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Finishing cattle at pasture at 30 months of age or indoors at 25 months of age: Effects on selected carcass and meat quality characteristics

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ABSTRACT

To examine the effect of a modification of a typically Irish dairy calf-to-beef production system, Charolais × Friesian steers were offered a finishing ration of grass silage *ad libitum* and 5.6 kg concentrates daily for 174 days prior to slaughter at 25 months of age or grass silage *ad libitum* for 174 days, followed by pasture for 167 days and slaughter at 30 months of age. Finishing at pasture increased carcass weight (376 vs. 342 kg) but did not affect intra-muscular lipid concentration (28 vs. 24 g/kg). Finishing at pasture decreased *Longissimus thoracis et lumborum* lightness (35.6 vs. 36.9) and increased shear force of muscle at 2 (8.54 vs 4.32) and 7 days (5.21 vs 3.64 kg) *post-mortem* but not at 14 days *post-mortem* (4.45 vs. 3.42 kg). Finishing at pasture did not affect the sensory characteristics of tenderness, juiciness, firmness or chewiness and tended ($P<0.1$) to decrease texture and acceptability. It is concluded that modification of this beef production system as described, had minor effects on beef quality which are unlikely to be of commercial significance.

1. Introduction

The majority of Irish calves are spring-born and the most widely practised system of beef production is slaughter of steers at approximately 2 years of age following a winter finishing period indoors (Keane and Drennan, 1991). The finishing ration is normally grass silage offered *ad libitum* with a fixed allowance of supplementary concentrates or a total mixed ration of fixed proportions of silage and concentrate where the concentrate represents 0.5 of total dry matter (DM). Maximising the length of the grazing season and/or feeding silage only during the winter and finishing the cattle at pasture (in a third grazing season) could result in improved labour and machinery efficiency and avoid the need for expensive concentrate feeds. Moreover, there is increasing consumer interest in "grass-fed" beef which provides additional market opportunities (Cox et al., 2006; Mathews and Johnson, 2010).

Of the production or "on-farm" factors that potentially influence beef quality and in particular appearance and sensory characteristics, ration composition and age at slaughter are of particular importance. There is some evidence, particularly from North American beef production systems, that concentrate-fed animals produce beef that is more tender and better-flavoured than forage-fed animals (Larick et al., 1987; Medeiros et al., 1987) but this is not a consistent finding in the literature (French et al., 2000; Realini et al., 2004; Resconi et al., 2010). Moreover, greater chronological age can decrease sensory tenderness of beef (Shorthose and Harris, 1990; Wulf et al., 1996). It is important therefore to determine the effect of any modification of an existing system of beef production on the meat quality characteristics that influence market acceptability and share.

The objective of this study therefore was to document the changes in appearance and the eating quality of beef in

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response to modifying a grass silage/concentrate-based steer beef production system by finishing at pasture at an older age.

2. Materials and methods

2.1. Experimental design and animal management

Twenty-four spring-born Charolais×Friesian steers which had just completed their second season of grazing a predominantly perennial ryegrass pasture (19 months of age, October 15) were weighed, blocked on bodyweight and within block assigned to either housing on October 15 (CON) or to remaining at pasture (P). The CON cattle were housed in pens of 4 in a slatted floor shed in 3 groups and offered grass silage *ad libitum* + 4 kg concentrates daily until December 1 and 6 kg concentrates daily thereafter. Concentrates were increased gradually after introduction. Thus, cattle were initially offered 3 kg concentrates daily. The allowance was increased by 0.5 kg on alternate days until the target level of consumption was achieved. The coarse concentrate formulation was 870 g/kg rolled barley, 67.5 g/kg soyabean meal, 47.5 g/kg molasses and 15 g/kg mineral/vitamin pre-mix. The estimated metabolisable energy (ME) concentration was 12.5 MJ/kg DM. The chemical composition of the silage was: DM 171 g/kg, crude protein (CP) in the DM 164 g/kg, *in vitro* DM digestibility (DMD) 711 g/kg, and pH 3.73. The estimated ME concentration was 10.3 MJ/kg DM. On December 1, P cattle were housed in groups of 4 in the same shed and offered the above grass silage without concentrate supplementation. After a 174 day finishing period, CON animals were slaughtered, while P animals were returned to pasture. The grazing area was laid out in six paddocks which were rotationally grazed to a target mean post-grazing sward height of 5 cm. Herbage in excess of the requirements of the experimental animals was removed. After 167 days at pasture, the P animals were slaughtered.

2.2. Post-slaughter measurements and sampling

On each slaughter date, the animals were transported 30 km to a commercial slaughter facility and slaughtered within 1.5 h of arrival, following stunning by captive bolt pistol. After slaughter, carcass weight was recorded, carcasses were assessed for fatness and conformation according to the EU Beef Carcass Classification Scheme (Anon, 1981) and the weight of kidney + channel fat was recorded. The pH of the *longissimus thoracis et lumborum* (LTL) was measured at hourly intervals for 8 h and at 24 h *post-mortem* by making a scalpel incision at the 10th/11th rib and inserting a glass electrode (Model EC2010-11, Amagruss Electrodes Ltd., Castlebar, Co. Mayo, Ireland) attached to a portable pH metre (Model no. 250A, Orion Research Inc., Boston, USA) approximately 2.5 cm into the muscle.

The sides were cold-boned at 24 h *post mortem*. Samples of the right side LTL were vacuum packed (SuperVac GK-166 T) and aged at 4 °C for 2, 7 or 14 days *post-mortem*. Steaks, 2.5 cm thick, were cut after 2 days for drip and cook loss, compositional and pH analysis and after 2, 7 and 14 days *post-mortem*, for sensory analysis and Warner–Bratzler shear force (WBSF) measurements. These were vacuum packed and frozen at −30 °C for subsequent analysis. Samples were collected after 2 days *post mortem* for colour analysis.

2.3. Meat quality assessments

Colour measurement was according to the procedure of Strange et al. (1974). Freshly cut samples were wrapped in an oxygen permeable PVC wrap and left to bloom at 4 °C for 3 h. The redness (Hunter 'a' values), the yellowness (Hunter 'b' values) and the lightness (Hunter 'L' values) of each sample were then measured using a Hunter lab Ultra Scan XE colorimeter with Universal Software Version 2.2.2 (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Road, Reston, VA, USA). Muscle saturation and hue were calculated as $\sqrt{(a^2+b^2)}$ and $\tan^{-1}(b/a)$, respectively. Final conversion of hue from radians to degrees was achieved by multiplying $\tan^{-1}(b/a)$ by $180/\pi$ (Liu et al., 1996). Drip loss and sarcomere length were measured in steaks (2.5 cm in thickness) cut at 2 days *post-mortem* according to Honikel (1987) and Cross et al. (1980), respectively.

Frozen vacuum-packed steaks were thawed in a circulating water bath at 10–15 °C and allowed to equilibrate at ambient temperature. Sensory analysis was performed by an eight member, trained panel on steaks grilled to an internal temperature of 70 °C, according to the American Meat Science Association Guidelines, (AMSA, 1978). Panellists were asked to assess the samples for the following attributes:

Tenderness (scale 1–8, 1 = extremely tough, 8 = extremely tender)
Moisture/juiciness (scale 1–8; 1 = extremely dry, 8 = extremely juicy)
Overall flavour (scale 1–6; 1 = very poor, 6 = very good)
Overall firmness (scale 1–8; 1 = extremely mushy, 8 = extremely firm)
Residual chewiness (scale 1–6; 1 = not chewy, 6 = extremely chewy)
Overall texture (scale 1–6; 1 = very poor, 6 = very good)
Overall acceptability (scale 1–6; 1 = not acceptable, 6 = extremely acceptable)

Warner–Bratzler shear force was measured according to the procedure of Shackelford et al. (1994). Steaks (2.5 cm) were cooked in retortable vacuum pack bags to an internal temperature of 70 °C, by immersing in a water bath (Model Y 38, Grant Instruments Ltd.) at 80 °C. The internal temperature of the steaks was measured using a Hanna Foodcare digital thermometer (HI 9041). Five cores (1.25 cm diameter) were cut from the steaks parallel to the direction of the muscle fibres and sheared using an Instron Universal testing machine equipped with a Warner–Bratzler shearing device. The crosshead speed was 5 cm/min. Instron Series IX Automated Materials Testing System software for windows (Instron Corporation, High Wycombe, Bucks, UK) was employed in the analysis.

2.4. Chemical analyses

Intramuscular fat and moisture concentrations of thawed minced LTL samples were determined using an automated, integrated microwave moisture and methylene chloride fat extraction method (Bostian et al., 1985) on a CEM moisture/solids analyser (Model AVC 80, CEM Corp., Matthews,