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Exposure of prepubertal beef bulls to cycling females does not enhance sexual development

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ABSTRACT

The objective of this study was to determine whether continuous, long-term, fenceline exposure of prepubertal beef bulls to cycling beef females reduced age at puberty and influenced the percentage of bulls that passed an initial breeding soundness examination (BSE). Bulls (Angus, n = 37; Simmental, n = 22; Hereford, n = 10; Simmental × Angus, n = 8) at an average age of 202 ± 21.5 days were given either continuous fenceline and visual exposure to cycling females (exposed, n = 41) or no exposure (control, n = 36). Estrus was induced in cycling beef females so at least three females were in standing estrus each week during the 182 days of exposure to bulls. Scrotal circumference (SC), body weight, and blood samples were collected every 28 days. When bulls had SC of 26 cm or more, semen samples were obtained monthly *via* electroejaculation until puberty was achieved ($\geq 50 \times 10^6$ sperm/mL with at least 10% progressive motility). Behavioral observations were conducted twice monthly: once when females were in estrus and once during diestrus. Homosexual mounting, flehmen responses, and number of times near penned females were recorded for each observation period. Breeding soundness examinations were conducted when the average age of bulls was 364 ± 21.5 days. Normal sperm morphology of at least 70% and sperm motility of at least 30% were required to pass the BSE. Age, body weight, and SC at puberty did not differ between exposed and control bulls (320 ± 28 and 311 ± 29 days; 466.2 ± 12.2 and 437.7 ± 13.5 kg; and 34.4 ± 2.5 and 34.9 ± 2.5 cm, respectively). Percentage of bulls passing their initial BSE did not differ between treatments (exposed, 87.8%; control, 75.0%). Treatment, month, and female estrous stage interacted (P = 0.05) to affect the number of mount attempts and flehmen responses. Exposed bulls entered the cow area more times (P < 0.001) during estrus than diestrus in Months 1, 2, and 3. We concluded that bulls given continuous, long-term, fenceline exposure to cycling beef females do not have enhanced sexual development.

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1. Introduction

Age at puberty is a crucial factor influencing a young bull's ability to pass a breeding soundness examination (BSE) at the age of 1 year, and reducing that age may prove beneficial to beef producers. Researchers have established that beef females can achieve puberty at earlier ages and reduce the duration of postpartum anestrus when exposed to mature bulls [1–3], and puberty is hastened in prepubertal gilts when exposed to boars [4].

Across species, pheromones secreted in urine, feces, and glands have been shown to influence the female reproductive system *via* pheromonal detection by the vomeronasal organ and subsequent effects on the hypothalamic-pituitary-gonadal axis [5,6]. Pheromones may act alone in combination with visual, auditory, and (or) tactile cues [5] such as mounting activity, vocalization,

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licking, and nuzzling, although potential effects of non-pheromonal cues largely remain to be delineated.

Considering both potential pheromonal and non-pheromonal effects, few studies have evaluated the effects of female exposure on bovine male sexual development. Price and Wallach [7] reported that bulls with exposure to females (weaning to 18 months of age) exhibiting estrus at various times throughout the study did not have advantage over nonexposed bulls in their sexual performance at an older age. Sexual stimulation before semen collection is well documented to enhance sperm output by bulls [8,9] and widely used in the commercial artificial insemination industry. Similarly, Geary and Reeves [10] reported that bulls use visualization rather than olfaction as the primary and preferred way to detect estrus in females.

Our hypothesis was that continuous, long-term visual and fenceline exposure of young beef bulls to cycling females would accelerate the pubertal process, and thus increase the percentage of bulls passing their first BSE at the age of approximately 1 year. Objectives were to (1) determine if continuous, long-term fenceline exposure of prepubertal beef bulls to mature beef females exhibiting estrous cycles influence age at puberty and (2) quantify the percentage of exposed bulls passing their initial BSE compared with bulls not exposed to cycling females. In addition, we determined how estrual females affected bull sexual behaviors such as bull mounting and flehman response incidence.

2. Materials and methods

This study was conducted at the Kansas State University Purebred Beef Teaching Unit in accordance with and approval of the Kansas State University Institutional Animal Care and Use Committee. A total of 79 bulls (Angus, n = 39; Simmental, n = 22; Hereford, n = 10; Simmental × Angus, n = 8) at an average age of 202 ± 21.5 days at treatment onset were used in this study. Bulls were weaned 10 days before the onset of the study, grouped by breed, and stratified by age within breed, then assigned randomly to one of two treatments: (1) continuous fenceline and visual contact with beef females exhibiting estrous cycles (exposed, n = 41) or (2) no visual or fenceline contact with beef females (control, n = 38). Two control bulls (one Angus and the other Simmental) were removed from the study; one had only one testicle, and the other was a carrier of a genetic defect. Hence, 41 bulls (n = 20 and 21 bulls per pen) were in the exposed treatment (Angus, n = 18; Simmental, n = 10; Hereford, n = 5; Simmental × Angus, n = 3), and 36 (n = 17 and 19 bulls per pen) served as controls (Angus, n = 20; Simmental, n = 11; Hereford, n = 5; Simmental × Angus, n = 5). Exposure to cycling females began on Day 0 and continued through the second BSE at Day 182 of the study.

2.1. Bull management

Bulls were housed in four 97.6 m × 42.7 m adjacent pens. A 3.4-m-high plywood wall served as a visual barrier between the exposed and control bulls, thus preventing the control bulls from observing the cycling beef females (minimum of 42.7 m from control bulls to penned females). Cycling females were housed in a 54.9 × 10.6-m pen located within one of the two pens of exposed bulls such that all exposed bulls had a minimum of 54.9 linear meters of fenceline exposure facilitating continual visual and nose-to-nose contact with cycling females during the study. Dietary rations for bulls consisted of four ration phases: a starter diet (46.3% wet corn gluten, 44.7% prairie hay, and 2.4% flaked corn) was fed for 10 days from weaning to onset of the study and the first 11 days of the study; a grower diet (47.5% wet corn gluten, 34.7% prairie hay, and 15.3% flaked corn) was fed for the next 70 days; and a finisher diet (44.6% wet corn gluten, 24.5% prairie hay, and 28.5% flaked corn) was then fed for the 61 days. The trial concluded with the grower diet for the final 39 days of the study. Diets were formulated for bulls to achieve an approximate average daily gain of 1.6 kg.

2.2. Female management

Beef females (n = 9) that continued to exhibit estrous cycles were divided into two groups (n = 4 or 5) for use in this study, and all females were in visual and fenceline contact with bulls throughout the duration of the study. Transrectal ultrasound was performed and the presence of a CL was confirmed to ensure that females were exhibiting estrous cycles before beginning the study. Females with a CL at the time of the ultrasound were administered 500 μg of cloprostenol (EstroPLAN; Agri Laboratories, Ltd., St. Joseph, MO, USA) im to cause luteolysis and bring females into estrus. All other females without a CL were subjected to an initial estrous synchronization protocol before the study in which a 100 μg GnRH (Factrel, 2 mL; Fort Dodge Animal Health, Overland Park, KS, USA) was given in conjunction with insertion of an intravaginal controlled internal drug release (Eazi-Breed CIDR; Zoetis, Madison, NJ, USA) insert for 5 days. On removal of the CIDR, 500 μg cloprostenol was given im to cause luteolysis and bring females into estrus. After this initial synchronization of estrus, each week beginning on Day 0, a group (n = 4 or 5) of females was estrus-synchronized by treating with 500 μg of cloprostenol im and the second group was synchronized the following week. On Day 46 of the study, seven of the original nine females were replaced with females that had been confirmed to be exhibiting estrous cycles. The pattern of weekly estrous synchronization continued throughout the study. A combination of ESTROTECT patches (Rockway, Inc., Spring Valley, WI, USA) and visual observation was used to detect females in estrus each week to confirm that females exhibited standing estrus behavior. Each week, a minimum number of three of the females in the group were confirmed to be in standing estrus. Synchronization of estrus continued through completion of the study (Day 182).

2.3. Body weights, scrotal circumference, and blood sampling

Initial body weight, scrotal circumference (SC), and blood sample were collected 3 days before the onset of treatment (Day 3). On Day 0, exposure to cycling females began, and a second time body weight, SC, and blood