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Puberty Occurs at the Same Testis Size in Both *Bos taurus* and *Bos indicus* Crossbred Beef Bulls

Donald D. Lunstra, John D. Crouse, and Larry V. Cundiff

Introduction

An increasing number of *Bos indicus*-blood bulls are being used in crossbreeding programs for commercial beef production in the U.S., but there is little information available on pubertal development, sperm production and semen quality for young bulls of this type. Puberty in young *Bos taurus* bulls has been defined in a variety of ways (e.g., first ability to serve, first sperm production, first ejaculation of motile sperm, etc.), but all of these criteria are costly and labor-intensive to determine. We have shown previously (Lunstra et al., 1978) that, among young *Bos taurus* beef bulls of various breeds reared in the same environmental and management conditions, puberty occurs when a scrotal circumference of 28 cm is achieved, regardless of large differences in body wt and age at puberty among and within different breeds of bulls. In that study, puberty was defined as the age at which a bull first produced an ejaculate containing ≥ 50 million sperm with ≥ 10% progressive motility. In addition, we (Lunstra and Echternkamp, 1982) and other researchers have shown that the major characteristics of semen quality improve linearly during the first 12 to 16 wk after reaching this criterion of puberty, and that these improvements in semen quality are highly correlated (r=0.44 to 0.75) with the steady linear increase in scrotal circumference that occurs during this post-pubertal timeframe in *Bos taurus* beef bulls. Thus, scrotal circumference appears to be an accurate and easily-obtained measurement that provides a relatively reliable predictor of age at puberty in young *Bos taurus* beef bulls. However, similar studies on *Bos indicus*-blood bulls are needed before this relationship can be assessed or confirmed in zebu-blood bulls.

It is not reasonable to attempt to use young bulls for natural mating or semen processing immediately after reaching this initial criterion of puberty (i.e., first ejaculate containing ≥ 50 million sperm with ≥ 10% progressive motility). It does not become economically feasible to use young beef bulls for collection and processing of semen for artificial insemination until ejaculates containing ≥ 500 million sperm with ≥ 50% progressive motility can be produced, and this is also a reasonable criterion for young bulls to reach before being used for natural mating. However, no studies using this more stringent semen criterion of puberty have been conducted in either *Bos taurus* or *Bos indicus* bulls. Because selection and use of superior sires at the youngest possible age is desired for natural mating and artificial insemination, further investigations of the relationships between postpubertal changes in testis size and aspects of semen quality are needed in young *Bos taurus* and *Bos indicus* beef bulls.

The following study was conducted to determine the age at which young *Bos taurus* and *Bos indicus* crossbred beef bulls reach this revised criterion of puberty (i.e., first ejaculate containing ≥ 500 million sperm with ≥ 50% progressive motility), and to evaluate interrelationships between pubertal age, testis size, and body wt in these specietyes of beef bulls.

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Procedures

To evaluate age at puberty and neopubertal changes in semen characteristics, 132 spring-born bulls (80 *Bos taurus*, 52 *Bos indicus*) were evaluated monthly from approximately 6 through 20 mo of age. *Bos taurus* crossbred bulls were 3/8, 1/2 or 5/8 Hereford, Angus and Pinzgaur, and *Bos indicus* crossbred bulls were 3/8, 1/2 or 5/8 Brahman and Sahiwal (remaining fraction in each cross was Hereford or Angus for both specietyes). Bulls averaged 223 ± 1 days of age at the beginning of the study, and initial age did not differ among specietyes. All bulls had been subjected to the same managerial and environmental conditions from birth, and all had been weaned at approximately 200 days of age. Postweaning, all bulls were placed in feedlot pens (approximately 44 bulls per pen) and were fed the same growing/finishing rations throughout the study. Body wt (BWT), testis length (TL), and scrotal circumference (SCR) were measured monthly. Paired testis volume (PTV) was calculated using the formula of Lunstra et al., 1988 [PTV = 0.0396 (average TL)(SCR)^2]. Semen collection via electroejaculation was continued monthly until each bull first produced an ejaculate containing ≥ 500 x 10⁶ sperm with ≥ 50% progressive motility (puberty). Electroejaculation was performed twice at each monthly collection date for each bull, and data for the ejaculate exhibiting the best semen quality were recorded. Semen was collected and maintained at 37°C for evaluation. Ejaculate volume was recorded, and progressive motility was determined immediately from duplicate estimates at 37°C, using a microscope (400x magnification). Sperm concentration was determined from spectrophotometer (550 nm) counts of duplicate semen aliquots diluted 1:200 with 1% formalin in 0.9% saline. Live sperm and sperm abnormalities were quantitated microscopically for each ejaculate by scoring 100 sperm in smears stained differentially with eosin-fast green.

Results & Discussion

Body wt and scrotal circumference increased linearly and continuously (P<0.01) in both specietyes of crossbred bulls throughout the study (Fig. 1). Although scrotal circumference at any given age was significantly smaller in *Bos indicus* cross bulls than in *Bos taurus* cross bulls during the first 7 mo of this study, prepubertal scrotal circumference increased at the same linear rate (.040 ± .002 cm per day; r=0.76, P<0.01) in both *Bos indicus* and *Bos taurus* cross bulls (Fig. 1). There was no difference (P>0.75; Table 1) between specietyes in scrotal circumference (32.1 ± 2 vs 32.0 ± 3.3 cm) at puberty (i.e., first ejaculate containing ≥ 500 million sperm with ≥ 50% progressive motility). However, *Bos taurus* cross bulls reached puberty at earlier age (P<0.001; 334 ± 4 vs 404 ± 6 day) and lower body wt (P<0.01; 922 ± 15 vs 1004 ± 20 lb) than did *Bos indicus* crosses. Despite these relatively large specietye differences in pubertal age and pubertal body wt, it is remarkable that bulls in both specietyes reached puberty at essentially the same testis size (Table 1).

By 20 mo of age, 100% (80/80) of *Bos taurus* cross and 83% (43/52) of *Bos indicus* cross bulls had reached puberty. A marked delay in pubertal development occurred...
only in a limited proportion of Bos indicus cross bulls (9/52 bulls, 17%), scrotal circumference averaged 25.5 ± 1.3 cm at 20 mo of age in these 9 bulls, and 4 of these 9 bulls were producing spermatozoa at 20 mo of age. However, it is unknown if these bulls would have reached puberty beyond 20 mo of age. Among bulls that achieved puberty, Bos indicus crossbred bulls reached puberty approximately 70 days (range 56 to 95 days) later than did Bos taurus crossbred bulls (Table 1), but scrotal circumference did not differ (P=.75; Table 1) between these specietypes at puberty (average scrotal circumference at puberty = 32.0 ± 2 cm).

Among the breedtypes within these two major specietypes of bulls (Table 2), Pinzgaur-cross bulls reached puberty 23 to 25 days earlier than did Hereford (P<.04) and Hereford-Angus bulls (P<.06), while Angus bulls were intermediate among Bos taurus breedtypes. Pinzgaur-, Angus-, Hereford-, and Hereford-Angus-cross bulls reached puberty 56 to 81 days earlier (P<.001) than did Brahman and 70 to 95 days earlier (P<.001) than did Sahiwal-cross bulls (Table 2). Again, regardless of the relatively large differences in pubertal age and pubertal body wt among these breedtypes, bulls of these breedtypes did not differ (P=.75; Table 2) in scrotal circumference at puberty (average = 32.0 ± 2 cm); in other words, regardless of breedtype, all bulls reached puberty (i.e., first ejaculate containing ≥ 500 million sperm with ≥ 50% progressive motility) at essentially the same testis size.

The coefficient of variation (CV) at puberty within specietypes (Table 1) was lowest for scrotal circumference at puberty (CV = 6.6%), and the CV was much larger for age at puberty and for body wt at puberty (CV = > 14%). The dramatic variations in age and body wt at puberty are depicted graphically in Figure 2. In addition, the low variation in scrotal circumference at puberty is also shown more clearly in Figure 2. These data indicate that both Bos taurus and Bos indicus crossbred bulls reached puberty (i.e., first ejaculate containing ≥ 500 million sperm with ≥ 50% progressive motility) when testis size reached a scrotal circumference of 32 cm, regardless of relatively large specietype and breedtype differences in pubertal age and pubertal body wt. The linear correlation between a single measurement of scrotal circumference obtained in all bulls between 10 to 12 mo of age and actual age at which those bulls reached puberty ranged from r=-.65 to r=-.69 (P<.001). Given the linearity of testis development in both specietypes of bulls (Fig. 1; .040 ± .002 cm per day; r=.76, P<.01), measurement of yearling scrotal circumference appears to be an easily obtained and relatively accurate predictor of the age at which a bull will reach puberty, regardless of large specietype and breedtype differences in pubertal age and pubertal body wt.

Acknowledgments

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References


Table 1—Comparison of age, body wt (BWT) and scrotal circumference (SCR) at puberty (~500 x 106 sperm with ~50% motility) among specietypes

<table>
<thead>
<tr>
<th>Specietype</th>
<th>n</th>
<th>Mean ± SEM</th>
<th>P&lt;.001</th>
<th>P&lt;.001</th>
<th>P=.75</th>
</tr>
</thead>
<tbody>
<tr>
<td>All bulls</td>
<td>123</td>
<td>358 ± 5</td>
<td>951 ± 12</td>
<td>32.0 ± 2</td>
<td></td>
</tr>
<tr>
<td>± SEMa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specietype:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bos taurus</td>
<td>80</td>
<td>334 ± 5</td>
<td>922 ± 10</td>
<td>32.1</td>
<td></td>
</tr>
<tr>
<td>Bos indicus</td>
<td>43</td>
<td>404 ± 12</td>
<td>1004 ± 20</td>
<td>32.0</td>
<td></td>
</tr>
<tr>
<td>Differenceb</td>
<td>P&lt;.001</td>
<td>P&lt;.001</td>
<td>P=.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient of variation (%)</td>
<td>14.5</td>
<td>14.3</td>
<td>6.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a SEM = Standard error of the mean.
b Probability of a significant difference between specietypes.
Table 2—Comparison of age, body wt (BWT) and scrotal circumference (SCR) at puberty (≥500 x 10⁶ sperm with ≥50% motility) among breedtypes.

<table>
<thead>
<tr>
<th>Breedtype:</th>
<th>n</th>
<th>Age (day)</th>
<th>BWT (lb)</th>
<th>SCR (cm)</th>
<th>SEM</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pinzgaur (1/2,5/8)</td>
<td>18</td>
<td>318</td>
<td>919</td>
<td>31.8</td>
<td>± 9</td>
<td>P&lt;.001</td>
</tr>
<tr>
<td>Angus (5/8)</td>
<td>24</td>
<td>334</td>
<td>925</td>
<td>32.0</td>
<td>± 30</td>
<td>P&lt;.05</td>
</tr>
<tr>
<td>Angus x Hereford (1/2 x 1/2)</td>
<td>16</td>
<td>341</td>
<td>888</td>
<td>32.7</td>
<td>± 5</td>
<td>P=.22</td>
</tr>
<tr>
<td>Hereford (5/8)</td>
<td>22</td>
<td>343</td>
<td>946</td>
<td>31.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brahman (3/8,1/2,5/8)</td>
<td>18</td>
<td>399</td>
<td>1018</td>
<td>31.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brahman x Sahiwal (1/4 x 1/4)</td>
<td>10</td>
<td>398</td>
<td>1008</td>
<td>33.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sahiwal (3/8,1/2,5/8)</td>
<td>15</td>
<td>413</td>
<td>985</td>
<td>31.2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means at puberty

Means (±SEM) ± 9 ± 30 ± 5

d = 001 = 0.05 = 0.22

a) SEM = Standard error of the mean, averaged per breedtype.
b) Probability of a significant difference between specietypes.

Figure 1—Comparison of changes in body wt (upper graph) and testis size (scrotal circumference; lower graph) in Bos taurus and Bos indicus crossbred bulls during pubertal development (8 to 20 mo of age). Puberty (i.e., first ejaculate containing ≥ 500 million sperm with ≥ 50% progressive motility) occurred at a relatively constant scrotal circumference (32.0 ± 2 cm) in both specietypes of bulls. There was no difference (P=.75) between specietypes in scrotal circumference at puberty. Prepubertal scrotal circumference increased at the same linear rate (.04 ± .002 cm per day; r=.76, P<.01) in both Bos indicus and Bos taurus cross bulls.

Figure 2—Scatter graphs depicting the variation observed for body wt at puberty (upper graph) and scrotal circumference at puberty (lower graph) in Bos taurus and Bos indicus crossbred bulls that reached puberty (i.e., first ejaculate containing ≥ 500 million sperm with ≥ 50% progressive motility) between 8 and 20 mo of age. As shown in the lower graph, scrotal circumference at puberty (32.0 ± 2 cm) was relatively constant in both specietypes of bulls. There was no difference (P=.75) between specietypes in scrotal circumference at puberty. Bull body wt at puberty exhibited considerable variation and was not related significantly to age at puberty or scrotal circumference at puberty in Bos indicus and Bos taurus crossbred bulls.