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Effect of concentrate feeding pattern in a grass silage/concentrate beef finishing system on performance, selected carcass and meat quality characteristics

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Abstract

Steers were offered grass silage *ad libitum* and 6.4 kg concentrates daily for 126 days or silage *ad libitum* for 35 days, followed by concentrates *ad libitum* (Experiment 1). Steers were offered grass silage *ad libitum* and 6 kg concentrates daily for 154 days, concentrates *ad libitum* or grass silage *ad libitum* for 112 days followed by concentrates *ad libitum* (Experiment 2). All treatments received the same total concentrate allowance. In Experiment 1, there was no difference in any measurement of meat quality. In Experiment 2, *ad libitum* concentrate feeding *per se*, decreased redness and increased shear force of muscle at 2 days *post-mortem*. Delaying concentrate feeding decreased fat yellowness, decreased shear force at 7 and 14 days *post-mortem* and increased muscle redness at 14 days *post-mortem*. Modifications of the beef production system examined had minor effects on beef quality which are unlikely to be of commercial significance.

Keywords: Concentrates; Beef quality; Fat colour; Muscle colour

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 & 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. To minimise feed costs, the concentrate proportion rarely exceeds 0.5 of total dry matter (DM) resulting in a modest ($\leqslant$1 kg) growth rate. Feeding both silage and concentrates daily during finishing is relatively inflexible in terms of labour and machine use and of meeting changing market specifications for carcasses. Accordingly, feeding silage only, initially, and reserving the concentrate allowance for feeding at a high level towards the end of the finishing period could result in improved labour and machinery efficiency and/or saving in the quantity of concentrates fed if favourable marketing opportunities emerged earlier than expected.

Of the production or "on-farm" factors that potentially influence beef quality and in particular appearance and sensory characteristics, ration composition and the quantity of ration consumed are of particular importance. There is evidence, particularly from North American beef production systems, that concentrate-fed animals produce more tender and better-flavoured meat than forage-fed animals (Larick et al., 1987; Medeiros, Field, Menkhaus, & Russell, 1987) and that an increase in growth rate before slaughter enhances beef tenderness (Aberle, Reeves, Judge, Hunsley, & Perry, 1981). Because there are also contradictory reports on the influence of ration composition and

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growth rate on beef quality (French et al., 2000, 2001; Moloney et al., in press), it is important 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 fat colour, appearance and the eating quality of beef in response to modifying the pattern of supplementation with a fixed quantity of concentrates during the finishing phase in a grass silage-based steer beef production system.

2. Materials and methods

2.1. Experimental design and animal management

Experiment 1: Twenty-eight spring-born Charolais × Friesian steers which had just completed their second grazing season (19 months of age) were housed for their second winter and blocked on weight to 4 groups of 7 animals each. Two groups were assigned at random to either (i) grass silage *ad libitum* + a flat rate of 6.35 kg concentrates daily (S) or (ii) grass silage only *ad libitum* for 35 days followed by concentrates *ad libitum* until slaughter (C). Concentrates were increased gradually after introduction to both treatments. Thus, cattle were initially offered 3 kg concentrates daily. The allowance was increased by 0.5 kg on alternate days until the target level or *ad libitum* level of consumption was achieved. Silage was reduced as concentrates neared *ad libitum* intake in treatment C. Each animal on *ad libitum* concentrates continued to receive 1 kg silage DM daily to ensure normal rumen function. The objective was to provide all animals with the same total concentrate allowance (800 kg) during finishing. Silage and concentrate intakes were measured per pen (2 pens per treatment) throughout the experiment. 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. All animals were slaughtered after 126 days.

Experiment 2: Thirty-six Charolais × Friesian and 18 Friesian spring-born steers which had just completed their second grazing season (19 months of age) were housed for their second winter and blocked on weight, within breed, to three treatment groups. Within finishing treatment and breed type, the animals were assigned at random to three pens of six animals each (4 Charolais × Friesians + 2 Friesians per pen). These were considered replicates for the purposes of feed intake measurements. All animals were offered grass silage *ad libitum* for 3 weeks prior to commencement of the study (day 0). The control treatment was grass silage *ad libitum* + a flat rate of 6 kg concentrates (similar composition as in Experiment 1) daily. Treatment CD0 was concentrates offered in increasing quantities from day 0 until *ad libitum* consumption was achieved after 3 weeks and then maintained to slaughter. Treatment CD112 was grass silage only *ad libitum* for 112 days followed by concentrates offered *ad libitum* beginning on day 112. Animals on *ad libitum* concentrates received 1 kg silage DM per animal daily to ensure normal rumen function. The objective was to provide all animals with the same total concentrate allowance (900 kg) during finishing. The chemical composition of the silage was: DM 200 g/kg, CP in the DM 157 g/kg, DMD 716 g/kg, and pH 3.9. The estimated ME concentration was 10.0 MJ/ME/kg DM. Animals were slaughtered by treatment when they had consumed their concentrate allowance.

2.2. Post-slaughter measurements and sampling

On each slaughter date, the animals were transported 30 km to a commercial slaughter facility and slaughtered humanely within 1.5 h of arrival, following stunning by captive bolt pistol. After slaughter, carcass weight was recorded and carcasses assessed for fatness and conformation according to the EU Beef Carcass Classification Scheme (Anonymous, 1981). The weight of kidney + channel fat was recorded in both experiments. In Experiment 2, a sample of kidney and channel fat was stored at 4 °C for 48 h prior to colour analysis and a sample of subcutaneous (s.c) fat was removed 48 h *post-mortem* and fat colour was measured immediately.

In Experiment 1, the pH of the *M. longissimus dorsi* (LD) 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 meter (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 LD were vacuum packed (SuperVac GK-166T) 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 loss, compositional and pH analysis and after 2, 7 and 14 days *post-mortem*, for sensory analysis (Experiment 1), cook loss and Warner–Bratzler shear force (WBSF) measurements (Experiments 1 and 2). These were vacuum packed and frozen at −30 °C for subsequent analysis. In Experiment 1, samples were collected after 2 days for colour analysis and in Experiment 2, after 2 and 14 days ageing.

2.3. Meat quality assessments

Colour measurement was according to the procedure of Strange, Benedict, Gugger, Metzger, and Swift (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)