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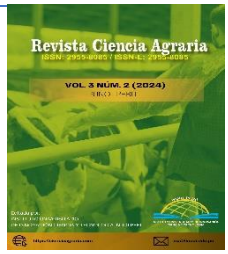

ORIGINAL ARTICLE

Comparative evaluation of the reproductive capacity of male goats in feedlot

Evaluación comparativa de la capacidad reproductiva de machos cabríos en confinamiento

Avaliação comparativa da capacidade reprodutiva de machos caprinos em confinamento

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KEYWORDS

goats, reproduction, reproductive efficiency, reproductive indices, selection.

ABSTRACT. The present work was carried out based on data and zootechnical records from a goat and sheep property in the city of Belo Jardim, Agreste of Pernambuco. With information on three male goats, data were obtained on the pregnant females and those that carried the pregnancy to term, in addition to live births and stillbirths. Based on this data, the Chi-square statistical analysis and Fisher's test were used to verify the reproductive efficiency of the male goat on the reproductive indices of the females, using the Systat 13 software. The results showed no significant differences between the evaluated males concerning their service capacity, according to the records of a breeding season during the years 2021, 2022, and 2023. This allowed the determination of the percentage of reproductive indices for each male and, with this, to proceed with selecting the most viable breeder for the herd or, if necessary, proceed with disposal. On the other hand, the equal environmental conditions for the males determined that only one showed significant results concerning the reproductive indices of the females. Meanwhile, significant differences were observed between the males during the breeding seasons of 2021 and 2023, but there was a significant effect among the males in the 2022 breeding season ($P<0.05$). Concluding that the evaluation of reproductive capacity and reproductive indices are important tools in the selection of breeding males.

PALABRAS CLAVE

caprinos, eficiencia reproductiva, índices

RESUMEN. El presente trabajo fue realizado con base en los datos y registros zootécnicos de una propiedad de caprinos y ovinos en la ciudad de Belo Jardim, Agreste de Pernambuco. Con la información sobre tres machos cabríos, se obtuvieron los datos de las hembras preñadas y aquellas que llevaron el embarazo a término, además de las crías nacidas vivas y mortinatos. A

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reproductivos, reproducción, selección.

partir de estos datos, se utilizó el análisis estadística Chi-cuadrado y el test de Fisher para la comprobación de la eficiencia reproductiva del macho cabrío sobre los índices reproductivos de las hembras, donde se utilizó el software Systat 13. En los resultados, no se observaron diferencias significativas entre los machos evaluados con respecto a su capacidad de servicio, según los registros de una estación reproductiva durante los años 2021, 2022 y 2023. Esto permitió determinar el porcentaje de los índices reproductivos de cada uno y, con eso, proceder seleccionar al reproductor más viable para el rebaño o si es necesario proceder al descarte. Por otro lado, las condiciones ambientales igualitarias, para los machos, determinaron que apenas uno demostró resultados significativos sobre los índices reproductivos de las hembras. Mientras que, se observaron diferencias significativas entre los machos en las estaciones reproductivas de 2021 y 2023, pero hubo efecto significativo entre los machos en la estación reproductiva de 2022 ($P<0.05$). Concluyendo que la evaluación de la capacidad reproductiva y los índices reproductivos son herramientas de gran importancia en la selección de machos reproductores.

PALAVRAS-CHAVE

caprinos, eficiência reprodutiva, índices reprodutivos, reprodução, seleção.

RESUMO. O presente trabalho foi realizado com base nos dados e registros zootécnicos de uma propriedade de caprinos e ovinos na cidade de Belo Jardim, Agreste de Pernambuco. Com as informações de três bodes, foram obtidos os dados das fêmeas prenhas e daquelas que levaram a gestação até o final, além das crias nascidas vivas e natimortos. A partir desses dados, utilizou-se a análise estatística do Qui-quadrado e o teste de Fisher para comprovar a eficiência reprodutiva do bode sobre os índices reprodutivos das fêmeas, onde foi utilizado o software Systat 13. Nos resultados, não foram observadas diferenças significativas entre os machos avaliados em relação à sua capacidade de serviço, segundo os registros de uma estação reprodutiva durante os anos de 2021, 2022 e 2023. Isso permitiu determinar a porcentagem dos índices reprodutivos de cada um e, com isso, proceder à seleção do reprodutor mais viável para o rebanho ou, se necessário, proceder ao descarte. Por outro lado, as condições ambientais igualitárias para os machos determinaram que apenas um apresentou resultados significativos sobre os índices reprodutivos das fêmeas. Enquanto isso, foram observadas diferenças significativas entre os machos nas estações reprodutivas de 2021 e 2023, mas houve efeito significativo entre os machos na estação reprodutiva de 2022 ($P<0.05$). Concluindo que a avaliação da capacidade reprodutiva e dos índices reprodutivos são ferramentas de grande importância na seleção de machos reprodutores.

1. INTRODUCTION

In the goats, just as in other mammals of zootechnical interest, the peak reproduction depends on internal fertilization of a female gamete (secondary ovocyte) by a male gamete (spermatozoid). Therefore, it is necessary that the male and female are in close contact and have a strong motivation to carry out copulation, that is, that the male has the ability to mount the female and that she is receptive (Fabre-Nys e Gelez, 2007; Da Silva, 2021ab).

The reproductive and service capacity of male goats is related to determinant parameters such as sexual behavior, spermatic quality, etc. (Cadena-Villegas et al., 2021).

The social environment of domestic goats, for the most part, is artificially controlled, that is, controlled by man (Silva et al., 2022). Nevertheless, aspects such as hierarchy and individual relationships can also have a direct and/or indirect effect on reproduction and sexual behavior in a way that is not controllable by men (Ungerfeld, 2021). That said, it is important to know the socio-sexual context considered normal for the species in which reproduction is inserted to understand the relationships of animals under controlled conditions, that is, animals in feedlot (Fabre-Nys, 2000; Schleske and Vásquez, 2014).

The sexual performance is generally referred to as the male goat's natural ability to massively mate a given number of females in a relatively short period of time (Robertson et al., 2020). This ability depends on the combination of sexual desire or motivation (libido), physical coordination, strength, endurance and nutritional

status of the animal (Fabre-Nys, 2000). A buck considered sterile is easily identified after mount, however, those who present reduced fertility cause serious problems and cause economic losses to breeders and the artificial insemination (AI) industry (Mocé et al., 2022).

The conducting behavioral observations in young male goats in goat herds can provide a basis for identifying and selecting males with greater sexual performance (Schleske and Vásquez, 2014). Additionally, the exposure of young males to females in estrus or heat tends to reduce the sexual performance problems and, thus, the efficiency of males in tests of service capacity can be improved, as occurs in other species, such as the bovine. A peremptory problem in different production systems is the inadequate selection of a male to be used as a breeder (Carneiro et al., 2023). Therefore, it is possible that when recording the libido or sexual motivation of males in goat production units, it will be possible to select animals that, after puberty, are possible breeders and successfully achieve sexual maturity, being able to contribute to improving efficiency reproduction of the production unit (Scheleske and Vásquez, 2014).

To mitigate the possible possibilities of errors, it is necessary to evaluate the various aspects of the future reproductor: such as the male's libido in contact with females in estrus, as well as the quality of his semen (Carneiro et al., 2023). The libido and seminal quality are two distinct characteristics and do not always present analogous data, since such characteristics are governed by different mechanisms (Nájera et al., 2023), that is, a caprine may have high libido, but its semen can present low sperm viability.

Another test that accurately reveals the reproductive capacity of males is the mount directed to a group of females and the subsequent farrowing, which involves spending time and money; for this reason, it is desirable to have available simple tests that allow rational prediction of the reproductive capacity of an adult buck (Schleske and Vásquez, 2014). Although the male's fecundity depends on several factors such as: 1) spermatozoids production, 2) viability and fertilization capacity of gametes, 3) libido and, finally, 4) the ability to mount, copulate or mate. The establishment of some behavioral tests, combined with the quality of the semen, as well as the possibility of recording some indices allows us to evaluate the reproductive aptitudes of each male goat.

In some studies, a test was carried out to measure sexual behavior for 10 minutes in a group of one year old male goats and tested six months later. Nevertheless, both times of the year were not compared, therefore, it is not possible to know whether the animals improved, worsened or maintained their behavior and libido throughout the reproductive seasons (Nuraine et al., 2021).

Given this scenario, the present study aims to evaluate the service capacity in a group of 3 male goats at full sexual maturity, with the purpose of covering receptive females and, with the recording of the data obtained, determine the percentage of some reproductive indices, especially fertility, which can be used to select breeders in production units and, therefore, contribute to improving the reproductive performance of the herd.

2. METHOD

The present study was carried in Cabanha Severino - Sheeps and Goats Creator in Serra do Vento, Belo Jardim, Pernambuco, Brazil, which is geoFiguraically located at 8º13'55" South and 36º20'56" West at 643 m altitude. According to Alvares et al. (2013) the climate is classified as BSh or hot semiarid tropical, or driest of tropical, with an average annual temperature of 18.5 ºC minimum and 28 ºC maximum, with average mensal precipitation of 32.4 mm, with 72% rain in summer and autumn and 28% in winter and spring (Climatempo, 2024).

For the study, a group of 3 adult male goats with an average of 18 to 24 months of age, at full sexual maturity, with an approximate weight of ±50 kg, housed in stalls of approximately 20 m2, covered, with water clean and fresh, and feed ad libitum composed of Tifton-85 hay and commercial concentrate with 15% crude protein (CP) and 65% total digestible nutrients (TDN) and a forage: concentrate ratio of, more or less, 40:60 according to Da Silva (2021c). A group of 15 females in estrus was used for each male.

The study was developed with the aid of records of breeding and births for the years 2021, 2022 and 2023. The mount station between males and females lasted 30 days and each male was exposed to 15 multiparous adult females in a specific paddock for the breeding season willing with cover, water, feed and pasture, with an approximate area of 1.8 ha.

The males remained inside the stalls where they were provided with the necessary food to meet their basic needs based on Da Silva (2021c), of which the ration was composed of cassava zest, soybean bran and vitamin-mineral premix, in addition to Tifton-85 hay and concentrated in appropriate quantities according to Da Silva (2021c) (Table 1). Remained daily in a stable environment, sometimes in the company of other males where dominance behavior occurred between them.

Table 1

Bucks nutrition requirements, feeds and ration composition

Requirement	DMI ($kg \cdot day^{-1}$)	CP (%)	TDN (%)
	0,85	15,0	65,0
Feeds composition		**CP (%)**	**TDN (%)**
Tifton-85, hay		11,7	56,5
Cassava, zest		2,8	82,0
Soy, bran		45,0	73,0
Ration composition			
Ingredients	**Quantity (%)**	**CP (%)**	**TDN (%)**
Tifton-85, hay	43,5	5,10	24,58
Cassava, zest	31,4	0,88	25,77
Soy, bran	20,1	9,02	14,65
Vitamin-mineral, core	4,0	-	-
Salt	1,0	-	-
Total	**100**	**15,00**	**65,00**
Requirement	**100**	**15,00**	**65,00**

Note. NRC (2007); Da Silva (2021c).

The direct fertility or service capacity of a male was considered to be the number of females calved between the number of females covered or that were exposed to a male during the 30-day mount season.

Semen samples from the 3 males were obtained using the Walmur artificial vagina, 2020, heated to 37 ºC to avoid thermal shock, and were immediately incubated in a water bath at 37 ºC. The samples were evaluated for ejaculate volume, sperm concentration, mass motility (MM), and percentage of motile, live and dead spermatozoids (Rocha et al., 2015). An aliquot of semen was diluted (1:400) in formaldehyde saline solution buffered (0.54% NaCl, 0.62% Na2HPO4, 0.13% KH2PO4, 5% formaldehyde, pH 7.4) (Evans and Maxwell, 1987) and evaluated in a Neubauer chamber to estimate spermatic concentration. A drop of semen was positioned on

a slide and evaluated for MM, with a scale between 0 and 5 being assigned under optical microscopy (100x). Another drop of semen was positioned, diluted (1:1) with PBS pre-heated to 37 ºC and covered to evaluate the percentage of motile sperm, under optical microscopy (400x) (Maxwell et al., 1996).

The data were analyzed using the chi-square method, Tukey test and Fisher's exact test to compare the proportions between males and lambings, using the Systat 13 statistical package (Chicago, Illinois, 2015). (Siegel, 1998).

The variables evaluated were fertility, natality, mortality, twinning, trigemelarity, simple parturitions and reproductive efficiency. Fertility was the variable used to determine and compare the service capacity of males.

The birth records for the years 2021, 2022 and 2023, according to data from the zootechnical bookkeeping for reproductive records, are summarized in Table 2.

Table 2

Reproduction form for recording births in Cabanha Severino

2021						
Number of the goat	Date	Type of parturition	Sex	Birth weight (kg)	Number of buck	Birth status
			Male	-		Dead
CS-c06	01/15/2021	Triple	Male	3,8	1	
			Female	3,5		
			Female	1,9	1	
CS-c08	01/15/2021	Doble	Male	3,2		
CS-c09	01/15/2021	Doble	Male	3,2	1	
			Male	3,0		
CS-c10	01/15/2021	Simple	Male	2,5	1	
CS-c11	01/15/2021	Doble	Male	4,0	1	
			Female	2,6		
CS-c13	01/17/2021	Doble	Female	2,9	1	
			Male	-		Dead
			Male	2,6		
CS-c14	01/17/2021	Triple	Male	3,9	1	
			Male	3,1		
CS-c17	01/18/2021	Doble	Female	3,4	1	
			Male	3,8		
CS-c18	01/18/2021	Simple	Female	2,9	1	
CS-c19	01/18/2021	Simple	Male	4,8	1	
CS-c20	01/18/2021	Simple	Female	3,8	1	
CS-c24	02/20/2021	Simple	Male	4,3	1	
CS-c25	02/20/2021	Simple	Male	3,0	1	
CS-c28	03/10/2021	Doble	Male	2,4	1	
			Female	4,0		
CS-c30	04/25/2021	Doble	Male	3,6	1	
			Female	3,3		
CS-c31	04/27/2021	Doble	Female	3,7	1	
			Male	3,1		
CS-c35	04/27/2021	Simple	Male	2,7	1	
CS-c40	04/28/2021	Doble	Male	3,8	1	

			Female	3,7		
CS-c45	05/01/2021	Doble	Female	4,2	1	
			Female	3,7		
CS-c60	05/04/2021	Simple	Male	3,7	1	
CS-c61	05/04/2021	Doble	Male	3,3	1	
			Female	2,8		
CS-c62	05/04/2021	Doble	Male	3,3	1	
			Female	2,9		
CS-c80	05/08/2021	Doble	Male	3,0	3	
			Female	2,9		
CS-c81	05/08/2021	Doble	Male	3,4	3	
			Female	3,0		
CS-c82	05/08/2021	Simple	Male	4,0	3	
CS-c83	05/09/2021	Doble	Male	3,1	3	
			Female	2,6		
CS-c84	05/09/2021	Simple	Male	4,4	3	
CS-c85	05/09/2021	Simple	Female	4,1	3	
CS-c86	05/11/2021	Doble	Male	3,3	3	
			Male	4,0		
CS-c87	05/12/2021	Doble	Male	3,3	3	
			Male	4,1		
CS-c88	05/20/2021	Simple	Male	3,8	3	
CS-c90	05/20/2021	Simple	Female	3,5	3	
CS-c95	05/20/2021	Simple	Female	3,6	3	
CS-c99	05/20/2021	Simple	Male	4,8	3	

2022

Number of the goat	Date	Type of parturition	Sex	Birth weight (kg)	Number of buck	Birth status
CS-c14	01/26/2022	Doble	Male	3,1	2	
			Male	3,1		
CS-c10	01/26/2022	Simple	Male	3,3	2	
CS-c11	01/26/2022	Doble	Male	3,1	2	
			Female	3,0		
CS-c13	01/27/2022	Doble	Female	3,0	1	
			Female	3,0		
CS-c61	01/27/2022	Simple	Female	3,2	2	
CS-c24	01/27/2022	Doble	Male	3,0	2	
			Male	3,2		
CS-c17	02/05/2022	Doble	Female	2,8	2	
			Female	2,2		
CS-c29	02/05/2022	Doble	Female	2,9	1	
			Male	3,1		
CS-c30	02/05/2022	Simple	Male	3,3	1	
CS-c32	02/09/2022	Simple	Female	3,0	1	
CS-cDUDA	02/09/2022	Doble	Female	3,0	2	Dead
			Female	3,1		
CS-c31	02/15/2022	Doble	Female	2,9	2	
			Female	2,7		
CS-c40	02/15/2022	Simple	Male	3,3	1	
CS-c45	02/16/2022	Doble	Female	2,7	2	

			Male	3,0		
CS-c60	02/26/2022	Doble	Male	3,1	2	
			Male	3,1		
CS-c62	02/26/2022	Doble	Female	3,0	1	
			Female	3,6		
CS-c80	03/01/2022	Doble	Female	3,1	1	
			Male	3,1		
CS-c82	03/01/2022	Simple	Male	3,2	1	
CS-c83	03/01/2022	Doble	Male	2,7	1	Dead
			Female	2,5		
CS-c84	03/05/2022	Simple	Male	3,2	1	
CS-c85	03/05/2022	Doble	Male	3,1	1	
			Female	3,2		
CS-c87	03/09/2022	Simple	Female	3,2	1	
CS-c88	03/09/2022	Simple	Female	3,2	1	
CS-c95	03/10/2022	Simple	Male	3,5	1	
CS-c99	03/10/2022	Doble	Male	3,0	1	
			Male	2,9		

2023

Number of the goat	Date	Type of parturition	Sex	Birth weight (kg)	Number of buck	Birth status
			Male	4,6		
CS-c10	01/05/2023	Triple	Female	-	2	Dead
			Female	3,0		
CS-c11	01/05/2023	Simple	Female	3,4	3	
CS-c13	01/05/2023	Simple	Male	3,0	3	
CS-c14	01/05/2023	Simple	Male	2,8	2	
CS-c16	01/05/2023	Simple	Male	3,5	3	
CS-c18	01/06/2023	Simple	Male	3,8	3	
CS-c29	01/06/2023	Doble	Male	3,0	3	
			Male	2,5		
CS-c30	01/07/2023	Simple	Male	4,1	3	
CS-c31	01/07/2023	Doble	Male	2,8	3	
			Male	3,2		
CS-c32	01/07/2023	Doble	Male	2,6	2	
			Female	2,5		
CS-c38	01/08/2023	Simple	Male	3,5	2	
CS-cDUDA	01/08/2023	Doble	Female	2,6	2	
			Female	2,5		
CS-c40	01/11/2023	Simple	Male	4,6	2	
CS-c42	01/11/2023	Doble	Female	2,7	3	
			Male	3,2		
CS-c45	01/11/2023	Simple	Female	2,0	3	
CS-c50	01/13/2023	Doble	Male	3,6	2	
			Male	3,0		
CS-c55	01/13/2023	Triple	Male	3,1	2	
			Male	2,5		
			Female	1,9		
CS-c60	01/15/2023	Doble	Female	2,5	2	
			Male	2,6		

CS-c62	01/15/2023	Doble	Male	2,7	3	
			Male	2,7		
CS-c65	01/20/2023	Simple	Male	3,8	3	
CS-c70	01/22/2023	Simple	Female	3,2	2	
CS-c80	01/25/2023	Simple	Female	3,1	2	
CS-c81	01/28/2023	Simple	Male	3,7	1	
CS-c82	01/28/2023	Doble	Male	3,2	2	
			Female	3,0		
			Male	3,7		
CS-c83	01/29/2023	Triple	Male	-	2	Dead
			Male	2,8		
CS-c84	02/02/2023	Doble	Female	3,0	1	
			Female	2,6		
CS-c85	02/02/2023	Simple	Female	3,8	1	
CS-c87	02/02/2023	Simple	Male	3,8	1	
CS-c88	02/02/2023	Doble	Male	3,1	1	
			Male	3,0		
CS-c89	02/03/2023	Simple	Female	-	1	Dead
CS-c90	02/06/2023	Simple	Male	3,7	1	
CS-c91	02/06/2023	Simple	Male	3,7	1	
CS-c92	02/10/2023	Doble	Female	3,0	1	
			Female	3,2		
CS-c95	02/10/2023	Simple	Female	-	1	Dead
CS-c98	02/15/2023	Simple	Female	3,7	1	
CS-c99	02/16/2023	Simple	Male	4,3	1	

The reproductive indexes were calculated based on data of Lima et al. (2016), Sousa (2018) e Maia and Nogueira (2019):

1) Fertility rate:

$$Fertility\ (\%) = \frac{Number\ of\ goats\ parous}{Number\ of\ goats\ expost}\ x\ 100$$

2) Natality rate/prolificity:

$$Natality\ (\%) = \frac{Number\ of\ goat\ kids\ total\ birth\ x\ 100}{Number\ of\ goats\ pregnant}$$

$$Prolificity = \frac{Number\ of\ goat\ kids\ total\ birth}{Number\ of\ goats\ pregnant}$$

3) Mortality rate:

$$Mortality\ (\%) = \frac{Number\ of\ goat\ kids\ birth\ dead}{Number\ of\ goat\ kids\ total\ birth}\ x\ 100$$

4) Gemelarity rate:

$$Gemelarity\ (\%) = \frac{Number\ of\ gemelar\ parturitions}{Number\ of\ goats\ pregnant}\ x\ 100$$

5) Trigemelarity rate:

$$Trigemelarity\ (\%) = \frac{Number\ of\ trigemelar\ parturitions}{Number\ of\ goats\ pregnant}\ x\ 100$$

6) Simple parturitions:

$$Parturitions\ (\%)\ = \frac{Number\ of\ simple\ parturitions}{Number\ of\ goats\ pregnant}\ x\ 100$$

7) Reproductive efficiency:

$$RE\ (\%)\ = \frac{Number\ of\ goat\ kids\ weaner\ live}{Number\ of\ goats\ expost}\ x\ 100$$

3. RESULTS

The results of seminal characteristics of breeders in the three mount seasons are found in Table 3.

Table 3

Seminal characteristics of bucks during reproductive season

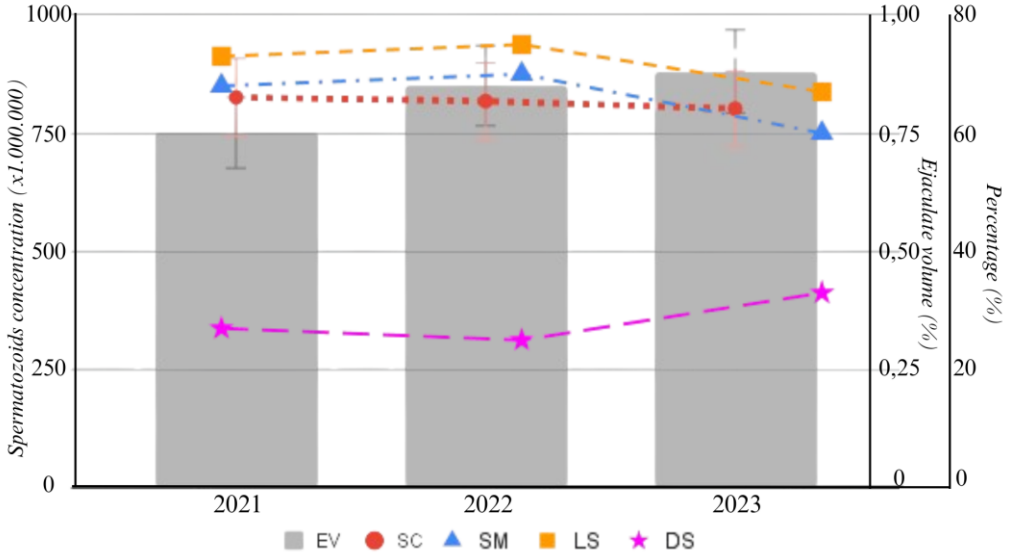
Buck 1						
RS	EV (mL)	SC (millions/mL)	MM (0-5)	MS (%)	LS (%)	DS (%)
2021	0,75[a]	825[a]	3,5[a]	68[a]	73[a]	27[a]
2022	0,85[a]	817[a]	3,5[a]	70[a]	75[a]	25[a]
2023	0,88[a]	801[b]	3,0[a]	60[b]	67[a]	33[b]
Buck 2						
RS	EV (mL)	SC (millions/mL)	MM (0-5)	MS (%)	LS (%)	DS (%)
2022	0,68[a]	830[a]	3,7[a]	70[a]	68[a]	32[a]
2023	0,71[a]	827[a]	3,5[a]	71[a]	72[b]	28[b]
Buck 3						
RS	EV (mL)	SC (millions/mL)	MM (0-5)	SM (%)	LS (%)	DS (%)
2021	0,71[a]	836[a]	3,2[a]	72[a]	65[a]	35[a]
2023	0,75[a]	830[a]	3,5[a]	75[a]	70[b]	30[b]

Note. RE: reproductive season; EV: ejaculate volume; SC: spermatozoid concentration; MM: massal motility; SM: spermatozoids motile; LS: live spermatozoids; DS: dead spermatozoids. Different letters between lines indicate significant difference P<0.05 by chi-square and Tukey tests.

It is noted that male 1 was the only one to be present in the 3 mount seasons, therefore, depending on the wear and age of the animal, it is possible to obtain, for example, an increase in the volume of the ejaculate, however smaller concentration sperm, mass motility and motile and live spermatozoids and an increase in the number of dead spermatozoids (Figure 1).

Figure 1

Evaluation of seminal characteristics of buck 1



Note. EV: ejaculate volume; SC: spermatozoid concentration; SM: spermatozoids motile; LS: live spermatozoids; DS: dead spermatozoids.

The evaluated and calculated reproductive indices, according to the records of the 2021, 2022 and 2023 mount seasons present in Table 2, are found in Table 4.

Table 4

Reproductive indexes of the evaluated herd, according to mount season

2021			
Reproductive parameter	Buck 1	Buck 2	Buck 3
Goats exposed	30	-	15
Pregnant goats	22	-	12
Fertility rate (%)	73,33[a]	-	80,00[a]
Natality rate (%)	172,72	-	141,67
Prolificity (goat kids/goat)	1,73	-	1,42
Mortality rate (%)	5,26	-	0,00
Gemelarity rate (%)	54,55	-	41,67
Trigemelarity rate (%)	9,09	-	0,00
Simple parturitions (%)	36,36	-	58,33
Reproductive efficiency (%)	120,0	-	113,3
2022			
Reproductive parameter	Buck 1	Buck 2	Buck 3
Goats exposed	15	15	-
Pregnant goats	15	10	-
Fertility rate (%)	100,00[a]	66,67[b]	-
Natality rate (%)	146,67	180,00	-
Prolificity (goat kids/goat)	1,47	1,80	-
Mortality rate (%)	4,55	5,56	-

Gemelarity rate (%)	46,67	80,00	-
Trigemelarity rate (%)	0,00	0,00	-
Simple parturitions (%)	53,33	20,00	-
Reproductive efficiency (%)	140,0	113,3	-
2023			
Reproductive parameter	Buck 1	Buck 2	Buck 3
Goats exposed	15	15	15
Pregnant goats	12	13	11
Fertility rate (%)	80,00[a]	86,67[a]	73,33[a]
Natality rate (%)	125,00	184,62	136,36
Prolificity (goat kids/goat)	1,25	1,85	1,36
Mortality rate (%)	13,33	8,33	0,00
Gemelarity rate (%)	25,00	38,46	36,36
Trigemelarity rate (%)	0,00	23,08	0,00
Simple parturitions (%)	75,00	38,46	63,64
Reproductive efficiency (%)	86,67	146,67	100,00

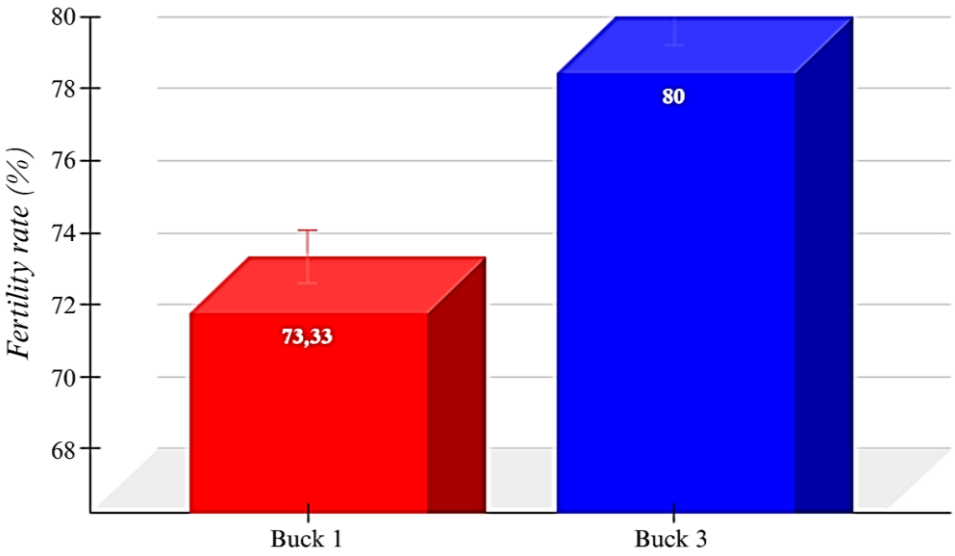
Note. Different letters between lines indicate significant difference P<0.05 by chi-square and Tukey tests.

Service capacity test over time

As mentioned above, fertility rate was used to assess the service capacity of males in the present study; therefore, based on the data in Table 4, the service capacity test in 2021 between males 1 (73.33%) and male 3 (80.00%) did not show a significant difference in terms of direct fertility considered as the number of goats that gave birth. The results can be seen in Table 4 and Figure 2. The percentage of fertility was not significant among this group of males and, therefore, there were no statistical differences in fertility values, considering a P value greater than 0.05 (P>0.05).

Figure 2

Fertility percentage of bucks group in reproductive station of 2021

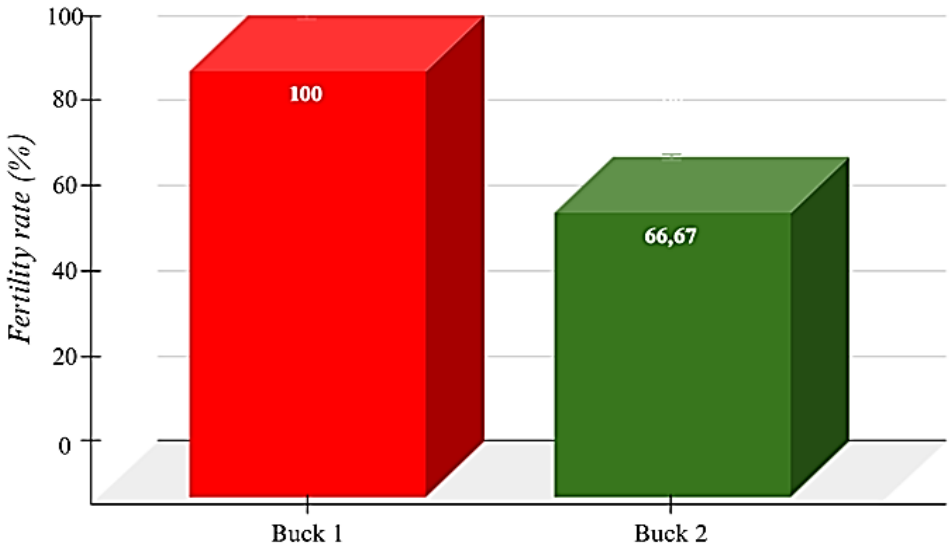


Note. NS não significativo P>0,05, teste qui-quadrado e Tukey.

In the 2022 mount season, there was a significant difference between male 1 (100.00%) and male 2 (66.67%), thanks to the chi-square and Tukey tests it was determined that male 1 had a percentage of higher fertility at P<0.01, compared to male 2 (Figure 3); thus determining the good reproductive performance of male 1 in the years 2021 and 2022.

Figure 3

Fertility percentage of bucks group in reproductive station of 2022

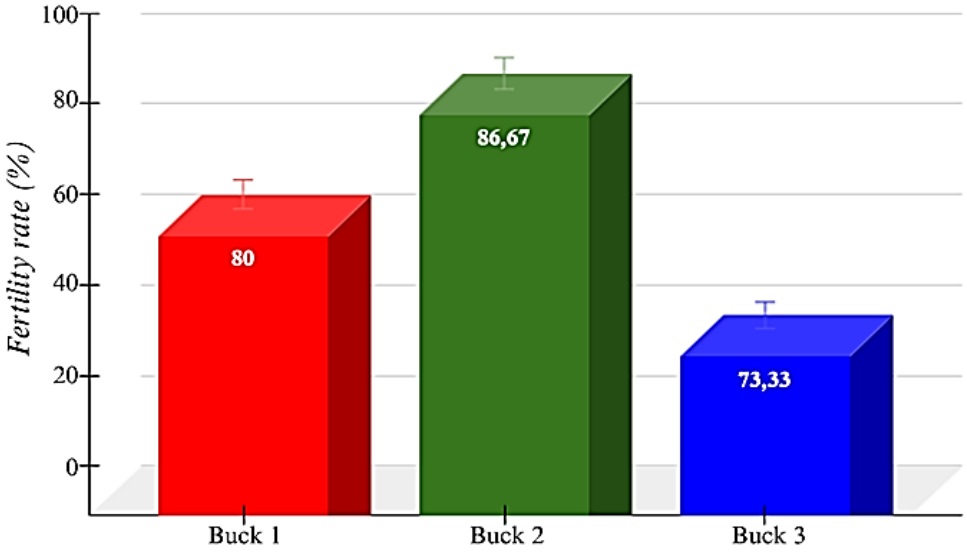


Note. DS diferença significativa P<0,01, teste qui-quadrado e Tukey, com um grau de liberdade.

As for the 2023 mount season, the percentage of fertility was not significant between male 1 (80.00%), male 2 (86.67%) and male 3 (73.33%), thanks to chi-square and Tukey tests it was determined that the percentage of fertility showed no significant difference between males this year and, therefore, there were no statistical differences in fertility values (Figure 4).

Figure 4

Fertility percentage of bucks group in reproductive station of 2023



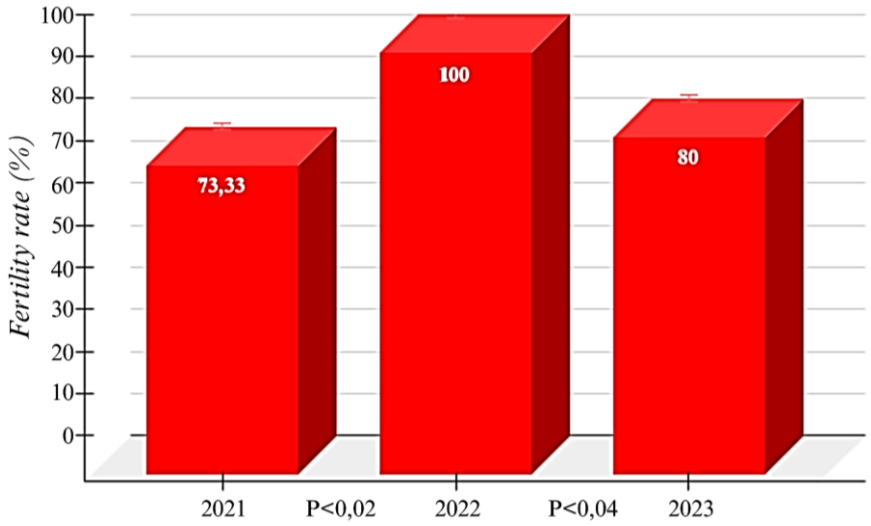
Note. NS não significativo P>0,05, teste qui-quadrado e Tukey.

Fertility comparison of each male over time

When we compared the fertility of males across the different mount seasons, that is, the reproductive seasons evaluated, it was noted that at the time of mount, that is, at the time of service of male 1, in the years 2021 (73.33%), 2022 (100%) and 2023 (80%), the percentage of fertility showed a significant difference according to the chi-square and Tukey tests; therefore, it was determined that male 1 had a higher fertility percentage at P<0.06 (Figure 5).

Figure 5

Fertility percentage of buck 1 in the three breeding seasons

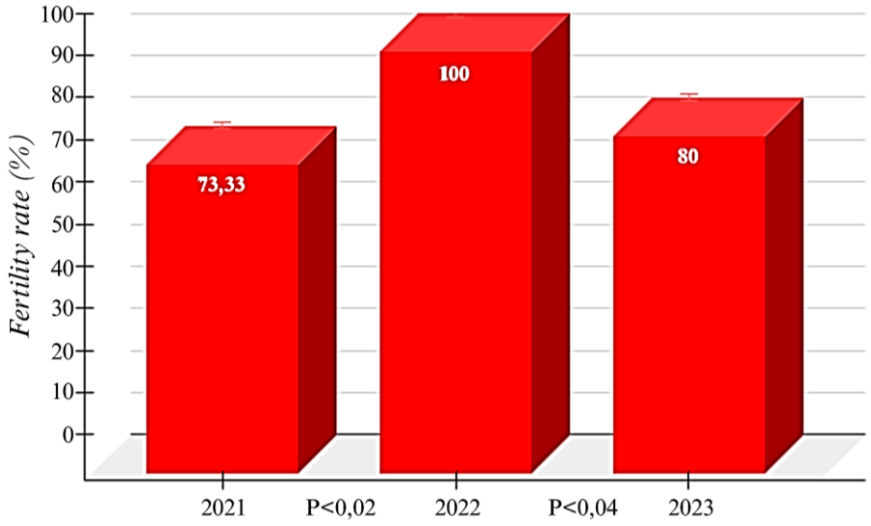


Note. DS diferença significativa P>0,06, teste qui-quadrado e Tukey.

Regarding the service of male 2 in the years 2022 (66.67%) and 2023 (86.67%), the fertility percentage did not show a significant difference using the chi-square and Tukey tests; therefore, it was determined that there is no relevance in the direct fertility rate of male 2 at P>0.05 (Figure 6).

Figure 6

Fertility percentage of buck 2 in the three breeding seasons

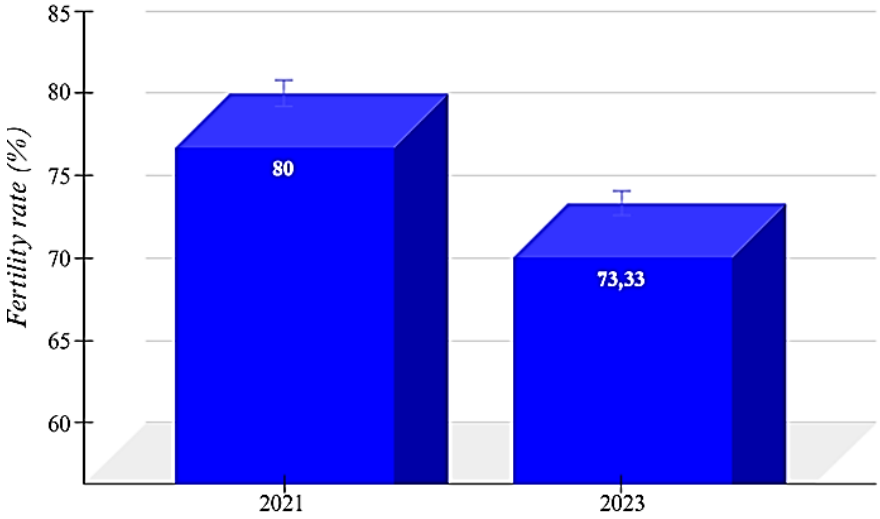


Note. NS diferença não significativa P>0,05, teste qui-quadrado e Tukey.

Finally, in relation to the service of male 3 in the years 2021 (80%) and 2023 (73.33%), the fertility percentage did not show a significant difference using the chi-square and Tukey tests; therefore, it was determined that there is no relevance at P>0.05 (Figure 7).

Figure 7

Fertility percentage of buck 3 in the three breeding seasons



Note. NS diferença não significativa P>0,05, teste qui-quadrado e Tukey.

4. DISCUSSION

As for the service capacity observed in the group of males in the present study, they behaved in a similar way. The exception to this behavior was male 1, who performed this behavior more frequently throughout the years 2021, 2022 and 2023, which can be configured as a greater motivation or sexual libido. This behavior was also observed in the study by Singh et al. (2023) when assessing the sexual behavior of a group of male goats exposed to female goats in heat and evaluating the reproductive capacity of both males supported by reproductive records of the number of females covered, pregnant and calved.

Galián Arnaldos et al. (2021) also observed similar behavior and corroborate the results in an evaluation with males of breed Murcian at different ages. These results can be influenced and be directly related to the age of the male, since male 1 is already an adult and has greater experience as he was used in all breeding seasons and his behavior and libido patterns are already well defined. AMJAD et al. (2021) and Galián Arnaldos et al. (2021) also corroborate the statement that the age of the male and his experience in reproductive life have a direct influence on his service capacity and, consequently, on reproductive indexes.

Appetitive sexual behaviors have already been studied and evaluated in other studies, such as in Cardelas (2010) which evaluated young bucks exposed to different male: female ratios and the relationship that seminal quality has on the reproductive capacity of males; as well as Schleske and Vásquez (2014) in observing the sexual conduct of adult bucks. These authors found similar results for pre-copulatory conducts.

Pereyro (2016) and Sánchez-Dávila et al. (2018) carried out similar studies with the males used in this study; however, the goats were still considered young and the results they obtained were different from the present study, since in this study the results among males were similar in terms of service capacity based on the results obtained. This condition was possible given the age of the males and the time of year in which the

mount season is more favorable for the animals to express their reproductive potential, this fact was corroborated by Amoah et al. (1996) in a study with female goats, as well as by Santos et al. (2016).

For example, male 1, being the male with older age and reproductive experience, was able to have 30 females to be mated by him and, thus, a higher percentage of fertility was obtained, which was significant compared to the others males for which there were no significant results, performing the chi-square and Tukey statistical tests, which resulted in a higher fertility percentage of $P<0.06$ for male 1 and $P>0.05$ for males 2 and 3. This similar situation was found by Delgadillo et al. (1997) in a study with male goats from tropical and subtropical zones.

In analysis, it can be stated that such a configuration is due to the sexual indices that, during the first stage, the males went through a period of learning, upon which the sexual behavior improved during the exposure of the males a number of times to the females continuously or not and that it is independent of other factors such as the time of year, which, in semi-arid conditions, there is no interference from the photoperiod in goat reproduction (Dias and Veloso, 2020). On the other hand, sexual indices also made it possible to highlight males with lower performance or reproductive potential over time, which can be discarded as breeders based on the results obtained; therefore, the direct fertility or fertility rate it is a parameter to be considered when choosing a breeder or when discarding males intended for reproduction.

5. CONCLUSIONS

The service capacity and fertility percentage are reliable tools to select a breeding male in general terms, but it is necessary to evaluate other characteristics such as seminal quality, fertility indexes, etc. which are tools that help us select one or more animals that can serve as breeders for the herd and, therefore, assist in choosing and maintaining the best animals with excellent reproductive characteristics.

The learning and obtaining of experience is a requirement of great importance for males to develop adequate sexual behavior, and for their level of reaction or service efficiency to improve with each mount and in a short period of time.

It is advisable to keep animals in stable environments that offer well-being, in addition to meeting their essential nutritional needs to ensure that their behavior is not affected. Males must be kept in separate stalls to avoid dominance and hierarchy of just one animal, thus avoiding possible aggression that could put others at risk, thus affecting their physical integrity and, consequently, their behavior and reproductive efficiency.

The service capacity helps us predict whether a male has superior reproductive capacity, excellent or deficient, but it must be complemented by a fertility test to ensure the accuracy of its high reproductive efficiency, favoring the herd's indices and, finally, in the number of animals available for slaughter or replacement.

Conflicto de intereses / Competing interests:
Los autores declaran que no incurrieron en conflictos de intereses.

Rol de los autores / Authors Roles:
Emanuel Cordeiro da Silva: Conceptualización, metodología, software, validación, curación de datos, análisis formal, investigación, recursos, escritura – borrador original, escritura – revisión y edición, visualización, supervisión, administración del proyecto, adquisición de fondos

Eduarda da Silva Fontain: Conceptualización, escritura – borrador original, escritura – revisión y edición, visualización, supervisión, administración del proyecto, adquisición de fondos

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Aspectos éticos / legales; Ethics / legals:
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