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Effect of enriched housing on welfare, production performance and meat quality in finishing lambs: The use of feeder ramps

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ABSTRACT

This study analyses the effect of environmental enrichment on the welfare, productive traits and meat quality of lambs housed in feedlots. Sixty lambs were placed in enriched (EE) or conventional (CO) pens (3 pens for each treatment, 10 lambs/pen) where EE had a wooden platform with ramps that provided access to a concentrate hopper, cereal straw as bedding and forage, and one play ramp. The CO pen was barren, similar to commercial feedlots. The physiological adaptation response of EE lambs was more efficient than CO, since the latter mobilised more body reserves (i.e., increased NEFA, $P < 0.05$), and had lower levels of immunity (i.e., increased N/L, $P < 0.05$), which indicate chronic stress, probably associated with the barren environment. The EE lambs had a higher ($P < 0.05$) average daily gain, with heavier carcasses and higher fattening scores, as well as lower pH_{ult}, higher L* and b* values, and lower values of texture ($P < 0.05$).

1. Introduction

In the future, one of the main challenges of the sheep industry will be to increase production to satisfy the global demand for meat consumption, as one more source of protein in the human diet (Montossi et al., 2013). Along those lines, in Mediterranean countries there has been a trend to adjust traditional pastoral sheep production to more intensive schemes (Bernués, Ruiz, Olaizola, Villarba, & Casasús, 2011; de Rancourt, Fois, Lavín, Tchakérian, & Vallenard, 2006). The development of intensive indoor management programmes, such as lamb feed-lotting, externalises the final stage of fattening to off-farm units (Aguayo-Ulloa et al., 2013). That process stratifies the system in two specialised parts, breeding the flock on the farm (under the farmer's responsibility) and fattening on feedlots, also called classification centres (CCs). These changes in lamb meat production simplify the finishing process for the farmer and improve carcass homogeneity (Miranda-de la Lama, Villarroel, Liste, Escós, & María, 2010; Miranda-de la Lama et al., 2010). However, both farmers and animals have to deal with new problems such as external resource dependency, multiple live transports, social mixing, novel and barren environments, and frequent handling (Aguayo-Ulloa et al., 2013; Miranda-de la Lama, Villarroel, & Maria, 2012). The lack of stimulation leads to boredom, which may cause the development of stereotypies, abnormal behaviour, frustration and stress (Fraser, 1980; Lawrence & Rushen, 1993; Wood-Gush & Beilhartz, 1983).

The new intensive sheep production described can have negative effects on animal welfare and the quality of products delivered to consumers. The welfare of farm animals is a growing public concern and considered a priority for an increasing number of Europeans (European Commission, 2006; Vanhonacker, Verbeke, Van Poucke, & Tuyttens, 2008). New regulations have been developed to improve the production chain of the intensive livestock industry to satisfy consumer demands (European Commission, 2006; Winter, Fry, & Carruthers, 1998).

Adequate environmental enrichment could reduce negative emotional states such as fear and stress associated with the adaptation to a novel environment (i.e., the CC). This will reduce the frustration that animals may experience when they are unable to express their behavioural needs (Hughes & Duncan, 1988; Nicol, 1992; Wood-Gush & Vestergaard, 1989). Environmental modifications can also improve physical health by promoting a wide range of movements to promote skeletal muscle and cardiovascular fitness (Chamove, 1989; Fraser, Phillips, & Thompson, 1986; Klont et al., 2001). Many ways to improve animal welfare through environmental enrichment have been explored, mainly in pigs (Bracke et al., 2006; van de Weerd & Day, 2009; Vanheukelom, Driessen, & Geers, 2012). The literature review by de Azevedo, Cipreste, and Young (2007) reports that food and structural enrichment are among the most successful. However, in farm animals

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most enrichment studies concentrate on structural applications and not on food presentation. One alternative in lambs is enrichment using several items (Abou-Ismail, 2011) but no studies have been performed during the fattening period in feedlots. The goal of the present study is to analyse the effect of functional full enrichment on a combined set of variables. Our study is based on the hypothesis that enrichment during the finishing period of fattening may improve the adaptation process of the lambs to a novel environment at the CC, which may optimise welfare and productive performance, thereby preserving farmer income. The effect of the enrichment items (feeder ramps and cereal straw) was measured on physiological welfare indicators, performance productive traits and meat quality variables during the finishing phase of fattening lambs.

2. Methods

The study was carried out using the installations of the Animal Experimentation Service of the University of Zaragoza in the Autonomous Community of Aragon, Spain (41°41′N). All the lambs were raised, transported and slaughtered according to current regulations of the European Commission (1986) for Scientific Procedure Establishments. Experimental protocols were approved by the Animal Experimentation Ethics Committee of the University of Zaragoza (ES 50 297 0012 006).

2.1. Study description

A total of 60 healthy Rasa Aragonesa male lambs (65 days old) with an average live weight of 17.13 (±0.18) kg, were allocated into two treatments (weights were balanced across treatments) according to their pen environment during the finishing phase of fattening, which lasted five weeks. Lambs were housed indoors in six pens with 10 lambs each (2.9 × 3.3 m, animal density of 0.95 m^2 per lamb) and three replicates per treatment. The lambs from the enriched environment (EE) were maintained in pens with a wooden platform with ramps that provided access to a concentrate hopper (Fig. 1). The platform dimensions were 2.35 m long, 1.55 m wide and 0.35 m high (1.67 m^2). The ramp slope was approximately 20°. The platform in the pen was attached to the solid fence that separated each pen, allowing the lambs to feed, explore or rest lying down. The lambs from EE were provided with cereal straw as bedding on the floor and as forage in a fodder rake. Additionally a small ramp (0.90 m long, 0.50 m wide, 0.35 m high and 0.08 m^2 surface) was situated near the opposite solid fence, but away from the food hopper and fodder rake, to allow lambs to play. The lambs in the conventional environment or controls (CO) were maintained in pens of the same size as EE, but without cereal straw (as bedding or forage) or ramps (common environmental conditions in CCs). For hygienic reasons a thin layer of sawdust was added at the beginning of the experiment. All lambs were fed with commercial concentrate (Ovirum Alta Energía®) containing barley, wheat, calcium carbonate, sodium chloride and a vitamin supplement corrector (18% crude protein and 11.5 MJ metabolisable energy/kg DM). Feeding and water consumption were ad libitum. In both treatments the concentrate hopper was wide enough to allow all lambs to eat simultaneously. Water was provided using a float drinker installed in a corner of each pen. Feed consumption (concentrate) was registered to estimate the conversion index during the fattening period. Animals were weighed individually at the beginning of the experimental period (W1) and just before slaughter (W2).

2.2. Physiological welfare indicators

Blood samples were taken by jugular venipuncture with vacuum tubes (before final weighing) to evaluate physiological responses to stress (two 4 ml tubes per animal, with and without anticoagulant, EDTA-K3). Samples were collected by the trained personnel that handled the animals and they performed the venipuncture in less than 1 min per lamb, as a necessary precaution to avoid sampling error. Samples were kept on ice for a maximum of 2 h and taken to the laboratory for routine haematological measurements. The EDTA plasma and serum were centrifuged at 3000 rpm for 10 min and aliquots were frozen and kept at −30 °C until analysed. An automatic particle counter (Microcell counter F-800 and auto dilutor AD-260, both Sysmex™) was used to count red blood cells (RBCs) and white blood cells (WBCs) (number per litre), haemoglobin (g/dl) and haematocrit (%). The leukocyte formula was estimated from blood swabs on clean slides. Staining was performed by the rapid panoptic method using dyes from Química Clinica Aplicada Inc. (QCA). Using an optic immersion microscope we counted and identified 100 leucocytes per sample (neutrophils, lymphocytes, eosinophils, basophils and monocytes). The neutrophil/lymphocyte ratio (N/L) was used as an indicator of chronic stress (Lawrence & Rushen, 1993). Serum samples were used to determine the concentration of glucose (mg/dl, Ref. Glucose AE2-17), and the activity of creatine

Fig. 1. Wooden ramps and cereal straw as forage and bedding for lambs (left side). Lambs using the feeder ramp (right side, above) and using the playing ramp (right side, below).