DOI: 10.1590/1089-6891v18e-21599
5.04.00.00-2 ZOOTECNIA

MORPHOMETRIC AND TESTICULAR CHARACTERISTICS OF BUFFALOS AT DIFFERENT AGES

CARACTERÍSTICAS MORFOMÉTRICAS E TESTICULARES DE BÚFALOS EM DIFERENTES IDADES

Renata de Oliveira Santos Ramalho[1*]
Douglas Mena do Couto[1]
Victor Cruz Rodrigues[1]
André Mantegazza Camargo[2]

[1] Universidade Federal Rural do Rio de Janeiro, Rio de Janeiro, RJ, Brazil
[2] Instituto Federal de Educação, Ciência e Tecnologia do Maranhão, Codó, MA, Brazil.
* Author for correspondence - renata.o.ra@live.com

Abstract

We evaluated the live weight (LW), morphological and testicular measures and their correlations in 31 Mediterranean buffaloes at three ages. We used seven animals at 8 months of age (T1), 13 animals at the age of 10 months (T2), and 11 animals at the age of 12 months (T3) coming from a farm of the Coastal Lowlands of Rio de Janeiro. The following morphometric measurements and testes were evaluated: rump height (RH), withers height (WH), rump length (RL), round thickness (RT), scrotal circumference (SC), testicular length (TL), testicular width (TW). Testicular volume (TV) and body mass index (BMI) were also calculated. The testicular form was determined by the ratio between the TW and TL. We found the following means for the variables LW (240.57 ± 18.36; 259.38 ± 28.66; and 331.82 ± 63.23), WH (113.28 ± 2.44; 116.23 ± 4.74; and 121.45 ± 6.95cm), RH (116.07 ± 3.09; 117.54 ± 4.97; and 125.45 ± 6.92 cm), RL (34.86 ± 2.03; 36.35 ± 2.80; and 38.09 ± 3.24 cm), RT (39.07 ± 2.22; 40 ± 2.37; and 42.91 ± 3.97cm), BMI (187.37 ± 11.45; 191.69 ± 14.61; and 222.39 ± 23.57) regarding the treatments T1, T2, and T3, respectively. We found the following means for the variables SC (17.43±1.81; 19.08±1.98; and 22.11±3.25 cm), TL (8.28 ± 0.99; 9.27 ± 1.33; and 10.68 ± 1.47 cm), TW (3.25 ± 0.25; 3.90 ± 0.58; and 4.66 ± 0.80cm), and TV (109.43 ± 24.93; 198.36 ± 87.08; and 343.83 ± 183.04 cm^3) regarding the treatments T1, T2, and T3, respectively. The predominant form in all treatments was long. There was no difference between the T1 and T2 for the studied variables. T3 had higher averages for LW, BMI, RH, SC, TV, and TW. For the variables WH, RL, TL, and RT there was no difference between T2 and T3. There was a correlation between measurements and testicular measures WH, RH, and RL and between SC and TV, TL, and TW.

Keywords: body measures; buffaloes; testicular measures.

Resumo

Objetivou-se com este trabalho analisar o peso vivo (PV), as medidas morfométricas e testiculares e

suas correlações entre si em 31 búfalos Mediterrâneo em três idades. Foram utilizados sete animais de 8 meses (T1), treze de 10 meses (T2) e onze de 12 meses (T3), de uma propriedade da Baixada Litorânea do Rio de Janeiro. As medidas morfométricas e testiculares avaliadas foram: altura da garupa (AG), altura da cernelha (AC), comprimento da garupa (CG), espessura de coxão (ECX), circunferência escrotal (CE), comprimento testicular (CT) e largura testicular (LT). Foram calculados o volume testicular (VT) e o índice de massa corpórea (IMC), e foi determinada a forma testicular pela razão entre a LT e o CT. Foram encontradas as médias para das variáveis PV (240,57 ± 18,36; 259,38±28,66 e 331,82±63,23), AC (113,28 ± 2,44; 116,23 ± 4,74 e 121,45 ± 6,95cm), AG (116,07 ± 3,09; 117,54 ± 4,97 e 125,45 ± 6,92 cm), CG (34,86 ± 2,03; 36,35 ± 2,80 e 38,09 ± 3,24 cm), ECX (39,07 ± 2,22; 40 ± 2,37 e 42,91 ± 3,97cm), IMC (187,37 ± 11,45; 191,69 ± 14,61 e 222,39 ± 23,57) para os tratamentos T1, T2 e T3, respectivamente. Foram encontradas médias para as variáveis CE (17,43±1,81; 19,08±1,98 e 22,11±3,25 cm), CT (8,28 ± 0,99; 9,27 ± 1,33 e 10,68 ± 1,47 cm), LT (3,25 ± 0,25; 3,90 ± 0,58 e 4,66 ± 0,80cm) e VT (109,43 ± 24,93, 198,36 ± 87,08 e 343,83 ± 183,04 cm^3) para os tratamentos T1, T2 e T3, respectivamente. A forma predominante para todos os tratamentos foi o Longo. Não houve diferença entre as médias dos tratamentos 1 e 2 para nenhuma das variáveis estudadas. Para as variáveis PV, AG e IMC, CE, LT e VT o tratamento 3 apresentou as maiores médias. Para as variáveis AC, CG, ECX e CT não houve diferença entre os tratamentos 2 e 3. Houve correlação entre todas as medidas testiculares e as medidas de AC, AG e CG e entre CE e VT, CT, LT.

Palavras-chave: búfalos; medidas morfométricas; medidas testiculares.

Received on December 12th, 2012.
Accepted on December 07th, 2016.

Introduction

Testicular biometry study is essential for the reproductive evaluation of the bull, principally in search of precociousness. To do so, besides qualitative and quantitative assessment of the semen, the evaluation of the morphological characteristics of the reproductive system is also used. In addition to being employed in the reproductive evaluation, studies have shown that testicular measures are correlated to carcass characteristics and other productive aspects, being an important productivity indicator. According to Barbosa et al.(1), proving the existence of favorable genetic correlation among growth, reproduction, and carcass characteristics would help animal selection since it would point to only a few characteristics.

Biometric measures of the testes are related to the production of testicular androgen hormones that have an effect in the increment of weight gain, generating a better anabolism of the endogenous nitrogen and improving feed efficiency(2). Pineda et al.(3) found a positive correlation between libido, scrotal perimeter at 18 months of age, which coincides with the greatest testicular growth and the beginning of puberty, a phase that involves high levels of plasmatic testosterone.

Morphology of buffaloes' genital system is similar to the bovines'; however, all the structures that constitute this system (preputial sheath, scrotal sac, testes, penis, and accessory sexual glands) are larger in buffaloes than in bovines.

The scrotal circumference (SC) is selected by the correlation with productive characteristics, such

as animal weight, and reproductive characteristics, such as spermatic production[4]. A favorable and high-magnitude genetic correlation between SC and weight suggests the SC measure is an adequate characteristic for the identification of bulls with higher weight gain potential[5,6]. Ohashi et al.[6] found favorable and high-magnitude correlations between SC and the other testicular biometry characteristics, indicating that the SC is a reliable characteristic to predict testicular size.

Rodrigues et al.[7] found a positive and significant correlation between ribeye area and SC, suggesting the scrotal circumference may be used to estimate ribeye area, and hence, the edible portion of the carcass. The authors also found a positive and significant correlation between the SC and thickness of the round.

Barbosa et al.[1] studied Nellore cattle and found positive genetic correlations between the scrotal circumference and fat thickness, indicating that the selection for greater testicular development aiming at more precocious animals does not jeopardize fat increment. It could even be beneficial. This positive correlation allows the selection to better the fat thickness finishing, it also it improves the characteristics related to sexual precociousness.

Therefore, the objective of this study was to analyze the live weight (LW), the morphometric and testicular measures, and the correlations among each other in 31 Mediterranean buffaloes at 8, 10, and 12 months of age.

Material and Methods

We used 31 Mediterranena buffaloes at three ages: seven animals at eight months of age (T1); 13 animals at ten months of age (T2), and 11 animals at 12 months of age (T3). The animals came from the Três Morros farm, in Casimiro de Abreu city, Rio de Janeiro State (RJ). Casimiro de Abreu is located at Coastal Lowlands - RJ, latitude 22º28'50'' and longitude 42º12'15'', 17 m altitude, warm and wet tropical climate, and an average temperature of 25 ºC. The animals were bred on pasture and received mineral salt at will. Capim-tangola grass was used at the farm. It is a native grass, a hybrid of *Brachiaria arrecta*, previously referred to as *B. radicans*, and *B. mutica*.

The measures were taken in the morning, and the animals were restrained. The average temperature and air relative humidity on the day of the measurement were 26.74 ºC and 78.87%, respectively. We evaluated the following characteristics:

Rump height (RH) - from the upper angle of the rump to the ground, vertically;

Withers height (WH) - from the upper point of the withers to the ground;

Croup length (CL) - distance (in cm) from the end of the hip to the end of the rump;

Round thickness (RT) - distance between the external edge of the right and left round;

Scrotal circumference - measured by tape measure at the median area of the testes[8].

To calculate the body mass index (BMI) we used the measures of withers height in meters (m), obtained by the following expression: BMI - weight (kg) / height²(m)[9].

The length (LENG) and width (WID) were obtained by caliper. To measure the length, we considered the testes, excluding the tail of the epididymides at the dorso-ventral direction; as for the width, we measured the median region of each testis at the latero-medial direction.

To calculate the volume we used the following formula, which was also used by Unanian et al.[8]:

$TV = 2 [(r^2) \times n \times h]$

Where r = radius calculated from the width (WID/2); h = length or height; $\pi = 3.14$. The volume was expressed in cm^3 and it represents both testes.

The shape of the testes was determined by the ratio between width and length and a 0.5-1.0 scale. We defined five different shapes of the testes, according to the ratio found:

- ratio 1 ≤ 0.5 = long;
- ratio 2 from 0.51 to 0.625 = long/moderate;
- ratio 3 from 0.626 to 0.750 = long/oval;
- ratio 4 from 0.751 to 0.875 = oval/spherical;
- ratio 5 > 0.875 = spherical.

The experimental design was entirely random with three treatments (7, 13, and 11 replications). The statistical analysis of the studied variables was interpreted by analysis of variance at 5%, using the statistical package SISVAR[10].

Results and Discussion

There was no significant difference (P>0.05) between T1 and T2 for the body measures analyzed. T3 presented the highest means for the variables weight, croup height, and body mass index. There was no difference between T2 and T3 for the variables withers height, croup length, and round thickness (Table 1).

Table 1. Body measures according to the ages

Ages	LW (Kg)	WH (cm)	CH (cm)	CL (cm)	RT (cm)	BMI (kg/m2)
8 (T1)	240.57^{a}±18.36	113.28^{a}±2.44	116.07^{a}±3.09	34.86^{a}±2.03	39.07^{a}±2.22	187.37^{a}±11.45
10 (T2)	259.38^{a}±28.66	116.23^{ab}±4.74	117.54^{a}±4.97	36.35^{ab}±2.80	40^{ab}±2.37	191.69^{a}±14.61
12 (T3)	331.82^{b}±63.23	121.45^{b}±6.95	125.45^{b}±6.92	38.09^{b}±3.24	42.91^{b}±3.97	222.39^{b}±23.57

LW = live weight; WH - withers height; CH = croup height; CL = croup length; RT = round thickness; BMI = body mass index.

The LW of the animals from this study is higher than that reported by Jorge et al.[11], who found mean weight of 169.84 ± 22.83 kg for Murrah calves at 8 months and 250.59 ± 25.12 kg for calves at 12 months of age. This fact may be explained because these authors[11] used dairy cattle. The other morphometric measures displayed in Table 1 agree with other studies on buffaloes and bovines, such as those by Pacheco[12] and Rodrigues et al.[7].

The evaluation of the testicular measures of SC, TL, TW, and TV (Table 2) indicates that there was no significant difference (P>0.05) between the means of T1 and T2 for any of these variables. As for the variables SC, TW, and TV, T3 presented the higher means. TL did not present any difference between T2 and T3, which might indicate that testosterone activity on the testes is stronger after 12 months of age.

The bigger SC found compared to Moura et al.[5] may be explained by the difference in LW of the animals from this study, since there is a high correlation between LW and SC. Moura et al.[5] did not find a significant difference for the SC between 10 and 12 months of age in Nellore bovines because the process of germinative cells proliferation was at the initial phase, having reduced influence on the structure and diameter of the seminiferous tubules. The greater growth after 12 months of age was due to the increase in the number and volume of the germinative cells and consequent increase in the diameter of the seminiferous tubules, coinciding with the elevation of the testosterone levels. In the present study, the significant difference in SC, TW, and TV measures between animals at 10 and 12 months of age may indicate that there was a precocious process of germinative cells proliferation compared to the animals from the study by Moura et al.[5].

Table 2. Testicular measures according to the ages

Age (months)	SC (cm)	TL (cm)	TW (cm)	TV (cm^3)
8 (T1)	$17.43^{a}\pm1.81$	$8.28^{a}\pm0.99$	$3.25^{a}\pm0.25$	$109.43^{a}\pm24.93$
10 (T2)	$19.08^{a}\pm1.98$	$9.27^{ab}\pm1.33$	$3.90^{a}\pm0.58$	$198.36^{a}\pm87.08$
12 (T3)	$22.11^{b}\pm3.25$	$10.68^{b}\pm1.47$	$4.66^{b}\pm0.80$	$343.83^{b}\pm183.04$

SC = scrotal circumference; TL = testes length; TW = testes width; TV = testes volume.

Unanian et al.[8] studied Nellore bulls and found lower testicular measures in Nellore bovines at 12 months of age (18.49 cm; 6.67 cm; 3.26 cm; 113.80 cm3, for SC, TL, TW, and TV) probably because the animals these authors[8] used had lower weights than the animals from the current study. The statistical difference between T2 and T3 for SC found in this study might mean that in these animals the process of germinative cells proliferation occurred earlier than in Nellore animals.

Rezende et al. (13) observed the following measures for SC, TL, TW, and TV: 13.56 cm; 8.93 cm, 4.32 cm, and 281.82 ml in Holstein/Zebu bovines with a mean of 118.9 kg.

All the testicular measures were in increasing order from T1 to T3, suggesting testicular growth from 8 to 12 months; however, there was significant difference in T3, showing bigger growth around 12 months of age.

We only observed three shapes of the five ones described in the animals of this study. The predominant shape for all the groups was long testes, tending to become long/moderate to oval with the advancement of age. These results agree with those by Unanian et al.[8], who evaluated Nellore bulls and observed a predominance of long testes and a tendency to become oval in older animals. According to Moura et al. [5], there is a higher growth of testosterone length in relation to testosterone diameter during pre-puberty, a pahse that coincides with the increase in basal secretion of testosterone.

By evaluating the correlations among the quantitative variables, we verified that all of them were positively and significantly correlated ($P < 0.01$) (Table 4).

The correlation among all the testicular measures and WH, CH, and CL might indicate that there is selection compatibility between reproductive characteristics and growth; therefore, the use of scrotal circumference as a selection criterion related to the animals' size is promising.

The high and positive correlations between SC and TV, TL, and TW indicate that SC is an adequate characteristic to predict testes size. Rezende et al.[13] also found a correlation between SC and the other testicular measures.

Table 3. Frequency of the different testicular shapes in relation to the ratio Width/Length according to the treatment

Groups	I	II	III
L	100%	84.61%	81.82%
L/M	0	7.69%	9.09%
L/O	0	7.69%	9.09%

L = Long (ratio 1 ≤ 0.5)
L/M = Long /moderate (ratio 2 from 0.51 to 0.625)
L/O = Long/oval (ratio 3 from 0.626 to 0.750)

Table 4. Correlation among age, weight, morphometric and testicular measures of Mediterranean buffaloes

	Age	Weight	WH	CH	PE	TL	TW	RT	CL	TV
Age	1.00									
Weight	0.66**	1.00								
WH	0.59**	0.90**	1.00							
CH	0.62**	0.93**	0.92**	1.00						
CE	0.60**	0.67**	0.58**	0.62**	1.00					
TL	0.59**	0.61**	0.54**	0.57**	0.82**	1.00				
TW	0.72**	0.67**	0.61**	0.58**	0.65**	0.68**	1.00			
RT	0.47**	0.78**	0.65**	0.76**	0.36*	0.47**	0.45*	1.00		
CL	0.49**	0.66**	0.64**	0.65**	0.38*	0.36*	0.61**	0.60**	1.00	
TV	0.65**	0.67**	0.61**	0.57**	0.67**	0.65**	0.97**	0.43*	0.56**	1.00

WH: withers height; CH: croup height; CE: scrotal circumference; TL: testicular length; TW: testicular width; RT: round thickness; CL: croup length; TV: testicular volume.
* = P< 0.05; ** = P< 0.01.

Conclusions

The animals at 12 months of age presented bigger morphometric and testicular measures than the animals at 8 and 10 months of age, which did not differ between each other. There is a correlation between the scrotal circumference and the other testicular measures and among the last ones and measures of withers height, croup height, and croup length. The predominant testicular shape was long. More studies with buffaloes are necessary to define the changes in testicular shape as the animal grows.

Ethics and Biosecurity Committee. According to the Ethics Committee in Research of UFRRJ/COMEP, process No. 23083.001386/2012-41, this investigation meets the basic principles of research involving the use of animals and it agrees with the ethical principals and of animal welfare, according to the resolution 714, from June 20th 2012, CFMV.

References

1. Barbosa V, Magnabosco CU, Trovo JBF, Faria CU, Lopes DTL, Viu MAO. Estudo genético quantitativo de características de carcaça e perímetro escrotal, utilizando inferência Bayesiana em novilhos nelore. Biosci. J, Uberlândia, 2010, 26 (5), p. 789-797, Set./Out. 2010. Disponível em: http://www.seer.ufu.br/index.php/biosciencejournal/article/view/7165

2. Restle J, Alves Filho DC, Faturi C, Rosa JRP, Pascoal LL, Bernardes AC, Kuss F. Desempenho na Fase de Crescimento de Machos Bovinos Inteiros ou Castrados de Diferentes Grupos Genéticos. Rev Bras Zootec, 29(4), p.1036-1043, 2000. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S1516-35982000000400013

3. Pineda NR, Fonseca VO, Albuquerque LG. Estudo preliminar da influência do perímetro escrotal sobre a libido em touros jovens da raça Nelore. Arq. Bras. Med. Vet. Zootec., 2000, 52(1), 69-75. Disponível em: http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0102-09352000000100016

4. Ohashi OM, Santos SSD, Miranda MS, Cordeiro MS, Costa NN, Silva TVG. Morfologia do sistema genital, distúrbio reprodutivo e manejo do macho bubalino (*Bubalus bubalis*). Rev. Bras. Reprod. Anim., Belo Horizonte, 2011, 35(2), 88-94. Disponível em: http://www.cbra.org.br/pages/publicacoes/rbra/v35n2/RB363%20Ohashi%20pag88-94.pdf

5. Moura AAA, Rodrigues GC, Martins Filho R. Desenvolvimento ponderal e testicular, concentrações periféricas de testosterona e características de abate em touros da raça Nelore. Rev. Bras. Zootec, 2002, 31(2, Suppl.), 934-943. Disponível em: https://dx.doi.org/10.1590/S1516-35982002000400017

6. Ohashi OM, Miranda MS, Cordeiro MS, Santos SSD. Desenvolvimento reprodutivo do macho bubalino: circunferência escrotal, atividade espermática e endocrinologia. Rev Bras Reprod Anim, Belo Horizonte, 2007, 31(3), 299-306. Disponível em: http://cbra.org.br/pages/publicacoes/rbra/download/299.pdf

7. Rodrigues VC, Andrade IF, Souza, JCD, Néto AI, Rodrigues VN. Avaliação da composição corporal de bubalinos e bovinos através do ultra-som. Ciênc. agrotec., Lavras, 25(5), 1174-84, 2001. Disponível em: http://www.editora.ufla.br/index.php/component/phocadownload/category/43-volume-25-numero-5?download=745:vol25numero5

8. Unanian MM, Silva AEDF, McManus C, Cardoso EP. Características biométricas testiculares para avaliação de touros zebuínos da raça Nelore. R Bras Zootec, 29(1), 136-144, 2000. Disponível em: https://dx.doi.org/10.1590/S1516-35982000000100019

9. Chacur MGM, Araújo MC, Kronka S. Características seminais, corpóreas e anatômicas do aparelho reprodutor de reprodutores da raça Canchim aos 14 e 48 meses de idade. Arq. ciên. vet. zool. UNIPAR, Umuarama, 9(1), 21-7, 2006. Disponível em: http://revistas.unipar.br/index.php/veterinaria/article/view/35/17

10. FERREIRA DF. Sistema de análises de variância para dados balanceados. Lavras: UFLA, 2000. (SISVAR 4. pacote computacional). Disponível em: http://www.dex.ufla.br/~danielff/programas/sisvar.html

11. Jorge AM, Andrighetto C, Castro VS. Desenvolvimento ponderal de bubalinos da raça Murrah criados em pastagem de Brachiaria brizantha no Centro-Oeste do Estado de São Paulo, Brasil. Ciênc Rural, *35*(2), 417-21, 2005. Disponível em: https://dx.doi.org/10.1590/S0103-84782005000200027

12. Pacheco A, Quirino CR, Pinheiro OLVM, Almeida JVC. Medidas morfométricas de touros jovens e adultos da raça Guzerá. Rev. Bras. Saúde Prod., jul/set, 2008, 9(3), 426-35. Disponível em: http://revistas.ufba.br/index.php/rbspa/article/view/929/663

13. Rezende PLP, Restle J, Pádua JT, Fernandes JJR, Freitas Neto MD, Fortes BDA. Morfometria testicular de bovinos mestiços jovens submetidos a diferentes estratégias de suplementação energética de pastagem de *Brachiaria Brizantha*. Ciênc Anim Bras, Goiânia, 2010, 11(4), 817-24. Disponível em: https://www.revistas.ufg.br/vet/article/view/7642/8722