e análise econômica de cabritos lactentes criados na região semiárida da Paraíba

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ABSTRACT: The objective of this study was to evaluate the performance and economic indicators of baby goats region submitted to different feeding systems in the Semiarid. A total of 30 baby goats of breed Parda Alpina × without defined racial pattern (SPRD) with initial weight of 3.35 kg ± 0.65 kg and final weight of 12.3 kg ± 0.5 kg were used, distributed in a completely randomized design in three breastfeeding systems with ten replicates each: traditional system (with natural breastfeeding), intensive breastfeeding system without concentrated supplementation, and intensive breastfeeding with concentrated supplementation. Goats submitted to the intensive artificial feeding system without concentrated supplementation showed a similar weight gain (121 g/day) when compared to the goats submitted to the system of suckling with concentrated supplementation (126 g/day). The highest income was provided by the animals submitted to the intensive system of suckling with concentrate. The gross margin for the two centenarians was positive, that is, revenues are higher than the effective operating cost, allowing us to conclude that the activity is paying off and will survive, at least in the short term. The diet of kids using concentrate provided better dry matter intake, greater weight gain and consequently presented better economic indicators.

KEY WORDS: weaning; goat breeding; meat production.

RESUMO: Objetivou-se avaliar o desempenho e indicadores econômicos de cabritos mamão submetidos a diferentes sistemas de alimentação na região semiárida. Foram utilizados 30 cabritos da raça Parda Alpina × sem padrão racial definido (SPRD) com peso inicial de 3,35 kg ± 0,65 kg e peso final de 12,3 kg ± 0,5 kg, distribuídos em delineamento inteiramente casualizado em três sistemas de aleitamento com dez repetições cada: sistema tradicional (com aleitamento natural), sistema intensivo de aleitamento artificial sem suplementação concentrada, e sistema intensivo de aleitamento artificial com suplementação concentrada. Os cabritos submetidos ao sistema intensivo de aleitamento artificial sem suplementação concentrada destacaram-se por apresentarem similar ganho de peso (121 g/dia) quando comparados aos cabritos submetidos ao sistema de aleitamento com suplementação concentrada (126 g/dia). A maior receita foi proporcionada pelos os animais submetidos ao sistema intensivo de aleitamento com concentrado. A margem bruta para os dois centenários foi positiva, ou seja, as receitas são superiores ao custo operacional efetivo, permitindo concluir que a atividade está se remunerando e sobreviverá, pelo menos em curto prazo. O sistema de alimentação de cabritos com uso de concentrado proporcionou melhor consumo de matéria seca, maior ganho de peso e consequentemente apresentou melhores indicadores econômicos.

PALAVRAS-CHAVE: desmame; caprinocultura; produção de carne.

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INTRODUCTION

Goat farming is one of the main livestock activities practiced in arid and semi-arid areas of the planet, given its economic and socio-cultural importance. In Brazil, according to IBGE (2017) 94% of goat herds are concentrated in the Northeast region, such volume is justified by the easy adaptation of these animals to edaphoclimatic conditions in the region. Likewise, dairy goat farming in the Semiarid region has significantly increased its participation in the Brazilian agricultural scenario, overcoming the constant challenge of conquering and maintaining new markets for goat's milk and its derivatives (SILVA, GUIMARÃES; OLIVEIRA., 2012).

The state of Paraíba is the largest producer of goat milk in Brazil, reaching 5.6 million liters per year (IBGE, 2017). In this context, much of the state's goat milk production still comes from family establishments, where the activity has a low production scale and little profit margin per liter of milk, making it, therefore, necessary to supplement the producer's income with other businesses or products (DAL MONTE et al., 2010). The production of "suckling goat" or "baby goat" is a viable alternative for adding another source of income to small and medium-sized goats, bearing in mind that goat meat has great acceptance by the consumer market and high added value to the product.

The goat breeding strategy has been investigated mainly for the rearing stages, evaluating supplementation strategies on pasture, in confinement or with supplementation (HAYES; LOURENÇON; BROWNING JR, 2019; PEREIRA et al., 2019; HTOO et al., 2018), however, few studies have been conducted with in order to evaluate strategies for baby goats in a semi-arid region favoring weight gain and age at slaughter with reduced production costs.

In general, the baby goat corresponds to the young animal, less than 90 days old and with a carcass weight of less than 12 kg. Such production is very similar to which is made with bovine calf, in which animals are raised predominantly on a liquid diet and slaughtered at a young age. The use of these animals for meat production is a widespread practice on the European market, especially in the coastal countries of the Mediterranean (MOUSQUER et al., 2013).

In the Semiarid region, the literature reports that there is a tendency for two types of management of dairy goat rearing, semi-intensive and intensive, as found by Diniz et al. (2014) and Aquino et al. (2016) in Pernambuco, Cardoso; Dantas; Felix (2010) in Rio Grande do Norte and Costa et al. (2008) in Paraíba. However, with regard to the management of the baby goats, semi-intensive systems are characterized by the creation of animals in part time next to the goats, breastfeeding them naturally; and in intensive systems, kids are prematurely separated from their dams and raised artificially to replace milk.

Different systems for raising goats can be used to reduce the costs of feeding and handling the young, providing the producer with a greater supply of goat milk marketable during the year and of baby goat meat.

Therefore, the objective was to evaluate the performance and economic indicators of baby goats in a semiarid region submitted to different feeding systems.

MATERIAL AND METHODS

The study protocol for this research was approved by the Ethics Committee on the Use of Animals at the Federal University of Paraíba (CEUA nº 0203/13).

The experiment was carried out simultaneously on two properties with different management systems, both located in the Semiarid region of the state of Paraíba, Brazil. In the first property, characterized as a traditional farm, located in the geographical coordinates (7° 37'8002 "S and 36° 52'1198" W), altitude 458 m and average temperature of 24 °C, having as main economic activity the dairy goat. The second area, characterized as an intensified production system, located at the Experimental Station of Pendência, belonging to the State Agricultural Research Corporation of Paraíba (EMEPA-PB), located at the geographical coordinates with latitude of 7° 8' 18"S and 36° 27' 2"W, with an altitude of 534 m and an average temperature of 30 °C.

In a homogeneous herd, 30 male newborn goats (10 per treatment) were selected, whole, with initial weight of 3.35 kg ± 0.65 kg, crossbred Parda Alpina x breed without defined racial pattern (SPRD). All kids received their first maternal care after birth, with colostrum provided naturally in the first 24 hours of life, and were then weighed and identified numerically with earrings. Subsequently, they were distributed equally in three groups, with 10 animals each. Each group constitutes a treatment or breeding system: traditional system - ST, intensive lactation system without concentrate - IS and intensive lactation system with concentrate - IS + C. In all systems the kids had an unrestricted access to drinking water and salt lick.

The traditional system (TS) was constituted by a semi-intensive system with natural breastfeeding using the residual milk left after the daily morning milking, not being weaned until slaughter. The baby goats together with their dams had free access to a pasture with buffel grass (*Cenchrus ciliaris* L.) containing 5% Crude Protein (PB), not being weaned until slaughter remaining with the goats until late afternoon, and during the night they remained separated in a stall collective.

In the intensive lactation system without concentrate (IS), the goats received pasteurized bovine milk at a temperature of approximately 38 °C twice a day, at 7:30 am and 3:30 pm, in graduated trough type drip. The supply was carried out individually, with each animal receiving the total daily volume corresponding to 20% of its live weight, this offer being adjusted every 7 days up to a total of 1.5 l of milk per day. The kids also received roughage supplementation after

the second week of life, consisting of chopped Tifton grass hay (9.4% CP) *ad libitum* in trough.

In the intensive lactation system with concentrate (IS+C), the lactation of the goats kids occurred in the same way as described in the IS. However, the feeding differed in terms of supplementation, in which in addition to Tifton grass hay supplied at will, the kids also received a specific commercial pelletized concentrate for kids containing 22% crude protein (CP), the same being gradually offered up to the maximum of 250 g/animal day.

Leftovers were collected daily in order to measure average daily consumption. Samples of all liquid and solid diets used in the different systems and leftovers were collected and analyzed. In roughage and concentrates, the contents of dry matter (DM), CP, Ash, ether extract (EE) were determined according to the methodology described by AOAC (1990), neutral detergent fiber and acid detergent fiber, according to the methodology described by Van Soest; Robertson; Lewis (1991). In goat's milk and cow's milk, the following parameters were analyzed: total dry extract and protein, lipids - Gerber method and lactose - Fehling Test method (ZENEBON; PASCUET; TIGLEA, 2005).

Animals were weighed at weekly intervals to measurements of the animals performance, calculating the total weight gain and average daily weight gain. The total weight gain was obtained through the difference between the final weight and the initial weight. The average daily weight gain was calculated by dividing the total weight gain by the number of days of the experiment. Feed conversion was calculated only for goats subjected to intensive feeding systems (lactation without concentrate and lactation with concentrate) since the consumption of DM was not estimated for kids submitted to the traditional system.

It was determined as a criterion for slaughter the animal body weight, when the animals reached a live weight above 12 kg, being subjected to previous fasting of solids and liquids for approximately 18 hours. All slaughter procedures were performed on the premises of the Pendência Experimental Station, following the rules of the technical Regulation for the Inspection of Products of Animal Origin (RISPOA) (BRASIL, 1997).

After stunting by cerebral concussion, the animals were suspended by their hind legs and then bleeding and skinning procedures were performed, the gastrointestinal contents, skin, head, legs and genitals being removed and weighed. Subsequently, weighing was performed to obtain the weight of the hot carcass (PCQ) and then the carcasses, protected with plastic, were transported to a cold room at 4 °C, where they were kept for 24 hours. Subsequently, the carcass was cut in half with the aid of an electric saw and in the left half-carcass and commercial cuts were made.

The economic analysis of the treatments was based on the calculation of the gross margin (GM), in which the gross revenue (GR) was generated from the sale of the meat produced, while the effective operating cost (EOC) comprised those referring to the food, labor and dewormer. The costs of feeding were obtained multiplying the unitary value of each input by the consumed quantity in each treatment, being presented the average values per animal. The prices were obtained by consulting buyers and suppliers in the region during the trial period.

To evaluate the economic analysis it was determined the gross margin (GM), the return tax (RT), leveling point (LP) and safe margin (SM), adapted from Hoffmann et al. (1987), considering EOC and GR as total cost and total return, in which:

GM = gross revenue (GR)-effective operating cost (EOC)
Return Tax = GM/EOC
Leveling Poin = EOC/meat price
Safe margin = (GR - EOC)/GR * 100

The data were submitted to analysis of variance, using the PROC GLM program of the Statistical Analysis System (SAS, 2001), the treatment averages were compared by the Tukey test at the 5% probability level.

RESULT AND DISCUSSION

The consumption and feed conversion comparison of the two intensive systems is presented in Table 1. The production system affected the performance of the goats evaluated in the present study. Although the goats started the research with similar initial weights, the goats that received supplementation showed a greater gain in daily weight (121 g/day) than those submitted to the traditional feeding system using residual milk from the milking of the goats (P = 0.041).

It is observed that the goats handled in the SI showed less feed conversion than the goats handled in the IS + C. This indicates that the goats handled in the IS were more efficient in transforming dry matter into body weight. Animals in this age group, due to the stage of ruminal development, have

Table 1. Dry matter consumption and feed conversion of baby goats submitted to intensive rearing systems

Variable	Breeding systems		P
	IS	IS+C	
DMC (g day-1)	219.1b	395.9a	0.001***
DMC (g $kg^{0,75}$)	34.74b	59.60a	0.001***
DMC (%PV)	3.09 b	5.73a	0.001***
FC (kg/kg)	1.74b	3.29a	0.001***

IS= feeding system without concentrate; IS+C = concentrate feeding system
DMC = dry matter consumption; FC = feed conversion
*** Means followed by different letters differ from each other by the Tukey test (P <0.05)

greater use of the liquid milk-based diet than the starch and protein of vegetable origin present in the concentrate, affecting the efficiency of digestion and absorption of nutrients. Thus, even when consuming a greater amount of dry matter from the increase promoted by the addition of concentrate, the supplemented animals presented a final weight similar (Table 2) to the weight of the animals without supplementation, affecting feed conversion.

The production system affected the performance of the goats evaluated in the present study (Table 2). Although the goats started the research with similar initial weights, the goats that received supplementation showed a better daily weight gain (121 g/day) than those submitted to the traditional feeding system with the use of residual milk from milking goats (P = 0.041).

For food supplementation systems with or without concentrate, bovine milk was used as a substitute for goat milk. The performance values suggest that the substitution of goat's milk did not compromise the weight gain of goats despite the greater average daily gain promoted by artificial feeding diets (103.26 g/day *vs* 120.89 and 126.23 g/day), however the experimental duration decreases by three weeks. Hassan et al. (2018) evaluated goat's milk substitutes in raising Shami kids, kids fed with milk substitutes had higher final live weight (14.22 ± 0.2 kg *vs* 15.19 ± 0.3 kg; P <0.01) and average daily gain (120 ± 2g/day *vs* 130 ± 3g/day) compared to animals on natural lactation. Strategies for the use of milk substitutes in goat farming are important to make the goat product more available to the market, since its economic value is greater, as suggested by Knupp et al. (2016).

However, when replacing the natural suckling of Alpine goats with a mixture of cheese whey, whey protein, beef tallow and coconut oil (18.5% DM, 23.5% EE and 23% CP), Piasentier et al. (2000) observed that animals submitted to natural sucking showed a lower age at slaughter (39 *vs* 43 days), greater daily weight gain (255 *vs* 220 g/day) and greater live weight at slaughter (14.15 *vs* 13.44 kg).

When slaughtering ages were evaluated, it was observed that animals submitted to food supplementation showed a lower age at slaughter, which possibly reduces costs related to facilities, management, labor, providing a greater efficiency of the production system.

Although the animals that received food supplementation with or without concentrate showed a similar age at slaughter and similar gain and weight, the same was not observed for the dry matter consumption values. The kids that did not receive concentrated supplementation consumed less DM (220 g/day) than the kids that received concentrate (396 g/day). Probably the effect of a higher consumption of DM in a greater gain in daily weight was not observed for the referred phase of development because the animals were slaughtered very early, between two or three months, a phase characterized by a relevant role of milk consumption.

In a similar study evaluating Pardo Alpino goats fed *ad libitum* or limited milk (1 kg/day) and with or without ad libitum supplement slaughtered at 10 or 13 weeks of age, Genandoy et al. (2002) observed a lower ADG for kids fed only restricted milk (55 and 49 g/day for animals slaughtered at 10 and 13 weeks of age, respectively; P <0.05), when compared to kids fed with other diets experimental. The authors reported similar ADG among animals slaughtered at 10 weeks fed with unrestricted milk and milk with supplement, however when the animals were slaughtered at 13 weeks, the diet of milk plus supplement provided greater weight gain (151,55 and 149g/day in 10 weeks and 110,49 and 144 g/day in 13 weeks for diets of unrestricted milk and supplemented milk, respectively).

It is noteworthy that in the present study the amount of bovine milk supplied was the same for both supplementation systems, which may justify the fact that similar performance values are observed. Said information should be evaluated with caution as the impact of concentrate consumption in this initial phase can affect the development of the rumen and consequently the performance of ruminants in more advanced stages of development (BALDWIN et al., 2004; JIAO et al., 2015).

The Table 3 shows that the highest costs were allocated to the feeding of the goats (56 and 58%) respectively of the total

Table 2. Performance of baby goats, depending on suckling systems

Breastfeeding System					
Variable	**TS**	**IS**	**IS+C**	**VC (%)**	**P**
Initial Weight	3.10	3.57	3.22	11.80	0.3330
Final Weight	12.74	11.70	12.51	11.16	0.2335
ED (days)	95.10a	67.2b	73.8b	7.88	0.001***
TWG (kg)	9.64	8.14	9.29	16.59	0.0885
DWG (g/day)	103.26b	120.89ab	126.23a	17.57	0.0407*

* Means followed by different letters differ by the Tukey test (P <0.05) ** (P <0.01) *** (P <0.001)
ED = experimental days; TWG= total weight gain in the period; DWG = average daily weight gain.
VC = variation coeficiente

Table 3. Breakdown of production costs for the purchase of animals, food, labor, dewormer and slaughter

Item (R$)	IS		IS+C	
	R$	U$$	R$	U$$
Cost of labor	408.90	173.78	408.90	173.78
Purchase of animals	150.00	63.75	150.00	63.75
Cost with feeding	930.00	395.24	1000	424.99
Cost of Medicine	23.42	9.95	17.18	7.30
Cost of equipment	75.00	31.87	75.00	31.87
Energy	15.00	6.37	15.00	6.37
Fuel/GLP	34.50	14.66	34.50	14.66
Others	17.88	7.60	21.12	8.98
EOC*	1654.70	703.23	1721.70	731.70

*EOC=Effective operating cost
Considering U$$ 1.00 = R$ 2.353 Dollar value in the experimental period

Table 4. Revenue obtained from the sale of the entire carcass (Scenario A) and aggregation of values- skin and non-constituents of the carcass (Scenario B) of hand-fed kids raised in different feeding systems

		Systems	
		IS	IS+C
Scenario (A)			
Whole carcass (kg)	Quantity (kg)	41.56	45.45
	Prince (U$$)	10.62	10.62
Non-carcass constituents	Quantity (kg)	17.55	19.30
	Prince (U$$)	3.61	3.61
Skin	Quantity (unity)	7.65	7.65
	Prince (U$$)	2.12	2.12
Gross Revenue A (U$$)		1226.49	1338.70
Scenario (B)			
Leg (kg)	Quantity (kg)	13.03	14.23
	Prince (U$$)	17.00	17.00
Rib (kg)	Quantity (kg)	11.03	12.75
	Prince (U$$)	10.62	10.62
Shoulder (kg)	Quantity (unity)	8.60	9.22
	Prince (U$$)	14.87	11.47
Loin (kg)	Quantity (kg)	4.73	5.11
	Prince (U$$)	23.37	23.37
Neck (kg)	Quantity (kg)	2.83	2.98
	Prince (U$$)	8.50	8.50
Skin	Quantity (unity)	7.65	7.65
	Prince (U$$)	2.12	2.12
Non-carcass constituents	Quantity (kg)	17.55	19.30
	Prince (U$$)	3.61	3.61
Gross Revenue B (U$$)		1602.39	1679.55

costs. An alternative to reduce food costs is the production of quality fodder as well as the use of commercial substitutes to reduce the costs with concentrates and milk.

Hassan et al. (2018) observed that the artificial breast-feeding system promoted greater profitability when compared to the system of natural suckling of goats (U$$ 315.53 *vs* U$$ 991.69). The authors associated the economic success obtained in the artificial feeding system with the increase in production of marketable milk by about 103.23 kg/goat more than the natural suction system during the trial period.

Lama et al. (2013) evaluated the economic performance of Criollo goats under three different systems (suckling by goats until weaning at 30 and 45 days of age and artificially raised with milk substitute until 45 days of age, receiving alfalfa hay and ground corn) and slaughtered at two different ages (60 and 90 days). The authors observed that the natural systems of rearing showed low values of gross return, however the price of the milk substitute must not exceed 20% of the value of the meat for the artificial rearing to become economically viable. It was also found that it is more economically viable for animals to be slaughtered after 90 days.

It is possible to observe the revenues obtained in two marketing scenarios generated in the different goat production systems in Table 4. In scenario A, there is a higher revenue generated by the animals submitted to the intensive lactation system with concentrate, providing an increase of 9.13% in total revenue. This increase can be justified because the animals from IS+C produced 9.16 kg of carcass than those from IS, generating an amount of U$$ 97.32 in the final revenue. As well as for scenario B with aggregation of values, IS+C generated an income of U$$ 77.16 higher than IS.

When comparing the marketing scenarios of the goats, it is observed that the IS in scenario B had higher income (U$$ 341.90) and (U$$ 341.04) for IS+C, providing an increase in income of 30.6 and 25.47% respectively.

The valuation of a carcass depends, among other factors, on the body weight: age of slaughter ratio, whose objective is to obtain higher weights at younger ages, in order to meet the demands of the consumed market. The efficient production of goat meat must be based on the system in which animals, in a short time and at reduced costs, produce carcasses that can be sold at high prices (PEREIRA et al., 2010). The carcasses are marketed whole or in the form of cuts. Meat cuts vary from region to region and, mainly, between countries, as a result of the habit of its consumers.

The Table 5 shows the production costs, revenue and economic indicators of the goat feeding systems. The value of the effective operating cost (COE), which shows how much resource is being diverted to cover expenses, showed a higher

Table 5. Economic indicators considering two production scenarios. (A = indicators for the sale of the entire carcass and B = commercial cuts, skin and non-constituents of the carcass)

Item	Scenarios	Systems	
		IS	IS+C
Effective Operating Cost (U$$)	A	703.23	731.70
	B	713.78	740.98
Gross Revenue (U$$)	A	1226.49	1338.70
	B	1602.39	1679.55
Gross Margin (U$$)	A	523.26	606.99
	B	888.61	936.87
Return Tax (U$$)	A	0.31	0.35
	B	0.53	0.54
Safe margin (%)	A	18.13	19.27
	B	23.57	24.64
Cost: benefit (U$$/day)	A	0.74	0.78
	B	0.95	0.96
Cost kg/carcass (U$$)	A	7.19	6.84

value for IS+C (U$$ 731.41), proving the importance of the participation of the cost of food.

The Gross Margin result for both scenarios was positive, that is, revenues are higher than the effective operating cost, allowing us to conclude that the activity is paying off and will survive, at least in the short term. These GM results also reflected in the rate of return (RT). For each U$$ 1.00 applied to scenario B, U$$ 1.18 return were obtained and U$$ 1.01 of scenario A in relation to IS and IS + C, respectively.

The Gross Margin result in both scenarios was positive, that is, the revenue is higher than the effective operating cost, allowing us to conclude that the activity is bearing fruit and will survive, at least in the short term. These GM results also reflected in the rate of return (RT). For each U $$ 1.00 applied to scenario B, returns of U $$ 1.18 were obtained and for scenario A, returns of U $$ 1.01 were obtained in relation to IS and IS + C, respectively.

As for the safety margin (SM) that represents how much sales may fall without the company incurring a loss, it is observed that it was higher for IS+C. This means that the market price per kg carcass and non-carcass constituents can depreciate up to 55.46 and 57.97% for IS and IS+C so that the systems continue to achieve profit.

It is observed that the cost-benefit ratio was higher for IS+C in both scenarios. For the carcass cost, the local market values in force in the experimental period (U$$ 7.02) were considered.

Knupp et al. (2016) found that the production of goats for slaughter is profitable and influenced by the sale price of the animals, the cost of the diet and the weight of the animals at slaughter. The same authors observed that bovine milk can and should be used in goat production systems as a way to cheapen the final product.

CONCLUSION

The feeding system of lactated goats supplemented with concentrate provided better consumption of dry matter, greater weight gain and better economic indicators.

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