The effect of two housing systems on productive performance of hair-type crossbreed lambs in sub-humid tropics of Mexico

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ABSTRACT

The effect of two housing systems during the fattening period on productive performance of lambs from different hair-type sheep breeds in southeastern Mexico was evaluated. Effects of housing system (raised-slatted floor cages (RFC) vs. floor pens (FP)), year (2009, 2012 and 2013) and season of the year (rainy vs. dry) on average daily gain (ADG), weights adjusted to 60 (P60) and 90 (P90) days post-weaning were evaluated. Data from 1213 lambs collected on the farm over a period of three years were analysed. The ADG, P60 and P90 were affected (P < .01) by the housing system, year and the housing system × year interaction. The season was not a significant source of variation. Lambs housed in RFC were heavier (ADG 306.5 ± 2.69 g, P60 33.2 ± 0.16 kg, P90 42.4 ± 0.24 kg) than those in FP (ADG 269.4 ± 4.24 g, P60 30.9 ± 0.25 kg, P90 39.0 ± 0.38 kg) (P < .01); however, the significant interaction housing system × year suggests that productive performance of lambs may vary between years, despite the housing system. It was concluded that productive performance of hair lamb was affected by housing systems, year and their interaction.

1. Introduction

Intensive lamb fattening systems have received considerable attention in many parts of the world, due to the high demand for lambs at favourable prices (Hartwell et al. 2010; Rihawi et al. 2010). In the Mexican tropics, there is an increase in intensive feedlot systems to improve sheep production efficiency (Muñoz-Osorio et al. 2016). The features of these systems were described recently (Muñoz-Osorio et al. 2015a); but, there is a lack of information on the productive performance of lamb of different hair-type breeds raised in different housing systems in the tropics (Muñoz-Osorio et al. 2015b, 2016). It is important to improve the facilities in fattening systems because the consumers have stressed the importance of lamb welfare (Montossi et al. 2013). In temperate regions of the world, the enrichment of environment in lamb fattening systems was developed to solve the problem of humidity and chill in pens and to reduce the stress of lambs during fattening periods (Gordon & Cockram, 1995; Tuyttens, 2005; Bøe et al. 2007; Teixeira et al. 2012; Pascual-Alonso et al. 2015). Improving facilities in lamb fattening systems allowed a cleaner and dryer environment, less exposure to pathogens, reduced energy expenditure and better comfort leading to higher animal production (Lupton et al. 2007; Hernández-Cortazar et al. 2014; Aguayo-Ulloa et al. 2014, 2015a, 2015b; Teixeira et al. 2015). Using straw for bedding in animal production under confinement is a common practice in temperate regions (Faervik et al. 2005; Tuyttens, 2005; Teixeira et al. 2013; De et al. 2015), but in sheep production, the cost of the straw is the major constraint to keep using it (Wolf et al. 2010; Teixeira et al. 2014). Alternatives to substitute the straw as bedding in sheep production has recently researched (Wolf et al. 2010; Teixeira et al. 2013; Teixeira et al. 2014; Aguayo-Ulloa et al. 2014, 2015a, 2015b). Teixeira et al. (2012) trying to improve lamb welfare, production and meat quality found no differences between lambs housed with or without cereal straw as bedding. Miranda de la Lama et al. (2012) using cereal straw as bedding found an increase on affiliation behaviour of lambs which promote better adaptation to the feedlot. Teixeira et al. (2015) using sawdust, cellulose, cereal straw and rice husk as bedding found an improved behavior and decreased animal stress, but, there were not any effects on lamb performance. Recent trials had proved the positive benefit of the enrichment of environment using beddings, bunks, wooden ramps or wooden screen with flaps on lamb welfare (Aguayo-Ulloa et al. 2014), final live weight and carcass conformation scores (Aguayo-Ulloa et al. 2015a, 2015b). The lambs in enriched pens showed a great preference for the provided items, which encouraged more natural and better behavior reducing stereotypes and lamb aggressions, and also increased the final body weight in 26% and improved the carcass quality. However, in the warm season, confinement is not appropriate to fattening lambs unless it is air conditioned which increase the production cost. In the dry regions of Syria, during
summer (environment temperature 35–40°C), lamb fattening outdoor (open barn under a shed) showed better performance than indoor (Rihawi et al. 2010). Under the warm condition, the confinement without good ventilation induces heat stress in animals and deleterious effect on welfare and performance (Rihawi et al. 2010; Centoducati et al. 2015). In the sub-humid tropics of Mexico, intensive lamb fattening systems in raised slatted floor cages (RFC) have been promoted to prevent the contact between animals and faeces and to provide adequate ventilation for them. In this context, it is possible that the lambs housed on RFC get a better productive performance compared to those housed in floor pens (FP) at the ground level. Therefore, the aim of this study was to evaluate the effect of two housing systems (RFC vs. FP) during a fattening period on productive performance of lambs from different hair-type sheep breeds in southeastern Mexico.

2. Material and methods

2.1. Area of the study

Data considered in this study were obtained from a farm fattening male lambs, located in Yucatan, southeastern Mexico (20° 29′ Latitude North and 89°43′ Latitude West) at an altitude of 30 m above sea level. The climate in this region is warm sub-humid (Aw0). According to rain records, there are two seasons during the year, rainy (June to November) and dry (December to May). The average annual rainfall is about 1034 mm with the peak of rains occurring from June to September. The average minimum and maximum relative humidity are 73% and 78%, respectively (Instituto Nacional de Estadística y Geografía 2011). The average minimum and maximum temperatures are 17.4°C (January and February) and 35.6°C (April and May), respectively (Comisión Nacional del Agua 2013).

2.2. Study description

At weaning (initial day of the fattening period), all lambs were ear-tagged, weaning dates and body weight were recorded. During the fattening period lambs were either kept on RFC or FP. The groups were composed of lambs with different genotypes. In a recurrent way, dams of a local, non-de-sired sires. The lamb number per pens was 19 and 16 in FP and RFC, respectively. Pen size for FP was 15 m² and stocking density of 0.56 m² per lamb while pen size for RFC was 9 m² and stocking density of 0.56 m² per lamb. The height to RFC from the ground level was 80 cm. The pens were provided with feeders and troughs. The RFC pens were made of metal or plastic slats flooring that maintained the pen clean and dry at all times. So, no lamb faeces or urine remained in contact with the lambs (Lupton et al. 2007). The latter was meant to reduce the risks of parasites, as well as offering better comfort for the lambs in the warm weather conditions of the study area (Hernández-Cortazar et al. 2014). The FP pens were at the ground level, and floor was either concrete or not covered soil. All animals were fed ad libitum with pellet concentrate in a feeder, as well as fresh water. The lambs were fed with commercial concentrate contained 12% humidity, 14.5% crude protein, 2.8% fat, 3.1% crude fibre, 5.0% ashes and 62.60% nitrogen-free extraitives (according to manufacturer). Additionally, all lambs received Cynodon nlemfuensis, Brachiaria brizantha or Zea mays hays as a supplement. At the beginning of the fattening period, all lambs were dewormed and vaccinated against pneumonia pasteurellosis, according to doses recommended by the manufacturer.

2.3. Database management

A total of 1213 records from productive performance of male lambs were collected in total for years 2009, 2012 and 2013. The initial and final body weights (IW, FW) and dates of beginnings and endings (SD, ED) of the fattening period from each housing systems (RFC and FP) were recorded. Lamb fattening period (LFP) was calculated as the difference between ED and SD and average daily gain (ADG) as the difference between FW and IW divided by LFP. The FW was adjusted to 60 (P60) and 90 (P90) post-weaning days, using the following formulae: P60 = ADG * 60d + IW and P90 = ADG * 90d + IW (Hinojosa et al. 2013). P60 was used because it was the aim of the fattening farm, while P90 was estimated according to the commercial finishing weight period in sheep-fattening farms located in Yucatan, southeast of Mexico (Muñoz-Osorio et al. 2015a). Data were classified according to housing system (RFC vs. FP), years (2009, 2012 and 2013) and season of the year (rainy (June to November) and dry (December to May)). Animals with inconsistent data were excluded from final statistical analyses.

2.4. Statistical analyzes

The data was analyzed by the general linear model procedure of SAS version 8 (SAS, 1999). In order to determine the effects of housing systems, year and season of the year for ADG, P60 and P90 analysis of variance was used. The model included the IW as a covariate to adjust differences of initial weights and simple interactions between fixed effects; however, the non-significant interactions were removed from the final model. The model used for the analysis of variance was: Yijk = μ + Si + Yj + Sk + (SY) ij + Eijk; where: Yijk = are the observations of the dependent variables, μ = the overall mean effect, Si = effect of the level ith of housing system factor, Yj = effect of the level jth of year factor, Sk = effect of the level ith of season factor, (SY) ij = effect of the interaction jth fattening system x year and Eijk = random error component. Differences between means were determined by Tukey test.

3. Results and discussion

The overall means and standard errors for ADG, P60 and P90 were 292.8 ± 1.87 g, 32.3 ± 0.16 kg and 41.1 ± 0.20 kg, respectively. In Table 1, least squares means and standard errors for ADG, P60 and P90 of lambs fattening by factor level and significance are shown. Housing systems, year and the housing system x year interaction had significant effects (P < .01) on ADG, P60 and P90. Lambs housed in RFC had 37.1 g, 2.3 kg and 3.4 kg ADG, P60 and P90, respectively, more than lambs
housed in FP (P < .01). During the first year of study (2009), ADG, P60 and P90 were higher than others years (2012 and 2013). Season of fattening had no effect on ADG, P60 and P90 (P > .05). Interactions between housing system × year affected all dependent variables only during 2012 (P < .01) (Table 1). The differences between means from dependent variables always were better for lambs at RFC; however, significant differences for ADG, P60 and P90 were only found for year 2012 (P < .01) (Table 1).

In the current study ADG of lambs at FP was higher compared to data reported by Canton et al. (2009) and Hinojosa-Cuéllar et al. (2013) in tropical areas, and also by Macías-Cruz et al. (2010) in dry and extremely hot areas of Mexico. However, it was similar to results from Muñoz-Osorio et al. (2010) in dry and extremely hot areas of Mexico. Cuellar et al. (2013) in tropical areas, and also by Macías-Cruz et al. (2015), on RFC, ADG were reported by Magaña-Monforte et al. (2015), on RFC, there was a better daily gain weight compared to confinement without ventilation. The confinement in sheep production for temperate regions has showed stress episodes caused by warm environmental conditions during summer in ewes (Centoducati et al. 2015) or during the finishing phase of fattening, decreasing the performance of feedlot lambs. Under this condition the ewes and lambs prefer expose their head outside of the pen looking for fresh air. Some authors have reported a negative relationship between lamb stereotypes frequency and productive performance (Aguayo-Ulloa et al. 2015a, 2015b; Teixeira et al. 2015). In the present trial, the welfare of the lambs was not evaluated. It is important to evaluate the effect of the housing (RFC and FP) on animal welfare, to know the behavioural and physiological profiles associated with the stress of the animals during the fattening period, as reported by some authors (Teixeira et al. 2012, 2015; Aguayo-Ulloa et al. 2015a, 2015b; Pascual-Alonso et al. 2015). Is it possible to improve the performance of the lambs in RFC system if the stocking pen is increased or if the environment is enriched? On the other side, if the FP system is enriched with bedding along the year, could the lamb welfare and performance be improved? Mexico currently is promoting the welfare in animal production systems, so, it is important to know if the behaviour of lambs under these fattening systems achieve the international standards of welfare.

The year as the main factor induced changes in productive performance over the time (Hinojosa-Cuellar et al. 2013). In the current study, lambs performed better in year 2009 followed by 2013 and 2012. Other authors, showed different ADG post-weaning in lambs along the years, attributing this performance to the similarity of environmental conditions during the years evaluated (Hinojosa-Cuellar et al. 2013). Differences between years for the response variables in the current study suggest that environmental conditions, including administrative management, availability of feed resources and climate could be different leading to changes in productive variables (Dixit et al. 2001; Benyi et al. 2006; Hinojosa-Cuellar et al. 2013).

There were no effects of season on the productive performance of fattening lambs. Hinojosa-Cuellar et al. (2013) reported the effect of the season in newborn F1 lambs (Pelibuey × Blackbelly) and their crosses with Dorper and Katahdin. These authors pointed out both greater ADG and body weight for lambs feeding (concentrate) and grazing lambs suggest that the diet composition has a greater influence on lamb performance their energy expenditure in activities (Lupton et al. 2007) and a better ventilation allowing a good animal performance. Rihawi et al. (2010) found that adding artificial ventilation for lambs during fattening in the outdoor condition showed better daily gain weight compared to confinement without ventilation. The confinement in sheep production for temperate regions has showed stress episodes caused by warm environmental conditions during summer in ewes (Centoducati et al. 2015) or during the finishing phase of fattening, decreasing the performance of feedlot lambs. Under this condition the ewes and lambs prefer expose their head outside of the pen looking for fresh air. Some authors have reported a negative relationship between lamb stereotypes frequency and productive performance (Aguayo-Ulloa et al. 2015a, 2015b; Teixeira et al. 2015). In the present trial, the welfare of the lambs was not evaluated. It is important to evaluate the effect of the housing (RFC and FP) on animal welfare, to know the behavioural and physiological profiles associated with the stress of the animals during the fattening period, as reported by some authors (Teixeira et al. 2012, 2015; Aguayo-Ulloa et al. 2015a, 2015b; Pascual-Alonso et al. 2015). Is it possible to improve the performance of the lambs in RFC system if the stocking pen is increased or if the environment is enriched? On the other side, if the FP system is enriched with bedding along the year, could the lamb welfare and performance be improved? Mexico currently is promoting the welfare in animal production systems, so, it is important to know if the behaviour of lambs under these fattening systems achieve the international standards of welfare.

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than the environmental conditions do (Gabryszuk et al. 2014), however, in the present study, lambs received the same diet (concentrate and pasture). In temperate regions especially in winter ewes prefer pens with straw bedding than wooden slats (Gordon & Cockram, 1995). Cooper and Jackson (1996) demonstrated that the sheep allocated in confinement with wooden slats floor showed more stereotypes than animals in straw-bedded pens. Færevik et al. (2005) showed that sheared ewes prefer straw-bedded pens, but, unsheared ewes did not have any preference for particular type of flooring materials. The average minimum and maximum temperatures in Yucatán, México are 17.4°C and 35.6°C, respectively, so, in this condition it could be expected that lambs prefer RFC than FP probably looking for comfortable temperatures.

In the current study, interactions between housing system × year influenced the lamb productive performance. The mean differences of dependent variables were better for lambs of RFC than FP, but significant differences for ADG, P60 and P90 were only found in year 2012, in which, the lambs had a lower productive performance compared to the other years. The interaction between housing system × year suggests an environmental variation, including factors such as feeding, housing, climatic conditions, preventive and bio-security factors as well as production objectives, between years. It is argued that under environmentally controlled conditions (free of parasites, same genotypes, ideal housing conditions including raised roof and clean environment), the animal performance under either RFC or FP could be similar, but considering the lamb welfare, it is important to evaluate the behaviour of the animal under both fattening systems.

4. Conclusion

The results of this study showed an improvement in the productive performance of lambs in RFC; however, the effect of interaction between housing system × year suggests that productive performance of lambs can vary due to factors described above. However, it is necessary to compare on a prospective study the productive performance of lambs housed on either RFC or FP. According to the current demands of meat lamb from consumers, it is important to evaluate the welfare of lambs fattening in these systems. On the other hand, the economic advantage of the fattening systems with RFC could be affected by the high investment on infrastructure in comparison to FP.

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