INFLUENCE OF BIOSTIMULATION BY MATURE BULLS ON OCCURRENCE OF PUBERTY IN BEEF HEIFERS

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ABSTRACT

The objective of this study was to determine if biostimulation of prepuberal beef heifers by mature bulls would alter proportions of heifers exhibiting puberty, or age or weight at puberty. Angus (A), A X Hereford (H) and Tarentaise X HA heifers (n = 103) were stratified by age and weight within breed-type and location of birth and allotted randomly to the following treatments: 1) heifers exposed to mature bulls (T1; n = 52) or 2) heifers isolated from bulls (T2; n = 51). At the start of the experiment, heifers in T1 and T2 were 287 ± 2 and 286 ± 2 d of age, respectively. Male-to-female ratio for T1 was 1:26. Heifers in T1 and T2 were maintained in drylots separated by .5 km. Heifers were observed for estrus twice daily for 152 d. Puberty was characterized by the following criteria: 1) behavioral estrus, 2) presence of a palpable corpus luteum (d 9; estrus = d 0) and 3) a rise in serum progesterone above 1 ng/ml (d 9). Proportions of heifers reaching puberty by 11, 12, 13, 14 and 15 mo of age did not differ (P>.10) between treatments. Percentages of heifers reaching puberty by the end of the experiment were 84 and 89% for T1 and T2, respectively. Age and weight at puberty did not differ (P>.10) between treatments and averaged 370 ± 7 d and 293 ± 4 kg, respectively. Results from this experiment indicated that presence of mature bulls did not alter proportions of beef heifers reaching puberty, or age and weight at puberty.

(Key Words: Puberty, Biostimulators, Heifers, Bulls.)

Introduction

Puberty in beef heifers is influenced by breed (Laster et al., 1972; Gregory et al., 1979; Stewart et al., 1980), plane of nutrition and growth rate (Short and Bellows, 1971; Mosely et al., 1982), season of birth (Grass et al., 1982), presence of mature cows (Nelson et al., 1985), photoperiod (Roy, 1980) and temperature (Dale et al., 1959).

Biostimulation has been defined as a stimulatory effect of a male on estrus and ovulation in the female via pheromones, genital stimulation or other less well-defined external cues (Chenoweth, 1983). Presence of males decreased age at puberty in female mice (Vandenbergh, 1967; Colby and Vandenbergh, 1974) and gilts (Brooks and Cole, 1970; Thompson and Savage, 1978).

The effect of males on puberty in ruminant species is not well understood. Drymundsson and Lee (1970) reported that "sudden" introduction of rams to prepuberal ewe lambs synchronized first estrus, but did not increase age at puberty. Short-term exposure of heifers to bulls before the breeding season had no effect on occurrence of puberty (Berardinelli et al., 1978; Macmillian et al., 1979). However, Izard and Vandenbergh (1982) reported that oronasal application of bull urine increased percentages of heifers reaching puberty. Length of exposure, type and (or) form of biostimulatory cues may be important in determining the response of prepuberal heifers to the presence of bulls.

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The objective of this study was to determine if long-term (152 d) exposure of beef heifers to mature bulls would alter proportions of heifers attaining puberty, or age or weight at puberty.

Materials and Methods

The experiment was conducted at the Montana State University Livestock Center, Bozeman. Included in the study were Angus (A) and A × Hereford (H) heifers from Montana State University Livestock Center and A, A × H and Tarentaise × HA heifers from the Red Bluff Research Ranch, Norris, Montana.

Heifers were weaned at approximately 200 d of age and managed as a single group. Heifers were fed to gain .6 kg·head⁻¹·d⁻¹ and given free access to a salt-mineral mix and water during the experiment. Heifers were weighed at consecutive 28-d intervals, except the final interval was 44 d.

Detection of estrus began 15 d before the start of the experiment and heifers were observed twice daily between 0730 and 0830 and 1730 and 1830 for 152 d. A 10-ml jugular blood sample was collected by venipuncture from each heifer 10 d before and at the start of the experiment (January 13, 1984).

One hundred three prepuberal heifers (n = 28 and 75 from Bozeman and Norris, respectively) were stratified by age and weight within breed-type and location of birth and allotted to one of two treatments. Treatments consisted of 1) heifers exposed to mature teaser bulls (T1; n = 52) and 2) heifers isolated from bulls (T2; n = 51). Heifers in each treatment were separated by a distance of .5 km to minimize influences of exteroceptive stimuli associated with each other. Heifers were maintained in open drylot pens of similar size and exposed to similar environmental and management conditions.

Average ages of heifers in T1 and T2 at the start of the experiment were 287 ± 2 and 286 ± 2 d, respectively. Two teaser bulls were placed with heifers in T1 for a male-to-female ratio of 1:26. Every 10 d one of the two bulls was removed and replaced by a third bull. As a result of this rotation each bull was exposed to heifers in T1 for 20 d and rested for 10 d.

Detection of estrus was similar to that of the 15 d pre-experimental period, except bulls were temporarily separated from heifers in T1 for daily estrous detection to ensure similar detection procedures between treatments. Estrus was characterized and recorded when a heifer stood to allow herdmates to mount.

Each heifer was palpated rectally for presence of a corpus luteum (CL) 9 d after estrus and a 20-ml jugular blood sample was collected, allowed to clot for 60 min and centrifuged at 1,000 × g for 10 min. Serum from each sample was decanted, frozen and stored until assayed for progesterone by radioimmunoassay. Blood samples that had been collected before the start of the experiment were handled in a similar fashion. After palpation and blood collection, heifers were returned to their treatment groups and observed for estrus. Subsequent estrous periods were not followed by rectal palpation or blood collection if a CL was detected on d 9 of the first estrous cycle and the next estrus occurred between 17 and 25 d after first estrus. Heifers displaying short cycles (7 to 10 d) or questionable signs of estrus were palpated and bled on the same schedule as mentioned previously, but were palpated and bled 9 d after their next estrus.

Serum samples were assayed for progesterone using a single antibody technique described by Orczyk et al. (1979). The assay was validated by demonstration of parallelism between serial dilutions of serum from a pool of luteal phase sera and ovariectomized cow serum containing increasing quantities of progesterone and the standard curve. Minimum sensitivity of the assay was 30 pg per tube. Assays included sera from both high (5.6 ± 2.0 ng/ml) and low (.59 ± .29 ng/ml) pools and had intra- and inter-assay coefficients of variation of 18.5 ± 1.8 and 20.1 ± 2.5%, respectively.

A heifer was considered to have attained puberty if she 1) displayed estrus, 2) had a palpable CL on d 9 and 3) had an associated progesterone concentration of >1 ng/ml on d 9. Weight at puberty was interpolated between the two weights nearest first estrus. Only those heifers that met the criteria for puberty during the experimental period were used in the statistical analyses. Age and weight at puberty were analyzed by least-square analysis of variance using the General Linear Models procedure of SAS (1982). The model was

$$Y_{ijk} = \mu + T_i + B_{ij} + (TB)_{ij} + b_i (W_{ijk} - W_i) + e_{ijk},$$

where

$$Y_{ijk} = \text{individual observation for age and weight at first estrus},$$
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\[ \mu = \text{overall mean}, \]
\[ T_i = \text{effect of the } i^{th} \text{ treatment}, \]
\[ \text{BL}_j = \text{effect of the } j^{th} \text{ breed-type location classified as breed-type and location of birth of heifer}, \]
\[ (\text{TB})_{ij} = \text{interaction of the } i^{th} \text{ treatment and the } j^{th} \text{ breed-type-location}, \]
\[ b_i(W_{ijk}-W_I) = \text{regression within treatment of the dependent variable on weight per day of age from birth to weaning (WDABW)} \]
\[ e_{ijk} = \text{the residual}. \]

Age of dam (AOD) and AOD x treatment were not significant in preliminary analyses and were not considered further.

Proportions of heifers in T1 and T2 reaching puberty by 11, 12, 13, 14 and 15 mo of age and proportions of heifers reaching puberty for the different breed-type-locations (BL) by the end of the experiment were analyzed by contingency chi-square (Steel and Torrie, 1960).

**Results**

Four heifers from T1 and one heifer from T2 were removed from the data set because of abnormalities of the reproductive organs or death. Treatments did not differ (P>.10) in age and weight at the start of the experiment or average daily gain during the experiment (table 1).

Forty and 44 heifers from T1 and T2, respectively, met the criteria necessary to establish an age and weight at puberty. Age and weight at puberty did not differ (P>.10; table 2) between treatments and averaged 367 ± 6 d and 292 ± 4 kg, and 373 ± 7 d and 295 ± 5 kg for heifers in T1 and T2, respectively. Breed-type-location of birth (BL) affected (P<.05) age at puberty; however, the interaction of BL x treatment did not (P>.10). Therefore, age at puberty was influenced by genotype and(or) location of birth to a similar degree in both treatments.

Linear regressions of age and weight at puberty on WDABW (TRT) were important sources of variation (table 2). Regression coefficients for age at puberty on WDABW were \(-157 ± 74\) and \(-155 ± 55\), and those for weight at puberty were 104 ± 53 and 44 ± 40 kg for heifers in T1 and T2, respectively.

Proportions of heifers reaching puberty at 11, 12, 13, 14, or 15 mo of age did not differ (P>.10) between treatments (table 3). Eighty-three and 88% of heifers in T1 and T2, respectively, reached puberty during the experiment. Proportions of heifers reaching puberty by the end of the experiment did not differ (P>.10) among the five BL classes.

**Discussion**

Greater preweaning weight gain was associated with younger age and heavier weight at puberty in both treatments. These observations are consistent with those reported by Wiltbank et al. (1966) and Greer et al. (1983), who reported that increased preweaning weight gain was associated with reduced age at puberty. The physiological mechanism whereby WDABW alters occurrence of puberty in beef heifers is not known.

Presence of mature bulls did not alter occurrence of puberty or age or weight at puberty of beef heifers in this study. These results are similar to those reported by Berardinelli et al. (1978) and Macmillan et al. (1979). Izard and Vandenbergh (1982) reported that a greater proportion of prepuberal beef heifers treated oronasally with bull urine reached puberty earlier than water-treated controls. They suggested that bull urine contained a pheromone that acted to decrease age at puberty.

<table>
<thead>
<tr>
<th>Treatment (^a)</th>
<th>n</th>
<th>Age, d</th>
<th>Weight, kg</th>
<th>ADG, kg/d</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>48</td>
<td>287 ± 2(^b)</td>
<td>230 ± 3(^b)</td>
<td>.6 ± .1(^b)</td>
</tr>
<tr>
<td>T2</td>
<td>50</td>
<td>286 ± 2</td>
<td>228 ± 2</td>
<td>.6 ± 1</td>
</tr>
</tbody>
</table>

\(^a\)T1 = heifers exposed to bulls; T2 = heifers isolated from bulls.

\(^b\)Column means do not differ (P>.10).
TABLE 2. ANALYSIS OF VARIANCE FOR AGE AND WEIGHT AT PUBERTY

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>Mean square</th>
<th>df</th>
<th>Mean square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment (TRT)</td>
<td>1</td>
<td>1.9</td>
<td>1</td>
<td>459.5</td>
</tr>
<tr>
<td>Breed-type-location of birth (BL)</td>
<td>4</td>
<td>3,613.3*</td>
<td>4</td>
<td>431.2</td>
</tr>
<tr>
<td>TRT X BL</td>
<td>4</td>
<td>658.9</td>
<td>4</td>
<td>831.8</td>
</tr>
<tr>
<td>WDABW (TRT)</td>
<td>2</td>
<td>6,464.0*</td>
<td>2</td>
<td>1,340.7**</td>
</tr>
<tr>
<td>Error</td>
<td>72</td>
<td>1,041.0</td>
<td>72</td>
<td>541.9</td>
</tr>
</tbody>
</table>

*P<.05.
**P<.10.

TABLE 3. PROPORTIONS OF HEIFERS REACHING PUBERTY FOR AGE GROUPS AND THEIR TOTALS

<table>
<thead>
<tr>
<th>Treatments(#)</th>
<th>N</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2</td>
<td>50</td>
<td>7/50</td>
<td>18/43</td>
<td>8/25</td>
<td>9/17</td>
<td>2/8</td>
<td>44/50</td>
</tr>
</tbody>
</table>

\(\#\)T1 = heifers exposed to bulls; T2 = heifers isolated from bulls.
\(b\)Column proportions do not differ (P>.10).

response of this theoretical pheromone was dependent upon body weight. The primary differences between the present study and that of Izard and Vandenberg (1982) were length and type of biostimulatory exposure. In the present study, and in those of Berardinelli et al. (1978) and Macmillan et al. (1979), the bull was used for 21 to 152 d. One could hypothesize that a positive response to bulls may not be a function of time of exposure, but rather a function of stimulus concentration (bull urine) or an interaction of these factors. Thus, the male-to-female ratio employed in the present study may have diluted the urinary pheromone stimulus such that any single heifer did not receive adequate exposure to respond.

The effect of males on reproductive processes of females varies with species (Avon, 1979) and possibly with reproductive state. Although it does not appear that presence of mature bulls hastens puberty in beef heifers, it may decrease the postpartum interval to estrus in beef cows (Zalesky et al., 1984). Further research is necessary to determine other factors and interactions by which social cues influence reproductive activity in the female bovine.

Results of the present study and previously reported literature indicate that biostimulation by mature bulls, for a short or extended period of time, does not alter occurrence of puberty or age or weight at puberty in beef heifers.

Literature Cited


