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The impact of oestradiol only hormone growth promotants (HGPs) on the eating quality of pasture finished steer carcasses

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ABSTRACT

A total of 200 *Bos indicus/Bos taurus* cross steers were allocated to control (CON) and an oestradiol (OES) implant treatments and pasture finished for 389 days. *Longissimus lumborum* (LL) and *gluteus medius* (GM) samples were aged for 5 and 35 days. Live weight, carcass weight and ossification scores ($P < 0.05$) increased in OES relative to CON. The three-way interaction between treatment, days aged and muscle was significant ($P < 0.05$) for tenderness, overall liking and meat palatability, whereby the OES had lower scores relative to CON at 5 days in LL ($P < 0.05$), although the difference halved by 35 days. For the GM, OES scores at 5 days were lower than CON ($P < 0.05$), apart from like flavour, and differences reduced by 35 days. LL shear force was higher for OES at 5 days ($P < 0.05$), though not 35 days ($P > 0.05$), or the GM at 5 or 35 days ($P > 0.05$). OES samples had a higher calpastatin activity ($P < 0.05$) in the LL at 19 h post mortem.

1. Introduction

Hormonal growth promotants (HGPs) have been used to increase growth performance of cattle for over 50 years. The steroid-based HGP implants usually consist of an oestrogen or an oestrogen combined with androgen or progesterone compounds. These are generally used for feedlot finished animals in Australia, Canada and Northern America. To a lesser extent, HGPs are also used in Australia for pasture finishing systems. Hormonal growth promotant implants increase live weight gain and increase feed efficiency by up to 30% and 15%, respectively (Duckett, Owens, & Andrae, 1997; Hunter, 2010; Morgan, 1997; Preston, 1997).

Consistent beef eating quality is critical for the repurchasing decisions of the consumer (Polkinghorne, Philpott, Gee, Doljanin, & Innes, 2008). The Meat Standards Australia (MSA) beef grading model consists of cook × cut combinations, which predicts eating quality of individual muscles from the carcass, using on-farm, carcass, processing and value adding data (Polkinghorne, Thompson, Watson, Gee, & Porter, 2008). For carcasses treated with a HGP, the MSA beef grading model decreases meat palatability points (MQ4) by up to 6 points (on a 100 point scale), depending upon the cut (after adjustment for increases in ossification and decreases in marbling scores, Watson, Polkinghorne, & Thompson, 2008).

Much of the literature that has examined HGP effects on live weight, carcass and eating quality traits refer to animals finished in feedlot production systems, and commonly with HGP implants which are a combination of oestradiol and trenbolone acetate (a synthetic androgen) compounds. There is much less published research examining HGP effects on animals finished in pasture systems, particularly when oestradiol only (OES) implants are used. Of this research, the results have been variable for both sensory and objective eating quality measurements. Burnham, Morris, Purchas, and McCutcheon (1997) reported higher shear force when animals were finished on pasture with OES implants. Thompson et al. (2008) demonstrated that when steers were re-implanted with short acting OES implants every 100 days, the detrimental HGP impact on sensory scores increased as *Bos indicus* content increased. Conversely, Hunter, Magner, and Allingham (2000) and Hunter (2000) reported no impact of long acting OES implants on shear force.

There is evidence that the negative impact of HGP implants on eating quality may be reduced through aging (Packer, Geesink, Polkinghorne, Thompson, & Ball, 2018; Schneider, Tatum, Engle, & Bryant, 2007; Thompson et al., 2008). This has important implications for the beef industry as it allows the use of HGPs to increase production efficiency, whilst the negative eating quality impact could be reduced by post mortem aging. Furthermore, the decrease in eating quality in HGP treated carcasses has been shown to be greater in muscles which have the greatest aging rate (Thompson, McIntyre, et al., 2008).

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Koohmaraie, Kent, Shackelford, Veiseth, and Wheeler (2002) concluded that the mechanisms which control muscle degradation, rather than synthesis, would regulate eating quality. HGP implants increase protein deposition in a live animal by increasing protein synthesis and slowing protein degradation rates (Kerth, Montgomery, Morrow, Galyean, & Miller, 2003; VanderWal, VanWeerden, Sprietsma, & Huisman, 1975). Calpastatin, which is an inhibitor of the calpain system, has been shown to have increased activity in HGP treated carcasses, resulting in a negative effect on eating quality (Gerken, Tatum, Morgan, & Smith, 1995; Packer et al., 2018).

This research aims to evaluate the impact of long acting OES implants on the eating quality of the LL and *gluteus medius* (GM), from steers finished on pasture for 389 days. It is hypothesised that the meat from the OES treated steers will have lower eating quality as assessed through consumer sensory scores, have higher shear force, and have higher calpastatin activity, than the untreated control (CON) steers. It is also hypothesised that the impact of OES implant will be greater in the LL than the GM, and that extended aging will reduce the magnitude of the impact on eating quality measurements. This research differs to that previously mentioned, as the impact of a long acting (400 days) OES implants on samples assessed by untrained consumers under MSA sensory protocols, has not been reported in the literature.

2. Materials and methods

2.1. Live cattle

A total of 200 steers from a composite breed (approximately 3/8 *Bos indicus*, 1/2 *Bos taurus*, 1/8 *Bos indicus-taurus* breeds) born over a four-month period, were transported from a Northern Territory cattle station to a central Queensland cattle property, for finishing on pasture. The un-implanted steers were allowed approximately one month to acclimate to the pastures on the finishing property, and reach weights suitable for induction (ca. 255 kg live weight). At induction, steers were randomly allocated to an un-implanted CON or OES treatment. The OES treatment animals were implanted with a long acting oestradiol only implant which had an active ingredient payout period of 400 days (Compudose 400, Elanco Animal Health, Indianapolis, IN, USA; 43.9 mg oestradiol-17ß). The cattle were run as one cohort for the duration of the research. Animal ethics approval was granted by the University of New England Animal Ethics Committee (authority number AEC14–045).

Animals grazed on pastures comprising a mixture of tropical and native species. Animals were given access to Leucaena (*Leucaena leucocephala*) when pastures were considered limiting in protein and energy. Animals were weighed and implant ear audits undertaken at days 57, 99, 202, 299 and 371 after induction, to determine if the OES implant was present and without any infection or scar tissue encapsulation, which may have inhibited the delivery of the hormone.

2.2. Slaughter and primal collection

After 389 days on pasture, animals were transported 864 km to an abattoir and slaughtered the following morning. Bodies were stimulated within 15 min following slaughter, using a low voltage stimulator for 35 s. Hot carcass weight and P8 fat depth were recorded on the hot carcass.

Approximately 19 h post mortem, carcasses were quartered at the 12th/13th rib prior to MSA grading. At grading, ultimate pH, hump height, eye muscle area and rib fat depth along with subjective scores for ossification, marbling, and meat color were measured (AUSMEAT, 2005). Also, a 3 mm slice from the quartered LL muscle was collected and diced. From this, a 5 g sub-sample was placed into a tube and frozen in liquid nitrogen for subsequent calpastatin analysis.

At boning, the rump primals from both sides (HAM 2110 – Rostbiff), and the striploin primal (HAM 2140 – Striploin) from the left side, were collected from all carcasses (AUSMEAT, 2005). These primals were vacuum packed and chilled prior to transporting to the meat laboratory at the University of New England, for further processing.

2.3. Sample preparation

Three days following slaughter, the LL and GM muscles were removed from the striploin and rump primals respectively and trimmed of all fat and epimysium. The LL muscle was divided into four equal portions. The rump cap (*biceps femoris*) was removed from the rump primal, and the GM separated along the connective tissue seam. The larger portion (the body of the muscle) was divided into anterior and posterior samples portions, and the smaller portion (the head of the muscle) discarded.

Sensory samples were prepared as described by Watson, Gee, Polkinghorne, and Porter (2008) whereby each sample portion was prepared as five 25 mm × 50 mm × 50 mm steaks cut perpendicular to the fibre direction or objective samples weighing approximately 250 g. Steaks were wrapped in plastic sheets prior to both the steaks and objective blocks being re-vacuumed and aged at 2 °C for either 5 or 35 days post mortem, before being frozen at −20 °C. The MSA beef grading model separates the LL into anterior and posterior positions. To align with the MSA model, the two anterior positions were grouped together, as were the two posterior positions, for both sensory and objective analysis.

2.4. Sensory analysis

Sensory analysis was conducted using the method described in detail by Watson, Gee, Polkinghorne, and Porter (2008) and Anonymous (2008). Briefly, groups of 60 untrained consumers assessed a total of seven steaks. Steaks were balanced for HGP treatment, aging period and muscle so that every consumer tasted a range of eating quality. Steaks were thawed and cooked using a Silex™ grill (Silex Pty Ltd., Marrickville, Australia) to a medium doneness prior to being rested, halved and served. The five steaks from one sample were served to ten different consumers. Consumers rated each steak for tenderness, juiciness, like flavour and overall acceptability, by placing a mark on a 100 mm line scale, representing scores from 0 to 100, anchored by the words not tender/very tender, not juicy/very juicy, and dislike extremely/like extremely for both like flavour and overall liking, respectively. Scores for tenderness, juiciness, like flavour and overall acceptability scores were multiplied by 0.3, 0.1, 0.3 and 0.3 respectively, and summed to calculate a MQ4 score. The highest and lowest two scores from the total of ten scores per sample, were discarded to reduce the standard error of the mean sensory score (Watson, Gee, Polkinghorne, & Porter, 2008).

2.5. Objective measurements

Objective shear force blocks were prepared as described by Perry, Shorthose, Ferguson, and Thompson (2001) with slight modifications as per Packer et al. (2018). Briefly, a thawed 60-80 g block was prepared from each 250 g sample block. Blocks were cooked in plastic bags in a water bath at 70 °C for 30 min, followed by cooling under running water for 20 min.

Cooking loss percentage was calculated as the percentage of difference between pre and post-cook weights relative to pre-cook weight. Shear force was measured using a Lloyd Instruments LRX Materials Testing Machine fitted with a 500 N load cell (Lloyd Instruments Ltd., Hampshire UK), which calculated the mean maximum force (N) of six sub-samples cut perpendicular to the fibre direction with a 0.64 mm triangular blade pulled upward at 100 mm/min (Perry et al., 2001).

2.6. Calpastatin activity

Calpastatin activity was measured using the methodology of Shackelford