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Effects of growth-promoting technology on feedlot cattle behavior in the 21 days before slaughter

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ABSTRACT

There is growing interest in the animal welfare implications of growth-promoting technology used in feedlot cattle, namely hormonal implants, ionophores, antibiotics and β_2-adrenergic agonists. Previous studies have focused on the effects of implants on aggression, but little work has evaluated other behavioral changes anecdotally reported with β_2-adrenergic agonists, such as an increase in lateral lying, a posture seen when cattle rest. The objectives of the present experiment were to quantify the effects of these technologies on lying and agonistic behavior in the 21 days before slaughter and to examine the sampling strategy required to measure lateral lying. Angus crossbred steers were assigned to 16 pens of 10 animals each. Treatments were applied in an additive manner to represent the decisions that feedlot managers would likely make about technology use. They were: (1) control (CON; no technology application), (2) monensin and tylosin phosphate (MON), (3) MON and growth implant (trenbolone acetate and estradiol, IMP) and (4) IMP and zilpaterol hydrochloride, a β_2-adrenergic agonist (fed day 24–3 before slaughter; BAA). Agonistic (pushing, displacements) and bulling behaviors were recorded on day 21, 17, 12, 7 and 3 before slaughter and lying behavior, including time and number of bouts of lateral and sternal lying, was measured on day 12, 7, and 3. These time points were chosen to overlap with the feeding period for zilpaterol. BAA cattle spent 31% more time lying laterally, compared to all other treatments (BAA: 2.4 vs. others: 1.7 h/24 h, SE: 0.18 h/24 h, $P = 0.020$), perhaps because of changes associated with muscle growth. Continuous measurement is needed to measure lateral lying; estimates generated with instantaneous scan sampling never met all of our criteria for accuracy ($R^2 > 0.9$, slope = 1, intercept = 0). BAA cattle engaged in more pushing and displacements than MON or CON ($P \leq 0.05$); IMP also increased pushing compared to MON or CON, but only during day 12, 7 and 3 before slaughter (IMP and BAA 12.5 pushes/steer/h vs. MON and CON 6.8 pushes/steer/h, SE 1.4 pushes/steer/h, $P = 0.007$). Together, these findings indicate that combined use of growth-promoting technologies tested in this experiment affected both agonistic and lying behavior.

1. Introduction

Growth promoting technologies (GPT) include the use of antibiotics, ionophores, steroid implants, and β_2-adrenergic agonists. Use of GPT in USA cattle is common (presented as % of USA feedlot cattle affected) and for a range of reasons. Antibiotics (48%) are fed to prevent and

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to treat illness and to increase weight gain; ionophores (90%) are used to reduce sub-acute ruminal acidosis by altering fermentation and feeding behavior (González et al., 2009, 2012; Nagaraja and Lechtenberg, 2007). Hormonal implants are small pellets that provide timed release of steroids to increase average daily gain and feed efficiency in 84% of USA cattle (Agriculture, 2011). β_2-adrenergic agonists (57%; Agriculture, 2011) are fed in the latter stages of the finishing period to increase average daily gain and feed efficiency, and maximize lean muscle growth (Avedaño-Reyes et al., 2006; Miller et al., 1988; Moloney et al., 1990; Vasconcelos et al., 2008). Decisions about use of GPT are additive; feed yards begin with the most common GPT (ionophores, hormonal implants) and then make decisions about what to add (e.g. β_2-adrenergic agonists).

In addition to the changes listed above, GPT affect other aspects of biological function, including changes in circulating blood steroid concentrations (e.g. with hormonal implants, Hayden et al., 1992) or act like endogenous catecholamines that bind to β-adrenergic receptors (e.g. with β_2-adrenergic agonists, Mersmann, 1998). These modes of action likely have other systemic effects that may be concerns in terms of animal welfare. For example, β_2-adrenergic agonists significantly increased the likelihood of death in feedlot cattle (Loneragan et al., 2014).

Animal welfare is multi-disciplinary and numerous measures can be used to assess it. In the present study, the focus was on agonistic and lying behaviors. Agonistic behavior is associated with injury and handling difficulty (Blackshaw et al., 1997; McGlone, 1986), but the effects of GPT that include androgens or β_2-adrenergic agonists on agonistic behaviors are poorly understood. In addition, at the time of the present experiment, β_2-adrenergic agonists were a newer technology and feedlot managers anecdotally reported an increase in lying laterally (lying on the side, with legs extended) when this GPT was fed in the month before slaughter (exact number of days fed varies by product). Dairy cattle spend more time lying on their side when more space is provided (e.g. open pens vs. tie stalls; Haley et al., 2000), but other factors, such as diet or growth rate, that may affect lying position have not been studied. Indeed, in contrast to other aspects of cattle behavior (Ledgerwood et al., 2010; Mitlöhner et al., 2001), little is known about how to quantify lateral lying in cattle accurately. Thus, the objectives of the present study were (1) to quantify the effects of GPT on agonistic and lying behaviors before slaughter, and (2) to examine a sampling strategy to measure lateral lying in feedlot cattle.

2. Materials and methods

The University of California, Davis Institutional Animal Care and Use Committee approved this work (protocol 17013).

2.1. Cattle, housing, and experimental design

In 2009, a total of 160 Angus crossbred steers with an average initial body weight (BW) of 436 ± 19.3 kg were each allocated to 1 of 16 pens with 10 animals/pen. Pens were assigned to one of four treatments (four pens/treatment): (1) a control with no feed additive or hormone implant (CON); (2) 33.1 mg/kg DM of monensin (Rumensin, Elanco, Greenfield, IN, USA) and 12.2 mg/kg DM of tylosin phosphate (Tylan, Elanco, Greenfield, IN, USA, MON); (3) MON and implantation with a combination of 120 mg trenbolone acetate and 24 mg estradiol (Revalor-S, Merck Animal Health, DeSoto, KS, USA, IMP) and (4) IMP and 8.3 mg/kg of DM of zilpaterol hydrochloride (ZH, Zilmax, a β_2-adrenergic agonist, Merck Animal Health, DeSoto, KS, USA, BAA). As per normal feedlot practice, all diets were mixed to label specifications (mg/kg DM); the amount of feed additives consumed by each steer depended on feed intake. Treatments were applied in an additive manner to represent the decisions that feedlot managers would likely make about technology use. All treatments began after a 2 week acclimation period to the feedlot and were fed until slaughter. ZH was fed according to the drug label: 20 days at the end of the feeding period (day 22–3 before slaughter), allowing a 3 day withdrawal. Animals were fed twice daily at 07:00 and 14:00 h, and diet composition and growth parameters are reported in Stackhouse-Lawson et al. (2013).

Pens were divided into four blocks (four pens or groups/block; treatments equally represented in each), based on body weight (BW), with 25% of the heaviest animals allocated to the first block and so on. This affected time to slaughter, which was based on final shrunk BW (calculated as 0.96 BW). The heaviest BW block was slaughtered after being on the treatments for 86 days and each of the remaining three BW blocks were slaughtered at 100, 114, and 128 days after entry into the feedlot. To create consistency across all blocks, timing is henceforth reported as days before slaughter.

From arrival at the feedlot to day 13 before slaughter, cattle were housed in pens with concrete floors and overhead shade oriented north–south. Space allocation for eight of the 16 pens was 29.7 m^2/head and the remaining eight pens were at 9.7 m^2/head; treatments were equally represented in each. Pens had 120 cm of linear bunk space (12 cm/steer). Thirteen days before slaughter, four groups of cattle (one from each treatment) were moved into four 185 m^2 fenced, dirt pens, each with a 13 m^2 concrete feed apron. Each pen was an enclosed by a larger, dome-like 22 m by 11 m structure with a white cover (Intertape Polymer Group, Montreal, Quebec, Canada) and a ventilation system to manage airflow. This process was repeated for the remaining 12 groups, in turn. Cattle were moved to these pens to facilitate measurement of greenhouse gas emissions (see Stackhouse-Lawson et al., 2013) and video recording (current work) during the ZH feeding period.

Body weight was measured every 28 days before the morning feed using a chute with calibrated scale (Silencer, Commercial Pro Model, Lorraine, KS, USA). Steers were also weighed when they were moved into and removed from the dirt-based pens.

2.2. Behavior

Behavior measurements were recorded the last 21 days before slaughter. This timing was chosen to capture the effects of the BAA treatment, as ZH is only fed for a limited