Meat Science 126 (2017) 36–42

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Effects on performance and meat quality of Holstein bulls fed high concentrate diets without implants following immunological castration

S. Marti [a], J.A. Jackson [b], N. Slootmans [c], E. Lopez [d], A. Hodge [d], M. Pérez-Juan [e], M. Devant [a,*], S. Amatayakul-Chantler [d]

[a] IRTA-Ruminant Production, Animal Nutrition, Management, and Welfare Research Group, Torre Marimon, Caldes de Montbui, Barcelona, Spain
[b] Veterinary Medicine R&D, Zoetis, Kalamazoo, MI, USA
[c] Veterinary Medicine R & D, Zoetis, Zaventem, Belgium
[d] Veterinary Medicine R&D, Zoetis, Parkville, Victoria, Australia
[e] Department of Product Quality, IRTA-Monells, Finca Camps i Armet, 17121 Monells, Girona, Spain

ARTICLE INFO

Article history:
Received 9 October 2016
Received in revised form 16 November 2016
Accepted 17 November 2016
Available online 25 November 2016

Keywords:
Immunocastration
Performance
Meat quality
Beef

ABSTRACT

The objective of this study was to evaluate the effect of the GnRH vaccine on the performance and meat quality of Holstein bulls fed high concentrate diets. A total of 493 approximately 7 month old bulls (initial BW 298 ± 1.2 kg) were allocated into 3 treatment groups, intact bulls ($n = 164$), animals surgically castrated at 15 to 17 d of the study ($n = 164$), and animals vaccinated on 0 and 28 d of the study with the GnRH vaccine ($n = 165$). Animals were slaughtered between 131 and 133 d and carcass quality was evaluated. Hot carcass weight, dressing percentage, fat classification and meat quality parameters did not differ significantly between surgically castrated and vaccinated animals but differed ($P < 0.05$) from intact bulls. Carcass classification, pH at 26 h, and fat color were not affected by treatment.

1. Introduction

Intact bulls show significantly higher ADG and more efficient feed use (Mach et al., 2009; Marti, Realini, Bach, Pérez-Juan, & Devant, 2011; Marti, Realini, Bach, Perez-Juan, & Devant, 2013) thereby decreasing production costs in comparison to castrates. Management of intact bulls is however challenging due to their tendency for aggressive and sexual behavior, adding an element of risk to human caretakers (Bonneau & Enright, 1995; Jago, Bass, & Matthews, 1997). Castration of bulls also modifies meat quality (Field, 1971; Mach, Bach, Velarde, & Devant, 2008; Seideman, Cross, Otjen, & Schanbacher, 1982). Late castration on post-pubertal bulls takes advantage of the performance gains and feed efficiency of intact animals while reaping the benefits of castration on meat quality and behavior (Mach et al., 2009). There are however considerable drawbacks associated with castration, chiefly the additional labor and cost that is required, and its implications for animal welfare (Bonneau & Enright, 1995).

An alternative to physical castration is active immunization against gonadotropin-releasing hormone (GnRH). This is an attractive approach in comparison to physical castration, as it potentially allows producers to capture the production gains from raising intact male cattle, while improving meat quality and controlling unwanted behavior through a strategically timed intervention. Many studies have demonstrated that immunological castration can be very efficient in preventing aggressive and sexual behavior in bulls (Jago et al., 1997; Marti et al., 2015; Price, Adams, Huxsoll, & Borgwardt, 2003). However, literature data indicate that there is no clear effect of immunocastration on performance; the growth of treated animals has been described to be equal to castrates and lesser to intact bulls (Cook, Popp, Kastelic, Robbins, & Harland, 2000; Hernández et al., 2005; Ribeiro et al., 2004), intermediate between those of intact and castrates (Adams, Daley, Adams, & Sakurai, 1996; Aïssat, Sosa, de Avila, Bertrand, & Reeves, 2002;) or equal to intact animals (Adams & Adams, 1992; Adams et al., 1996; Amatayakul-Chantler et al., 2012; D'Occhio, Aspden, & Trigg, 2001; Finnerty, Enright, Morrison, & Roche, 1994 Huxsoll, Price, & Adams, 1998; Pérez-Linares et al., 2017). This divergence in performance data can be explained by the great variety of beef production systems existing around the world, so, immunological castration has been studied under different breed, vaccination programs, diets and implant programs. All these factors affect animal growth and in consequence may alter the animal growth response to the immunological castration programs. For this reasons it's necessary to evaluate the application of immunological castration programs under the different production systems (breeds, diets, implants). The objective was to study the efficacy of GnRH vaccine (2 doses program) in 7 mo old Holstein bulls fed high concentrate diets without implants as an alternative to surgical castration.

* Corresponding author.
E-mail address: maria.devant@irta.cat (M. Devant).

http://dx.doi.org/10.1016/j.meatsci.2016.11.013
0309-1740/

2. Materials and methods

2.1. Animals, housing, and diets

Four hundred and ninety male three Holstein calves (298 ± 1.2 kg of initial BW and 216 ± 0.2 d old) were managed following the principles and guidelines of the Animal Care Committee of IRTA (DMAH 5590 and 5591) and assigned to one of the 3 treatments: intact bulls (bulls), surgically castrated animals (castrated), and animals vaccinated with GnRH (vaccinated). Animals were brought to the farm in Montgai (Spain) between 14 and 20 days after birth from different origins but form the same market, and were fed milk replacer for 5 weeks after arrival. After 3 mo, animals were allocated to 4 identical solid construction barns with open front and metal gated pens (with natural ventilation provided by a space of approximately 0.5 m high between the roof and the walls) with 6 pens in each barn with a stocking density of 20 to 22 animals each. Each barn contained two statistical blocks and pens were assigned randomly to each treatment. Each pen measured 12 m × 6 m (72 m^2 per pen) and was equipped with 1 concentrate feeder with 6 feeding spaces, 1 straw feeder with 7 feeding spaces, and 1 watertrough. Pens were deep bedded with straw that was replaced every 15 days. From that point in time to trial started, all animals were managed equally. On the day that trial started, animals were blocked based on age and on BW All animals were fed the same pelleted concentrate (46.7% corn, 27.2% barley, 12.2% soybean meal, 7.4% soyhulls, 5.1% palm oil, 0.93% calcium carbonate, 0.3% salt, 0.2% premix; 14.6% CP, 8.7% EE, 16.0% NDF, 4.1% ash, 3.54 Mcal ME/kg; DM basis) and barley straw (3.5% CP, 1.6% EE, 70.9% NDF, and 6.1% ash; DM basis) *ad libitum* throughout the experiment.

On day 0 and 28 of the study, 1 mL of GnRH vaccine (Bopriva, Zoetis, Louvain-la-Neuve, Belgium) was administered subcutaneously to animals in the vaccinated treatment group on the left side of the neck through a 12.5-mm, 16-gauge needle by single injection using a safety vaccinator (Simcro Sekurus safety injectors; Simcro, New Zealand). The safety vaccinator was used to prevent inadvertent self-administration. The shroud fitted onto the safety vaccinator encourages tenting of the animal skin and facilitating single hand delivery of vaccine by subcutaneous injection. On the same study days, 1 mL of 0.9% saline solution was subcutaneously injected to intact bulls and surgically castrated animals.

Surgical castration was performed on day 15, 16 or 17 of the study. Deep sedation was achieved through an intramuscular injection of Xylazine (1 mL per 100 kg of Sedaxylan, Eurovet, Bladel, Netherland). After administration of local anesthesia (2% lidocaine, Xilocaina Ovejero, Laboratorios Ovejero, Vilecha, Spain) through the distal pole of each testicle (3 mL per testicle) and into the distal end of the scrotum (2 mL), a vertical incision was made into the scrotum over the area of each testicle and through the parietal tunic to allow exteriorization of each testicle. Each testicle was removed *via* emasculation and division of the spermatic cord was made using an emasculator. At the same time, analgesia (3 mg/kg BW of flunixin meglumine, Fluxinin Injectable Norbrook, Laboratorios Karizoo S.A., Spain) and antibiotic treatments (12 mg/kg BW, procaine benzylpenicillin, Depocillin, Laboratorios Intervet, S.A., Spain) were administered. Both analgesic and antibiotic treatments were repeated at 48 h after castration.

2.2. Measurements and sample collection

Animals were weighed on day −14 and BW records were used to block treatment groups. On day −13 to −11, a testicle examination was performed as only animals with the 2 descended testicles could participate in the study. Animals were also weighed on day 0, 35 and every 14 d until day 126 before animals were transported to the slaughterhouse. On day 0, 35 and every 14 d until d 126 a 10-mL blood sample was harvested by jugular venipuncture (BD Vacutainer, non-additive tube) from all animals for subsequent serum testosterone concentration and serum GnRH antibody titers analysis. All blood samples were centrifuged at 1500 × *g* at 4 °C for 15 min, and serum was decanted and stored at −20 °C until further analysis. On day −13 to −11, 56, 84, and 126 of the study, testicular examination included an assessment of testicular consistency by manual palpation and scrotal circumference measurements using a metal scrotal tape. Consistency was graded using a 5-point scale: 1: very firm; 2: firm; 3: moderate; 4: soft; and 5: very soft.

2.3. Chemical analyzes

Feed samples were analyzed for DM (24 h at 103 °C), ash (4 h at 550 °C), CP by the Kjeldahl method (AOAC, 1995), NDF according to Van Soest, Robertson, and Lewis (1991) using sodium sulfite and alpha-amylase, and fat by Soxhlet with a previous acid hydrolysis (AOAC, 1995).

Serum GnRH IgG antibody titers were determined by dissociation enhanced lanthanide fluorescence immunoassay (**DELFIA**; Ankelo et al., 2007; Bonin, Tiru, Hollander, & Bredberg-Raden, 1999) according to Amatayakul-Chantler et al. (2012). Intra- and inter-assay CV were 6.7 and 8.5%, respectively. Serum testosterone concentration was determined using the DIAsource Testo-Easia kit following the instructions of the manufacturer (Testo-EASIA kit, DIAsource Immunoassays S.A., Nivelles, Belgium). Intra- and interassay CV were 4.85 and 7.15%, respectively. The range of the assay was 0 to 19 ng/mL, with a detection limit of 0.05 ng/mL.

2.4. Carcass and meat quality measurements

On day 131, 132 or 133 all animals of one block that was randomly selected (one pen per treatment) were transported to a commercial slaughterhouse (Mercabarna, Barcelona, Spain). Before each loading, animal BW was recorded. Animals were slaughtered after stunned using a captive bolt pistol, suspended by a hind leg and exsanguinated. Hot carcass weight was recorded, and the degree of carcass fatness and conformation were graded according to the (S) EUROP categories (EU Regulation No. 1208/81, 1026/91) and according to the 1 to 5 scale EU classification system (EU Regulation No. 1208/81), respectively. Carcass bruising score were assessed according to the Australian Carcass Bruising Scoring System (ACBSS, Anderson & Horder, 1979). Carcasses were then moved through a cold chamber at 0 °C of temperature at 1.25 m/s of velocity; airing was in a room between 0 °C to 2 °C of temperature at 0.85 m/s of velocity; finally, carcasses were kept in a cooling rom at 0 °C to 2.5 °C of temperature at 0.5 m/s of velocity. At 4 and 26 h after slaughter, pH of LM were measured using a pH meter (PH 25 DL, Crison, Alella, Spain) on the left half of the carcass between L4 and L5. If pH at 26 h after slaughter was at least 5.8, carcass was defined as dark, firm, and dry (DFD).

For meat quality measurements, meat samples from 56 animals randomly chosen from each treatment group were analyzed. A bone-in rib section between the 9th and 11th ribs was removed after the 26 h pH as outlined by Hankins and Howe (1946) and used to determine physical separable fat, lean, and bone and other meat quality parameters.

The LM was removed from each rib section, cut between the 10th and 11th rib and instrumental meat, and fat color measurements were recorded. Lightness (L^*), redness (a^*), and yellowness (b^*) were measured on the exposed cut surface of the LM after 30 min of bloom time using a Minolta colorimeter (CR-400, Minolta Inc., Osaka, Japan) in the CIE-LAB space (Commission International de l'E'clairage, 1976) with illuminant D65 and 2° viewing angle. Fat thickness over rib eye and rib was measured and rib eye area was estimated using a digital image from the exposed surface and processing with image software (Pomar, Rivest, dit Bailleul, & Mercaux, 2001). The LM was cut into 2 steaks (2.5 cm each) which were individually vacuum-packaged, stored at 4 °C, and then frozen after 1 and 7 d of aging for subsequent Warner-Bratzler shear force (WBSF) measurements. The remaining steak of the LM was vacuum-packaged and stored at −20 °C until