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Measurement of scrotal circumference in beef bulls in Rio Grande do Sul

[*Determinação da circunferência escrotal em touros de corte no Rio Grande do Sul*]

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ABSTRACT

The variability of scrotal circumference and the effects of age and breed as well as the relationship between testicular weight (TW), scrotal circumference (SC), and live weight (BW) were investigated in bulls. Devon, Polled Hereford, and Red Angus breeds showed higher SC values than the other British, Continental, Synthetic, and Zebu studied breeds. The percentage of culled bulls because of low SC ranged from 7.01 to 24.25%. The increase of SC was proportional to the increase in TW and they were highly correlated (r^2= 0.90). The results suggest that SC in young bulls is the best way to predict TW and, therefore, a useful tool for their selection.

Keywords: fertility, scrotal circumference, testicular weight

RESUMO

A variabilidade da circunferência escrotal e os efeitos de idade e raça,assim como, as relações existentes entre o peso testicular (PT), a circunferência escrotal (CE) e o peso vivo (PV) foram investigados em touros. As raças Devon, Polled Hereford e Red Angus apresentaram valores de CE mais altos que as demais raças avaliadas, tanto inglesas, como continentais, sintéticas e zebuínas. O percentual descartado de touros devido à baixa CE variou de 7,0 a 24,2%. O aumento da CE acompanhou o aumento do PT dos animais, e estes foram altamente relacionados, r^2 = 0,90. Os resultados sugerem que, em touros jovens, a CE é a melhor forma de predizer o PT e, portanto, uma ferramenta útil para selecionar touros.

Palavras-chave: bovino, circunferência escrotal, fertilidade, peso testicular

INTRODUCTION

The reproductive process in beef cattle, even with the improvements in reproduction techniques, has not shown significant advancements in its efficiency parameters, as it is quite difficult to implement them. Additional gains regarding the cow-calf system, mainly in terms of genetics and fertility, have strongly limited this process; and taking good advantage of these gains, such as male and female precocity, is crucial in increasing productivity (Van Melis et al., 2010).

Bulls play a key role in cow-calf production and represent an important source of bioeconomic capital in this activity. However, 15 to 25% of bulls can have fertility problems due to various causes (physical condition, testicles, foreskin, musculoskeletal system, penis, etc) (Vale Filho, 1997; Moraes et al., 1998; Menegassi et al., 2006; 2008).

Lunstra et al. (1988) selected bulls with larger testicles and found a heritability of 41% for age at puberty in their daughters and for scrotal circumference in half-brothers, while Van Melis

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(2010) found 53% and 42% for these characteristics. Therefore, increased precocity based on the selection of bulls for larger scrotal circumference may enhance the precocity of their progeny (Gressler et al., 2000).

Scrotal circumference is one of the parameters assessed during clinical examination, which is part of a reproductive evaluation of a bull. Measurement of scrotal circumference is important because it assesses testicular volume and is highly correlated with sperm output.

Considering that this measurement is easy to perform and accurate, it can be used for the selection of young bulls.

The aims of this study were to quantify the variability of scrotal circumference in beef bulls by establishing minimum values for this characteristic, and to investigate the relationship between testicular weight and scrotal circumference.

MATERIAL AND METHODS

Two experiments were carried out. In Experiment 1, scrotal circumference was measured in 9,664 bulls, aged from two to three years old, belonging to the following breeds: British (B): Aberdeen Angus (AA), Red Angus (RA), Hereford (H), Polled Hereford (PH), Devon (D), and Shorthorn (Sh); Synthetic (S): Brangus (Ba), Braford (Br), Santa Gertrudis (SG), and Montana (Mo); Continental (C): Charolais (Ch) and Limousin (L); and Zebu (Z): Nelore (N) and Tabapuã (T).

The assessments were performed on farms belonging to 54 municipalities located in the state of Rio Grande do Sul, southern Brazil, during breeding soundness examination, for sale at fairs and auctions, or for on-farm use by the Bull Evaluation Program (BEP), which was implemented in Júlio de Castilhos, a town in RS, in 1998. In 2000, the management of it was taken on by the Brazilian Institution – Serviço Nacional de Aprendizagem Rural (SENAR) – during five years until Casa Rural RS was put in charge of the program in 2008. The purpose of the program is to evaluate bulls on farms of the state of RS, because around 25% of mature bulls are deemed unsuitable for reproduction, as pointed out in the literature. During the years in which the program was in force, over 120 veterinarians attended 12 courses, in which they were taught anatomy, physiology, and learned about reproductive diseases and had practical lessons on BSE, so that culling criteria could be standardized. After identification of unsuitable bulls and BSE results, the bull owner can purchase new bulls taking a loan at a bank. The bulls can be purchased on farm; it is not necessary to buy them at auctions or official fairs, between 2001 and 2004, in compliance with the American Society for Theriogenology, 1976, adapted by Chenoweth and Ball (1980). The data were embedded into an Excel spreadsheet and analyzed using the SPSS software/2003 for descriptive statistics. Statistical significance was set at 95% and the means were compared by Tukey's test.

In Experiment 2, 70 grass-fed Charolais cross bulls, aged from 11 to 12 months old from the Plateau region of Rio Grande do Sul, were evaluated. Live weight, scrotal circumference, and testicular weight were measured. The animals were managed during the suckling period and fed pearl millet (*Pennisetum americanum* Leeke) until they were weaned at the age of six and seven months old, and later fed on black oats (*Avena strigosa L.*) and annual ryegrass (*Lolium multiflorum L.*). They were identified at birth by numbered ear tags and weighed at the end of the experimental period, followed by scrotal circumference measurement according to the American Society for Theriogenology guidelines, 1976, adapted by Chenoweth and Ball (1980).

The bulls were restrained in a squeeze chute for scrotal circumference measurements. Later, they were given an injection of 2% lidocaine in the pampiniform plexus and submitted to bilateral orchiectomy. The testicles were weighed after removal from their respective epididymides and visceral lamina using a precision scale.

The descriptive statistics, regression equations, and Pearson's correlation coefficient were calculated by the SPSS software/2003.

RESULTS AND DISCUSSION

In Experiment 1, the mean SC obtained for bulls of all breeds amounted to 35.15 and 36.47cm for two and three years old, respectively (Table 1).

According to Elmore et al. (1976) SC is closely correlated with the bull's age and live weight. When the breeds were categorized into British (B), Continental (C), Synthetic (S), and Zebu (Z), the group consisting of breeds B and Z yielded the highest and lowest SC means, respectively, at two and three years old.

The breeds were separately assessed within each breed group. Amongst the British breeds at the age of two years old, PH had the largest SC measurement (37.86cm). At the age of three years old, breeds D, RA, and PH showed the highest SC values, 38.06, 37.88, and 37.86cm, respectively, whereas Sh showed the lowest SC values at the ages of two and three years old, 33.38 and 35.05cm, respectively. This variation in SC values among British breeds possibly demonstrates a larger or smaller selection of this trait.

In Continental breeds, Ch bulls had a larger SC than L ones, regardless of their age.

In the group of synthetic breeds, Mo bulls at the age of two years old showed the largest SC (36.18cm), whereas SG and Br bulls had the lowest values (34.98 and 34.93cm, respectively). At the age of three years old, Mo and Ba bulls showed the highest SC values, 37.47 and 37.13cm, respectively.

Among Zebu bulls, those of the N breed had an SC larger than that of T bulls. The mean SC values for the N breed were similar to those found by Fonseca et al. (1997).

The differences in SC values ($P<0.05$) among B, C, S, and Z bulls can be explained by breed differences, year and location of measure, and difference in testicular development between *Bos taurus taurus* and *Bos taurus indicus*.

Puberty is characterized by factors such as body weight, scrotal circumference, hormone concentration, sexual aggressiveness, and semen production. In addition to puberty, anatomical characteristics of the testicles should be also considered.

The results obtained by Viu et al. (2006) suggest a predomination of testicles elongated shapes in Nellore bulls 17-24 months of age. Probably for this reason in Nellore bulls the testicular volume is a better predictor of testicular development (Viu, 2009).

Table 1. Mean and standard deviation of scrotal circumference for bulls of the assessed breeds at the ages of two and three years old

Breed group	Breed	two years old			three years old		
		N	Mean	SD	N	Mean	SD
British	Aberdeen Angus	1,681	36.45b	2.79	1,439	37.53ab	2.76
	Devon	364	36.69ab	3.05	280	38.06a	2.73
	Hereford	600	36.43b	3.19	535	37.08b	3.08
	Polled Hereford	1,376	37.86a	3.30	966	37.86a	2.92
	Red Angus	1,705	36.83ab	2.99	1,485	37.88a	2.82
	Shorthorn	12	33.38c	2.48	51	35.05c	2.13
	Total	5,738	36.27A	3.09	4,756	37.24A	3.03
Continental	Charolais	516	36.19	3.11	346	37.52	3.11
	Limousine	69	32.98	3.31	36	36.62	3.41
	Total	585	35.45AB	3.22	382	37.07A	3.04
Synthetic	Braford	1,210	34.93b	2.91	1,162	35.99b	2.99
	Brangus	1,312	35.71ab	3.29	1,401	37.13a	3.05
	Montana	310	36.18a	2.64	59	37.47a	2.47
	Santa Gertrudis	77	34.98b	2.95	46	36.84ab	3.01
	Total	2,909	35.45AB	3.36	2,668	36.85A	3.08
Zebu	Nelore	344	32.45	3.29	261	34.17	2.79
	Tabapuã	88	32.13	3.43	168	34.13	2.89
	Total	432	32.29B	3.57	429	34.15B	3.14
	Overall total/mean	9,664	35.15	3.31	8,235	36.47	3.07

Different letters (lower case and capital) in the same column indicate statistical difference ($P<0.05$).

These differences are noticed by on increase in SC between the second and third years of life. B bulls increased SC by 0.97cm from the second to third years of age whereas SC values corresponded to 1.62cm, 1.40cm, and 1.86cm for breeds C, S, and Z, respectively.

The mean SC found by Coulter et al. (1987), when they compared 7,918 bulls at the age of two years old, were as follows: 37.2cm for Angus, 36.3cm for Charolais, 36.1cm for Hereford 35.6cm for Polled Hereford, 34.9cm for Shorthorn, and 32.2cm for Limousin. These means, except for the one obtained for the Polled Hereford, were similar to those observed in this study. The mean SC values found in the present study are similar to those reported by Mies Filho et al. (1982) for Aberdeen Angus, Hereford, Charolais, and Devon. However, the bulls assessed by the authors were reared to be exhibited at fairs and, therefore, had no dietary restriction. So, the data observed in this study demonstrate a significant improvement in SC of bulls in the state of RS.

The results of Devon and Nellore scrotal circumferences in this study were similar but larger for Aberdeen Angus bulls at two years of age to those observed by Gottschall and Mattos (1997) in a study involving 150 two and three years old bulls of breeds Aberdeen Angus (68), Devon (62) and Nellore (20). Although no differences in SC among breeds were observed by Mies Filho et al. (1980a).

The rate of culling based on SC results was assessed in this study using a below-the-mean standard deviation for each breed, as a criterion for bull selection (Table 2). At the age of two years old, the breeds Limousin and Brangus had the lowest and highest culling rates (10.1 and 17.4%, respectively); at the age of three years old, the breeds Brangus and Red Angus yielded the lowest and highest culling rates (9.8 and 19.9%, respectively). This difference in the culling rate within breeds indicates the existence of smaller or larger range of SC values within the breeds, thus contributing to a lower or higher standard deviation for this measurement.

Table 2. Culling rates (C%) for bulls of the assessed breeds at the ages of two and three years old

Breed group	Breed	Two years old	Three years old
		C (%)	C (%)
British	Aberdeen Angus	12.67	10.28
	Devon	11.81	19.29
	Hereford	14.83	11.03
	Polled Hereford	14.68	12.11
	Red Angus	12.84	19.87
	Shorthorn	16.67	11.76
	Total	12.13	12.57
Continental	Charolais	17.25	16.47
	Limousin	10.14	11.11
	Total	17.61	17.54
Synthetic	Braford	10.91	11.45
	Brangus	17.38	9.78
	Montana	12.90	15.25
	Santa Gertrudis	15.58	10.87
	Total	16.91	14.06
Zebu	Nelore	13.95	15.33
	Tabapuã	14.77	14.88
	Total	9.49	15.15
	Overall total/mean	13.78	13.42

Coulter et al. (1987) recommend to use a below-the-mean standard deviation for each age and breed as culling criterion for small SC in order to enhance the selection of this characteristic. If this recommendation is followed, 16 to 20% of the bulls would be culled, similarly to the findings of the present study.

When evaluating the breed groups in terms of culling rate, at the age of two years old, the groups consisting of Zebu and Continental breeds had the lowest and highest culling rates, 9.5 and 17.6%, respectively. At the age of three years old, the groups consisting of British and Continental breeds yielded the lowest and highest culling rates, 12.6 and 17.5%, respectively.

In Experiment II, the mean live weight found for Charolais cross bulls assessed in the present study amounted to 306.8kg (Table 3). Vaz and Restle (2003) observed mean weights of 258.6kg for Charolais bulls (n=157) managed during the suckling period and left to feed on native pasture until weaning, subsequently allowed to feed on warm-season cultivated pasture, consisting of pearl millet (*Pennisetum americanum* Leeke), and then fed on winter cultivated pasture, consisting of black oats (*Avena strigosa* L.) + annual ryegrass (*Lolium multiflorum* L.) in the Central Depression (*Depressão Central*) region of Rio Grande do Sul, and perceived that they gained more than 0.5kg/day from birth to slaughter. According to the Associação Brasileira de Criadores de Charolês, the recommended minimum weight for bulls aged from 10 to 12 months old for official breed shows is 401kg. These animals are kept on cultivated pastures since birth, allowed to suckle their mothers and given dietary supplements. During the State Animal Fairs in Esteio, RS, in 1978 and 1979, Mies Filho et al. (1980b) observed a mean live weight of 460.3kg for 10-month-old Charolais bulls (n=54). Lunstra et al. (1988) found a mean of 451kg for Charolais yearling bulls (n=197).

The variation in live weight among beef animals, as observed by the authors afore mentioned, probably be determined by the rearing system and site.

Table 3. Means and standard deviations of live weight, scrotal circumference, and testicular weight of Charolais cross bulls at 11 months of life

	Mean	Standard deviation
Live weight (kg)	306.8	36.2
Scrotal circumference (cm)	28.8	1.8
Testicular weight (g)	363.9	23.2

Information on scrotal circumference helps predict the sperm output of young bulls as it is associated with testicular development. The mean SC observed in Charolais cross bulls (n=70) corresponded to 28.8cm whereas testicular weight amounted to 363.9g. The relationship between testicular weight and scrotal circumference was equal to 12.63 g/cm.

Siddiqui et al. (2008) found an SC of 28.2cm in ZebuxHolstein bulls at 20.3 months of life. However, Lunstra (1982) found a value of 30.4cm for this parameter in one-year-old Charolais bulls, similarly to what Anderson et al. (2000) observed in Hereford bulls at 12 months of life (30.8cm).

Coulter and Foste (1975) noted a mean testicular weight of 368.8g in 250 Holstein bulls at 19 to 189 months of life. Nevertheless, Almquist and Amann (1961) assessed seven Holstein cross bulls from 25 to 48 months and observed a mean testicular weight of 259.0g, and Killian and Amann (1972) found 181g in Holstein bulls at 12 months of life, which is lower than the value obtained in this study.

In young bulls, SC measurements are influenced by breed, body condition scores, age at onset of puberty, and breeding system. Testicles show a maximum growth rate during puberty and the nutritional status of developing young bulls plays a major role in the age at which puberty begins (Almquist and Amann, 1961). Variation in SC as a function of live weight of the assessed bulls is shown in Figure 1. The increase in live weight leads to a linear increase in SC within the age at puberty. Elmore et al. (1976) measured the SC and the weight of bulls of different breeds, aged 14 from to 36 months old, with live weight from 408 to 680kg, and concluded that SC measurements should amount to at least 32cm in Charolais bulls of breeding age and weight so that they can be regarded as suitable for reproduction. As SC indicates potential fertility, SC measurements and the selection of young bulls provide greater possibilities for sperm output (Coulter et al., 1987).

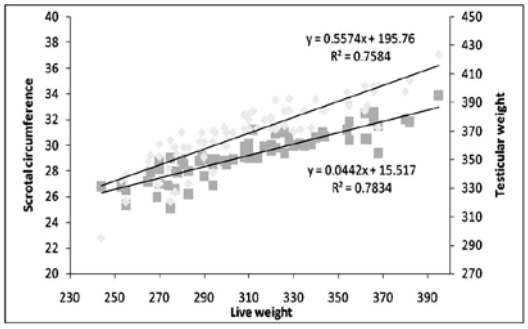

Figure 1. Relationship between scrotal circumference and testicular weight as a function of live weight of the assessed bulls.

The increase in testicular weight is proportional to the increase in live weight, as shown in the equation (Figure 1).

The regression equations for testicular weight x live weight yield better coefficients of determination than the equations for testicular weight x age (Coulter and Foste, 1975).

The relationship between testicular weight and SC is described by the linear regression equation (Figure 2). Using this equation to predict testicular weight, it is possible to obtain very reliable values as these measurements are highly correlated. This is an advantage because SC measurements allow gathering useful information for the assessment of reproductive capacity.

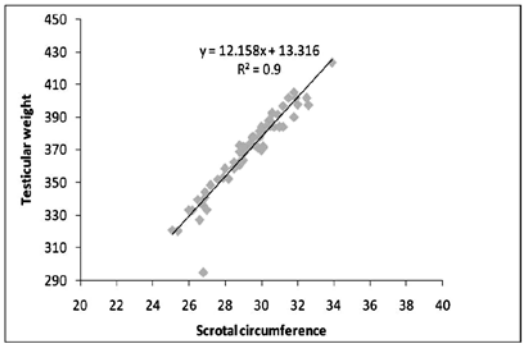

Figure 2. Relationship between scrotal circumference and testicular weight in the assessed bulls.

Given that SC is easy to measure, highly reproducible (Hahn et al., 1969), shows high heritability (Coulter et al., 1975), and highly correlated with testicular weight (volume), it should be used in the selection of young bulls with larger testicular growth and possibly greater sperm output.

CONCLUSIONS

The results obtained in the two experiments show the importance of measuring SC in bulls, as this measurement can be made when a bull enters puberty, determining its potential for sperm output and reproduction in cow-calf systems.

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