Livestock Science 180 (2015) 220–225

Contents lists available at ScienceDirect

Livestock Science

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

Effect of floor type on hoof lesions, dirt scores, immune response and production of beef bulls

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ARTICLE INFO

Article history:
Received 22 January 2015
Received in revised form
22 July 2015
Accepted 1 August 2015

Keywords:
Bulls
Hoof lesions
Cleanliness
Concrete slats
Rubber mats

ABSTRACT

The objective of the study was to investigate the effect of old and new concrete slats (CS) with or without rubber mats (RM) on animal performance, hoof health, dirt scores and health status of finishing bulls. Continental crossbred beef bulls ($n=72$; mean initial live weight=441 (s.d. 45.1) kg) were blocked by breed and live weight and randomly assigned by block to one of four treatments; (1) Old CS (2) New CS, (3) Old CS covered with RM, (4) New CS covered with RM. Each treatment had 3 pens of 6 bulls at a space allowance of 2.9 m^2 per animal. Bulls were fed a total mixed ration (TMR) of silage and rolled barley on a 54:46 dry matter (DM) basis for 148 days. Feed was weighed into each pen daily and refusals were weighed twice weekly. Bulls were weighed every three weeks to coincide with dirt scoring. Total leucocyte, neutrophil, lymphocyte, eosinophil, monocyte, basophil and red blood cell number and haemoglobin concentrations were measured on day 0 and day 148. Bull's hooves were inspected for the presence of lesions at the start of the study and again at slaughter. After slaughter, carcass weight, carcass gain, conformation and fat score, kidney and channel fat and hide weight were recorded. Bulls on RM had a greater average daily gain (ADG) (0.16 kg/day) ($P<0.01$), kidney and channel fat weight (KCF) ($P<0.05$), hide weight ($P<0.01$) and a better feed conversion ratio (FCR) ($P<0.05$) than those on CS. Floor type had no effect on dry matter intake (DMI), slaughter weight, carcass weight, kill out percentage, conformation score or fat score. Bulls on RM had 44% more hoof lesions ($P<0.01$) than those on CS. There were slat × time ($P<0.05$) and mat × time ($P<0.01$) interactions for dirt scores. Bulls on slats were dirtier than those on mats on days 63, 84 and 126 ($P<0.01$) while bulls on new slats were dirtier than those on old slats on days 21 ($P<0.01$) and 42 ($P<0.05$). Floor type had no effect ($P>0.05$) on any of the haematological variables measured which suggests that the immunological status of the bulls was not affected by treatment. While there was no evidence of lameness in bulls on RM, the increased number of hoof lesions suggests that hoof health may be compromised in bulls housed on RM.

1. Introduction

Fully slatted floors are used throughout Europe for accommodating beef cattle during the winter (Rouha-Muelleder et al., 2012). Due to the seasonality of grass growth in countries such as Ireland, the production systems in use for rearing and finishing beef cattle usually consist of a grazing season of 8 months followed by a winter housing period of 4–5 months duration (Mayne and O'Kiely, 2005). Concrete slatted floors are the predominant winter housing system in use in Ireland (Mazurek et al., 2010). In some systems, particularly with spring born beef bulls, the housing period is not limited to the winter months as bulls may be housed after their first summer and finished intensively indoors over a period of 9 or 10 months (Drennan and McGee, 2009; Keane, 2003; Keane and Allen, 1998). While steers tend to have shorter housing periods than bulls; the amount of time they spend indoors is greater as they are usually slaughtered at 24 months or above (Keane, 2003; Keane and Allen, 1998) thus spending two winter periods housed indoors.

Recently, concerns have been expressed about the cleanliness and lameness, of beef cattle housed on concrete slatted floors (EFSA, 2006a, 2006b, 2009, 2012). One alternative to exposed concrete slats (CS) that has been studied is covering them with rubber mats (RM). Studies examining the effect of CS and RM on the welfare of beef cattle are limited and conflicting.

Graunke et al. (2011) reported that bulls housed on RM had a greater incidence of heel erosion but fewer sole lesions than those on CS when housed over a 9 month period. Rouha-Muelleder et al.

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http://dx.doi.org/10.1016/j.livsci.2015.08.002
1871-1413/

(2012) carried out a similar study over a 5 month period and reported similar results for heel erosion; however they reported that bulls on RM had a greater number of sole lesions. Lowe et al. (2001) and Schulze Westerath et al. (2007) used cleanliness as a measure of welfare for finishing steers and bulls, respectively, and reported no difference in cleanliness between RM or CS. Blood biological variables, including white blood cell (WBC), neutrophil, lymphocyte and leucocyte numbers have been used as biomarkers of housing stress (Fisher et al., 1997; Hickey et al., 2003) in cattle housed at varying space allowances on CS, however, in both these studies treatment had no effect on blood biomarkers. Eicher et al. (2013) used WBC counts to compare the immune function of dairy cows housed on rubber flooring to those housed on concrete and reported a greater lymphocyte count in cows on concrete flooring which may indicate the immune function of these animals was compromised. Sutherland et al. (2014) also used blood biological variables when comparing different floor types for artificially reared dairy heifer calves. There are no studies that have evaluated blood physiological variables in beef cattle housed on CS with RM.

There is limited published research comparing the performance of beef cattle on CS and RM. Earley and Prendiville (2008) and Lowe et al. (2001) reported no difference in ADG between steers housed on CS and RM, however, Earley and Prendiville (2008) reported a greater carcass weight for steers housed on RM. Conversely, Graunke et al. (2011) reported a greater ADG for growing bulls up to 400 kg housed on RM but found no difference in the performance between the two floor types for bulls in the finishing phase. Cozzi et al. (2013) also reported a greater ADG for bulls housed on RM than CS, however, this study compared CS to perforated floors covered with RM.

There are conflicting results in the literature on the effect of RM on performance, cleanliness and hoof health. Along with cleanliness and hoof health, animal performance and immune function also contribute to the assessment of animal welfare (Welfare Quality®, 2009). Thus, the hypothesis of the present study was that covering CS with RM will improve the performance, immune function, hoof health and cleanliness of finishing beef bulls when housed indoors over a 148 day winter finishing period. Old and new slats were used to determine whether old CS should be replaced with new CS or whether covering them with RM will have the same effect on performance, immune function, hoof health and dirt scores.

The objective of this study was to evaluate concrete slatted flooring (old and new slats) with and without rubber mats on performance, dirt scores, hoof health and immune function of finishing beef bulls, housed for a duration of 148 days.

2. Materials and methods

2.1. Care and use of animals

All animal procedures performed in this study were conducted under experimental licence (B100/2869) from the Irish Department of Health and Children in accordance with the Cruelty to Animals Act 1876 and the European Communities (Amendment of Cruelty to Animals Act 1876) Regulation 2002 and 2005.

2.2. Animals, management and experimental design

The study was conducted at the Teagasc Beef Research Centre, Grange, Co. Meath from December to May. Seventy-two clinically healthy, Charolais and Limousin crossbred beef bulls, with a mean initial live-weight of 441 (s.d. 45.1) kg were used in the study. Bulls arrived on farm 21 days before commencement of the study. In order to acclimatize the bulls to housing and diet, the bulls were housed in a different concrete slatted floor shed for the first 21 days. On day (d) 0, the bulls were blocked by liveweight and breed and assigned by block to one of four treatments: (1) Old CS, (2) New CS, (3) Old CS with RM attached and (4) New CS with RM attached.

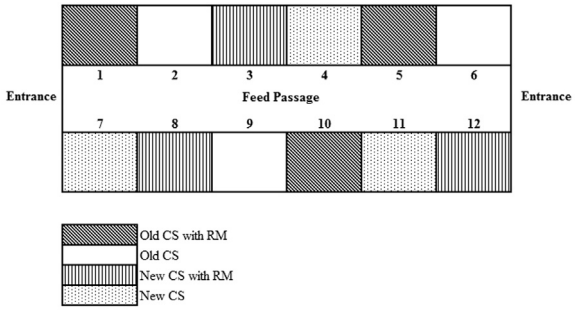

Fig. 1. Diagram showing distribution of pens throughout the shed.

2.3. Experimental pens

All the experimental pens were located in one building with a feed alley in the centre and pens on both sides of the alley. The experimental pens were randomly located throughout the shed (Fig. 1). The dimensions of the pens were 3.76 m × 4.66 m (17.5 m^2). Each pen housed 6 bulls, with three replicates of each treatment, at a space allowance per animal of 2.9 m^2 based on the recommendations of Hickey et al. (2003). The old CS, representing the floor type typical on Irish farms, were *in situ* for 30 years prior to the commencement of the study and were in good condition with no obvious defects. Each pen was fitted with single slats that were 3.34 m long × 0.125 m wide. A concrete apron, 0.42 m wide, at the feed face, extended the length of each pen. The void space between every slat was 42 mm. The ratio of concrete to void space in each pen was 3.5:1. Durapak mats (Durapak Agri Ltd. Ballincollig, Co. Cork) were fitted to the respective pens by a commercial technician. The mats were 22 mm thick, comprised mainly of natural rubber and had a mean shore A hardness (± s.e.) of 1.64 (± 0.18).

2.4. Animal diets and composition

Bulls were fed a grass silage and rolled barley based total mixed ration (TMR) on a 54:46 DM basis. They were acclimatised to the diet for 21 days prior to the commencement of the study. Approximately 2000 kg of silage and 500 kg rolled barley were mixed in a 12 m^3 Abbey Vertical Mixer (VF 12) fitted with a Digi-star weighing system (Digi-Star Europe, Panningen, The Netherlands). The weighing system was calibrated at the beginning of every 2nd week before the bulls were fed. Feed was weighed into each pen every day throughout the study and refusals were weighed back manually twice weekly. Silage, concentrates and TMR offered were sampled twice weekly and these samples were stored at −20 °C pending laboratory analysis. Samples of silage were subsequently pooled on a weekly basis for DM determination and on a three-week basis for chemical analysis. Sample processing and chemical analysis for the silage and concentrates was carried out as described by Owens et al. (2008). The mean (s.e.) chemical composition and nutritive value of the TMR offered to animals was: DM: 315.5 (6.5) g/kg, pH: 4.1 (0.1), crude protein concentration: 142.1 (1.48) g/kg DM, dry matter digestibility: 774.1 (5.2) g/kg DM, acid detergent fibre: 227.6 (3.78) g/kg DM, ash: 78.9 (5.15) g/kg DM and nitrogen: 23.6 (0.29) g/kg DM.