Lack of straw during finishing affects individual and social lamb behavior

Dayane L. Teixeira [a], Genaro C. Miranda-de la Lama [b], Morris Villarroel [c], Juán Escós [a], Gustavo A. María [a]

Abstract

The aim of this study was to analyze the effect of straw bedding on individual and social behavior in lambs. Four groups of 6 lambs of the Rasa Aragonesa breed (n = 24; 17.2 ±0.2 kg live weight and approximately 60 days old) were formed and fattened for 28 days, in an experimental design that included 2 treatments and 2 replicates. One treatment was given cereal straw either to eat or to lie on, whereas the other treatment had no straw. All groups were housed in 5.6 m2 feedlot pens (ad libitum commercial concentrate and water). The lambs in each pen were recorded using a digital video camera (08:00-20:00 hours) for 28 days to measure lying, standing, walking, feeding, and drinking behavior as well as the use of space (scan sampling every 10 minutes). Stereotypies, social interactions, and productive performance parameters were observed by continuous sampling on days 1, 7, 14, 21, and 28 of fattening. There were no significant differences in terms of productive performance. In general, the frequency of standing, walking, and eating concentrate was higher in lambs without straw ($P \leq 0.001$). As expected, lambs spent more time standing in the straw box when this substrate was available ($P \leq 0.001$). Aggressive interactions decreased after 2 weeks in both treatments, but just lambs without straw kept low levels until the end of the trial ($P \leq 0.05$). Affiliative interactions increased in both groups throughout the experiment, indicating greater group cohesion. Stereotypic behaviors were more frequent in lambs with no straw on all observation days ($P \leq 0.05$). The absence of cereal straw was a source of stress for the lambs, which affected their behavior during fattening. Providing straw can be a practical way to increase environmental enrichment aimed at improving welfare.

Keywords:fattening lambs; straw; environmental enrichment behavior; Labour; welfare

1. Introduction

Welfare can be defined as the state of animals regarding their attempts to cope with their environment (Broom, 1986). The wel-fare of farm animals is a growing public concern and considered a priority for an increasing number of Europeans (European Commission, 2006; Vanhonacker et al., 2008). New regulations have been developed to control the quality of housing, and man-agement procedures have been used throughout the production chain to satisfy consumer demands regarding welfare quality (Winter et al., 1998; María, 2006), but production systems change with time, requiring up-to-date analyses of how animals are coping under new conditions.

With respect to sheep production, traditional pastoral systems are now giving way to more intensive schemes with large flocks with increased productivity. In Spain, the second largest lamb producer in Europe, there are now 2 specialized subsystems; breeding the flock (under the farmer's responsibility) and fattening on large feedlots called classification centers (CCs). The main output is the highly appreciated meat from light lambs (slaughtered at 100 days old and 8.5-13 kg carcass weight; Sañudo et al., 1996) that are fed indoors with ewe milk and a concentrate (CO)-based diet until weaning (45-50 days old). After this period, they receive CO and straw at the CCs until slaughter. Although the new scheme simplifies the process and reduces farm labor, the social mixing,

[a] Department of Animal Production and Food Science, Faculty of Veterinary Science, University of Zaragoza, Zaragoza, Spain
[b] Department of Food Science, Group of Animal Welfare and Sustainable Livestock Production, Metropolitan Autonomous University, UAM-Lerma, México, México
[c] Department of Animal Science, E.T.S.I.A. Polytechnic University of Madrid, Madrid, Spain

changing environments, increased handling, and need for double haulage may be stressful, affecting lamb welfare (Miranda-de la Lama et al., 2012). Although litter (usually chopped straw) may be provided at the CC, there is generally little else to stimulate activity. In addition, many CCs are now trying to reduce production costs and eliminate straw provision altogether, either as bedding or forage, which makes conditions quite barren. Feedlot managers argue that lambs at this age could be considered preruminants and so do not require straw, but the effect of lack of straw on lamb welfare is unclear.

Barren environments may cause chronic stress in lambs (Teixeira et al., 2012). Poor housing conditions also bring about behavioral changes, which may indicate reduced welfare and affect the normal ontogeny of relevant behaviors in this species (Pearce and Paterson, 1993; Newberry, 1995; Tuyttens, 2005). Providing environments with some kind of bedding substrate may increase the amount of exploratory behavior and reduce the animals' responsiveness to novel stimuli at the end of the rearing period (Courboulay and Meunier-Salaün, 2002). As well as interacting with the substrate, animals walk and run more, reducing the incidence of lameness, skin problems, and fear reactions (Faull et al., 1996). In addition to stimulation, straw can provide comfort and safety to confined animals, improving their welfare (Le Neindre et al., 2004). This need of the animals is particularly important in the context of intensive environments where they must occupy long periods with a limited range of behavior patterns (Hughes and Duncan, 1988). The manager's decision to provide some type of bedding material during the finishing phase for fattening lambs is a practical way to enrich the environment in intensive systems, and the cereal straw is the main option presently available on the market (Fraser et al., 1991).

The influence of bedding materials on the health, welfare, and behavior of housed livestock has been extensively researched (Tuyttens, 2005), but relatively few studies focus on lamb produc-tion (Teixeira et al., 2012). Behavioral comparisons between straw and slat systems for ewes were performed by Cooper and Jackson (1996) and Gordon and Cockram (1995). The sheep with access to straw demonstrate a more natural and richer behavioral mainte-nance pattern (Cooper and Jackson, 1996; Day et al., 2006; Wolf et al., 2010). Choice studies that test bedding substrate prefer-ences have been carried out by Gordon and Cockram (1995), Wolf et al. (2010), and Teixeira et al. (2013). The lambs clearly prefer soft and dry bedding materials such as straw or sawdust. Similar studies have been performed by Færevik et al. (2005) for adult ewes after shearing. The aim of this study was to analyze the effect of the presence of straw as bedding material on individual and social behavior in lambs during the finishing phase of fattening. The hy-pothesis was that not providing straw to lambs can make their adaptation to their new challenging environment at the CC more difficult, decreasing their welfare.

2. Materials and methods

The study was carried out at the experimental farm of the University of Zaragoza, Spain (latitude 41 41' N). The area is located in the Ebro River depression, characterized by a dry Mediterranean climate with an average annual temperature of 15 C and an average 317 mm annual rainfall. All protocols were approved by the animal experimentation ethics committee (Comisión Etica Asesora) of the University of Zaragoza.

Subjects and study description

Twenty-four entire male lambs of the Rasa Aragonesa breed, clinically healthy, were used. Average live weight on arrival to the experimental farm was 17.20 (±0.2) at approximately 60 days old. Following the traditional management protocols for this breed, lambs had been weaned at 45 days of age. All animals were kept in a holding pen during 24 hours and, after sorting by weight, were individually identified by numbers marked on their sides and back with livestock paint spray for easy identification. Four groups of 6 lambs were formed and fattened for 28 days, in an experimental design that included 2 treatments and 2 replicates (n = 24). The animals were housed randomly in 1 of four 1.7 x 3.3 m pens, with a stocking density of 0.93 m^2 per lamb. One treatment was given cereal straw either to eat or to lie on, whereas the other treatment had no straw. All groups were fed ad libitum with pellet CO in a feeder as well as fresh water. The commercial CO used (Ovirum High Energy) contained barley, corn, wheat, vegetable fat, soya tort, sugarcane molasses, calcium carbonate, sodium chloride, and a vitamin mineral corrector (18% crude protein and 3.5 Mcal/kg dry matter/day of metabolizable energy).

Productive performance parameters

Animals were weighed individually at the beginning of experi-mental period (W1) and just before transport (W2). Average slaughter live weight was 27.32 (0.61) and 26.59 (0.61) kg, for lambs with straw and without straw, respectively. The addition of CO in the feeder and feeder rejection (at the end of experiment) were both recorded. The total consumption of CO was estimated as the difference between the CO added and the CO and forage refused. Average daily gain was estimated by the difference be-tween W2 and W1 (weight gain) divided by the total fattening days (28). The conversion index was estimated as CO/weight gain. The animals were slaughtered within the weight range of the Ternasco-type category at a European Commission-approved abattoir after overnight lairage following standard commercial procedures.

Behavioral profile

A video-recording device (model VDVR-9; Circontrol S.A., Ter-rassa, Spain) was set up in a room close to the pens to record lamb behaviors. One camera was placed in front of 2 pens, 220 cm above the ground. Two kinds of recording were carried out for 12 hours per day (08:00-20:00 hours): scan sampling every 10 minutes throughout the experiment; and continuous sampling on days 1, 7, 14, 21, and 28 (a total of 60 hours per pen). Each video was observed twice by the same trained observer to record the behaviors in each group.

The use of space in each pen was recorded by instantaneous sampling. Four areas were defined in each pen (Figure 1): (1) straw box, (2) feeder hopper, (3) drinker, and (4) resting area. Every 10 minutes, the position of each lamb and maintenance behavior were noted. The behaviors recorded as instantaneous samples included lying (lamb resting with eyes open or closed), standing (lamb standing on all 4 legs), walking (lamb on all 4 legs and in motion), feeding (lamb searching for feed CO in the trough and eating it), and drinking (lamb drinking water from the drinker).

The continuous behavior sampling (Martin and Bateson, 1993) was used to record social interactions and stereotypic behaviors. As all animals were individually identified, the total number of affili-ations and aggressions initiated by each individual per day were considered for statistical analyses. Aggressive interactions included butts (when the lamb used its forehead to hit another lamb on any part of its body), pushing (when a lamb used its body to push another lamb to access the feeder or water thought), mounting (when a lamb mounted another lamb from behind to move the latter, without an apparent sexual function), kicking (when a lamb hit another lamb on any part of its body, with its forelegs), threats (when a lamb turned toward or approached another lamb with its head down and then lunged, without contact), and persecution (when a lamb moved toward another lamb, causing the latter to walk or run away). Affiliative interactions included rubbing (when a lamb was rubbing or scratching another lamb), nibbling (when a lamb was grooming another lamb's body using teeth), licking (when a lamb was licking another animal's body), and sniffing (when a lamb was sniffing another animal's body). Stereotypic behaviors were defined as licking or gnawing repeatedly on feeders, walls, fences, or wood or metal objects without feed consumption (Miranda-de la Lama et al., 2012).

Statistical analysis

Data were analyzed using SAS/STAT (version 9.1; SAS Institute, Inc, Cary, NC) by SAS (1998). Data were tested for normality before analysis by examination of box and normal distribution plots and transformed when necessary. The KruskaleWallis test was used to find out if there were any significant effects of straw presence on the behaviors observed by instantaneous sampling. In this analysis were used the frequency of each animal performing each behavior and their position throughout the experiment. This test also was used to compare the effect of the treatment in each week (1, 2, 3, and 4) and to compare the weeks within treatment. Following the Bonferroni methods (Martínez-González et al., 2006), the Manne Whitney U tests were used to compare median percentage times between weeks, penalizing by the number of comparisons used. The data are presented as percentage of the animals performing each behavior or in each position within each week of the experi-ment. The behaviors observed from the continuous sampling (average per animal per day) were analyzed using the mixed pro-cedure of repeated measurements (day) with treatment as the fixed effect and lamb as the random effect. No significant interactions between treatment and day were found. The effects of straw on productive performance were analyzed using a general linear model with treatment as the fixed effect. Least squares means ± standard error) are reported throughout, and the probability of obtaining P values 0.05 was deemed to be statistically significant.

3. Results

The average daily gain was 323 16 g in lambs with straw and 297 16 g in lambs without straw. The conversion index was 3.20 ± 0.19 kg in lambs with straw and 3.39 0.19 kg in lambs without straw. No clinical health problems or injuries were observed in the lambs in either treatment.

The frequencies of behaviors per lamb per week are presented in Figure 2. All behaviors were significantly different between treat-ments throughout the experiment ($P \leq 0.05$), except lying. How-ever, within each treatment, lambs lied down less frequently in the 3rd week compared with previous weeks ($P \leq 0.05$). During the 4weeksoffinishing, animals without straw showed a higher fre-quency of standing than lambs with straw ($P \leq 0.05$). Within each treatment, lambs stood more frequently during week 3 than weeks 1 and 2 ($P \leq 0.05$). Similarly, animals without straw spent more time walking but, within each treatment, lambs walked less in week 2 than in week 3 ($P \leq 0.05$). Lambs without straw spent more time eating CO than lambs with straw during the first 3 weeks ($P \leq 0.05$). Within each treatment, lambs without straw spent more time eating CO during week 3 compared with week 1 (P 0.05).

The frequency of the use of space in each week of the experi-mental period is presented in Figure 3. The use of space was significantly affected by week in both treatments (P 0.05). Lambs with straw spent more time in the straw box during the 4 weeks (P 0.05). Lambs without straw spent significantly more time in the other areas, with exception of the feeder hopper in week 4 and the resting zone in week 3.

The behaviors observed by continuous sampling were also affected by treatment and time (days of finishing). The least square means (standard error) per animal per day of aggressive and affiliate interactions and stereotypic behaviors for days 1, 7, 14, 21, and 28 are presented in Figure 4. In lambs without straw, there were more aggressive interactions on day 7 compared with lambs with straw (P 0.05), but no differences were found between treatments on the other days. Aggressive interactions decreased from day 1 to day 14 in both groups (first half of the trial) but decreased in lambs without straw by day 28 ($P \leq 0.05$).

Affiliative interactions were higher in lambs without straw on days 14 and 28 ($P \leq 0.05$). The average number of affiliate in-teractions increased after day 1 in both treatments ($P \leq 0.05$). They peaked on days 7 and 21 for lambs with straw ($P \leq 0.05$), with a similar tendency found for lambs without straw. There was more stereotypic behavior in lambs without straw on all days (P 0.05). They were also more frequent on days 7 and 21 in lambs with straw ($P \leq 0.05$), although the same tendency was found for the treatment without straw.

4. Discussion

In our study, the productive performance of lambs with and without straw bedding was within the expected ranges for com-mercial fattening (Sañudo et al., 1998). Flaherty et al. (1999) and Day et al. (2006) also failed to find an effect of straw bedding on feed efficiency or growth rate in lambs, respectively. Before dis-cussing the behavioral results, we noted that it was not possible to obtain as many pens as needed, so animals were used as the experimental unit, hence some caution is required in the overall interpretation of these results.

In terms of behavior, in general the frequency of standing, walking, and eating CO was higher in lambs without straw. Those results agree with the study by Cooper and Jackson (1996), although they found that the frequency of lying in sheep with straw was also higher, which was not apparent in our study. The fact that lambs with straw were quieter and walked less suggests that straw had a calming effect, which can be important during social mixing after weight classification (Miranda-de la Lama et al., 2012).

Lambs were more active (spent less time lying) on the third week of fattening, which suggests that bedding material was less attractive or comfortable. Wolf et al. (2010) did not find differences in lamb behavior throughout the fattening period, whereas, Gordon and Cockram (1995) found initial differences in the lying behavior of rams when they were allocated on slats or straw bedding. Lying behavior can also be affected by environmental temperature (Bøe et al., 2007), but our study was carried out in autumn with temperatures well within the thermoneutral zone of this kind of lamb (Tuyttens, 2005).

At the end of fattening, drinking frequency was higher in lambs with straw, implying that they may have consumed more dry matter during the last week. However, that could not be confirmed because it was not possible to measure straw consumption. Our results disagree with Cooper and Jackson (1996) who found that sheep on slats drank more water than on straw bedding. As ex-pected, the frequency of eating CO was higher in lambs without straw than lambs with straw, corroborating results found by Cooper and Jackson (1996). That finding suggests that lambs redirect their motivation to eat forage, to eat more CO.

Spatial restriction is one of the main problems in intensive animal production systems (Fraser, 2008). One of the best ways to improve the welfare of the animals is to provide enough space or enrich the environment (Young, 2003). Analyzing the use of space and the use of enriched areas is an important way to verify the efficiency of a system in terms of welfare. In our study, the straw box area had the highest occupation (in the group with straw bedding), whereas the group without it spent more time in the other 3 areas. Færevik et al. (2005), Hansen and Lind (2008), and Jørgensen and Bøe (2009) also found an effect of environmental enrichment on the areas where sheep chose to rest. Marsden and Wood-Gush (1986) suggest that the quality and quantity of space affect the use of space and that both must be considered in hous-ing design. They show that the dominant animals in a group appropriate specific resting areas, but that is conditioned by animal density.

Throughout our experiment, animals with straw decreased their occupation of the straw box in the last week of the trial, whereas lambs without straw tended to increase their occupation of this area (but always less than the former group). Our results agree with Peeters et al. (2006) who found that pigs were very interested in straw at the beginning of the trial but decreased their interest throughout the fattening period perhaps because of habituation with this substrate. As opposed to Morgan et al. (1998), who did not find significant differences in feeder use between pigs with and without straw, lambs without straw in our experiment used the feeder more during the first 3 weeks. On the last week, both groups increased their occupation in that area, probably liked with a higher demand for CO.

The differences in drinker use between treatments tended to decrease toward to the end of the trial, when lambs without straw used it less frequently and lambs with straw used it more frequently. Perhaps the latter increased drinker visits because of higher CO consumption during that period. However, that was not the case in lambs without straw, which reduced occupation of the drinker area while increasing visits to the feeder area. In general, lambs from both groups tended to decrease their occupation of the resting area toward to the end of the experiment. In the no-straw group, lambs increased their frequency in the resting zone during the fourth week, which corresponds with less occupation of straw box area.

Briefly, the differences in the use of space between the lambs with and without straw access in our experiment suggest that the animals in the nonenriched environment do not use each space not because of their functions but because of a better utilization of the space in the pen.

At the beginning of continuous observations, there was a high level of aggression, indicating unstable social groups (Weary et al., 2008) or the development of strategies to establish a social hier-archy (Keeling and Gonyou, 2001). Mixing unfamiliar animals increases aggressive interactions (Ruiz-de-la-Torre and Manteca, 1999) and stress (Barnett and Hemsworth, 1990). However, it can be an indicator of social instability and, therefore, poor animal welfare. As the trial continued, the level of aggressive interactions decreased, which can indicate the establishment of a social hier-archy (Fraser and Rushen, 1987). It is also possible that the level of aggressive interactions was affected by environmental aspects. In general, the lambs without straw showed highest level of aggressions, mainly on the second week. From the third week until the end of the fattening period, the level of aggression was similar in both groups. We did not find other studies that evaluated the effect of the straw presence/absence on aggressive behavior in sheep. However, Morgan et al. (1998) found with straw that pigs increase their activity and level of aggressions at the feeder.

Affiliative behavior can be described as reciprocal and voluntary contact between 2 or more individuals that is not related to reproduction (Wasilewski, 2003). Unfortunately, these positive in-teractions have been poorly researched in farm animals (Keeling and Gonyou, 2001), but it is known that, under intensive housing conditions, animals normally direct their behavior toward fellow pen mates (Kelly et al., 2000). In our study, affiliate interactions increased throughout the fattening period in both treatments, indicating greater group cohesion. As commented previously, there is a lack of information on the effect of straw on social behavior in lambs, but in pigs, Peeters et al. (2006) observed that the affiliate interactions increased with the straw provision during 6 weeks previously of the slaughter. Lambs without straw had more affiliate behavior after about halfway through the fattening stage, possibly because they concentrated more intensely on social relationships because of their poor physical environment.

There were more stereotypic behaviors among lambs without straw. In a more barren environment, lambs tend to perform more repetitive, apparently meaningless behaviors, which also provides information about their level of stress (Mason, 1991). These findings are in agreement with Cooper and Jackson (1996), who suggest that abnormal oral activities performed by sheep on slats may substitute for foraging activities such as eating hay or nosing straw, normally performed with straw bedding. Both group of lambs in our exper-iment showed an initial tendency to increase the incidence of ste-reotypies, which could be an effect of the novel environment (Cooper et al., 1996) and social mixing after classification (Miranda-de la Lama et al., 2012). Throughout the experiment, both groups had 2 peaks of these behaviors at the same periods, probably because of external factors, but they were always higher in lambs without straw. Those results can be explained by the effect of environmental enrichment provided by the straw and the strong effect of the intensive system (Yurtman et al., 2002).

5. Conclusions

In conclusion, although the productive performance of lambs was within the expected range for commercial fattening in both treatments, lambs with straw appeared to be more calmer and spend less time walking. Lambs without straw performed more stereotypic behaviors, concentrating more on social relationships because of a more barren physical environment. Using cereal straw is a practical way of providing environmental enrichment, which improves welfare. The result obtained will help feedlot managers to prevent welfare consequences of the lamb's adaptation to feedlots. Our results will be useful to European Union legislators in the development of scientific-based regulations proposing feasible so-lutions to the welfare problems observed in the system.

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