Effect of the use of straw on animal welfare and meat quality during fattening in light lambs

Teixeira D.L [1], Miranda-de la Lama G.C. [1], Olleta J.L. [1], Sañudo C. [1], Villarroel M. [2], María G.A. [1]

[1] University of Zaragoza/Faculty of Veterinary, Zaragoza, Spain. E-mail: levrino@unizar.es
[2] Polytechnic University of Madrid/Department of Animal Science, Madrid, Spain

*Abstract*ð **Due to the increase in the cost of straw, lamb feedlots have proposed eliminating its use during lamb fattening. The objective of this study was to analyse how straw (as an enrichment material in light lambs) affects animal welfare and meat quality. Two experiments were carried out. Experiment 1 included two treatments and two replicates with six male lambs (17.20±0.2 kg live weight) in each. One pen was provided with straw for forage and bedding while the other had none. Feeding with concentrate and water were *ad libitum*. Live weight and concentrate consumption were recorded to calculate average daily gain and the conversion index. The welfare indicators analysed were cortisol, stereotypic behaviours, agonistic and affiliative interaction. In experiment 2, 24 lambs were divided in two groups to analyse the effect of the same treatments on meat quality parameters. The meat quality from M. *Longissimus* was analysed in terms of pH_{ult}, colour (*L* a* b**, chroma and hue) and meat texture by Warner Bratzler. No significant differences in production and meat quality traits were observed between treatments. The lambs housed without straw presented higher levels of cortisol at the end of treatment and stereotypic behaviours indicating poorer welfare. Affiliative interactions were greater in lambs without straw as a result of the barren environment. The results suggest that straw provision can be considered as an effective environment-enriching tool to improve animal welfare.**

*Keywords*ð **Lamb, welfare, straw**

I. INTRODUCTION

Traditional *ternasco* (protected geographical indication) light lamb production systems have evolved towards more intensive farming systems. Amongst the reasons for this change are the increase in demand for this product, which is very popular with consumers, and also the current shortage in farm labour. The new farming scheme divides the system into two stages: the breeding stage which is carried out by farmers and the fattening stage which takes place at cooperative classification centres (CC). This simplifies the process and reduces farming labour needs whilst providing a more homogeneous product that has a quality mark for consumers (*Ternasco de Aragón*®). However, at CCs the animals are exposed to new stress factors such as the social mix, new environment, mass handling or double haulage. A basic principle of these centres is to reduce production costs and hence, due to the high cost of straw, some classification centres are considering eliminating this bedding material during lamb fattening, which usually lasts four weeks (Miranda de la Lama et al., 2010a).

As well as providing a comfort for lambs, straw is also a stimulating substrate and can be considered to be a practical means of enriching the environment with the aim of improving welfare (Fraser et al., 1991). A reasonable hypothesis is that the lack of straw may make it more difficult for lambs to adapt to their new environment and that this would affect their welfare and, probably, the quality of the product. The aim of this study was to analyse the effect of the presence and/or absence of cereal straw during lamb fattening on welfare, production and lamb meat quality indicators in light lambs.

II. MATERIAL AND METHODS

The study was carried out on a total of 48 Rasa Aragonesa male lambs distributed between two consecutive studies. The main purpose of the first study was to analyse the effect of straw on animal welfare and behaviour. Twenty four 60-day old lambs from a CC, with a live weight of 17.20(±0.2) kg, were used. Four groups were formed with six lambs randomly assigned to each group. Two groups were given cereal straw for bedding and food, whilst the other two groups were not provided with this substrate. The animals were marked with livestock

paint to identify them. The four groups were provided with commercial feed (Ovirum®) and water *ad libitum*. The lambs were housed in 6 m² pens.

Each group was filmed from 8:00 to 20:00 hours on day 1, 7, 14, 21 and 28 of fattening. The day after filming, the lambs were weighed and blood samples taken. Feed consumption and conversion ratios were recorded for each group. Levels of cortisol in blood and behaviour (stereotypic, agonistic and affiliative) were recorded. The animals were slaughtered on day 32, after a 12 hour pre-slaughter period in abattoir pens at Mercazaragoza. 24 hours *post mortem*, recordings were made of pH in M. *Longissimus* weight of the cold carcass, conformation, fat cover and carcass bruising ratio.

The second study focused on an in-depth analysis of the effect of the use of straw on meat quality. Twenty four lambs from a CC with a weight of 17.75(±0.7) kg were used. Two treatment groups (with or without straw) were formed with 12 lambs randomly assigned to each one. Following the commercial protocol of 4 weeks fattening, the animals were slaughtered in similar conditions to the animals in the first study. Meat quality variables related to texture and colour were evaluated.

Behaviour and physiological variables were analysed by the SAS PROC MIXED procedure (SAS, 1988) of repeated measurements (day) with the treatment as the fixed effect and the lamb as the random effect. The behaviour data were transformed by the square root function. Meat quality and production variables were analysed by a conventional GLM analysis.

III. RESULTS

Table 1 show the least mean squares (± SE) for production and carcass quality indicators, which were not affected by the presence of straw. Data relating to texture and colour were not affected by the presence or absence of cereal straw either.

The least mean squares (±SE) for the effect of the use of straw on cortisol levels and on the square root of the number of events observed for each behaviour (stereotypic, agonistic, affiliative) for days 1, 7, 14, 21 y 28 are shown in figure 1.

Table 1 Least mean squares (± SE) for the effect of the use of straw during fattening on the production and meat quality indicators.

Variable	Straw	No straw
Average daily gain (g)	323±16.	297±16
Conversion Index (kg)	3.20±0.19	3.39±0.19
Cold carcass weight (kg)	12.96±0.41	13.01±0.41
Bruising (nota 1-3)	0.83±0.27	0.50±0.27
Conformation	6.44±0.13	6.10±0.13
Fat cover	6.41±0.25	6.50±0.25
pH24	5.60±0.03	5.54±0.03
Texture with Warner Bratzler		
Maximum load (kg)	4.15±0.29	4.19±0.29
Toughness (kg/cm^2)	1.62±0.14	1.72±0.14
Colour		
L*	36.02±0.56	37.36±0.56
a*	11.87±0.46	11,04±0.46
b*	8.83±0.29	8.74±0.29
Chroma*	14.81±0.49	14.11±0.49
HUE*	36.83±0.95	38.46±0.95

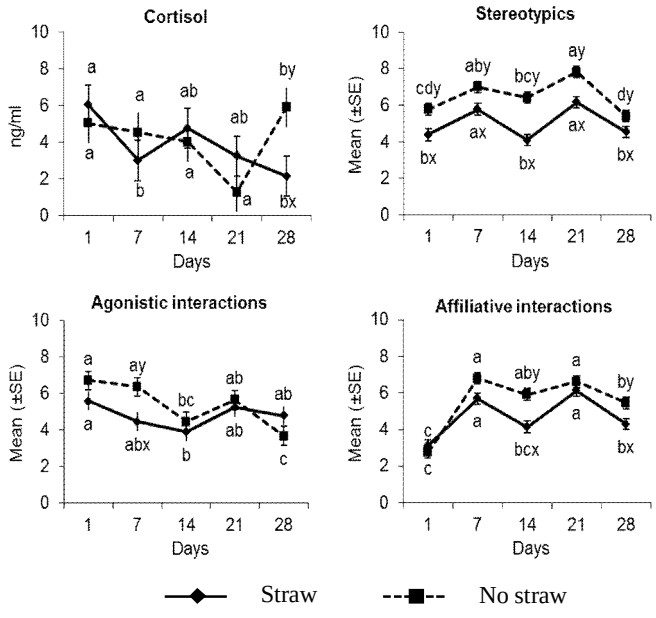

Fig. 1 Evolution of cortisol and behaviour variables during fattening. Different letters (a b c) represent significant differences (p<0.05) between days. Different letters (x and z) represent significant differences (p<0.05) between treatments within the day.

IV. DISCUSSION

Previous studies suggest that environmental enrichment can improve the welfare of growing animals by offering substrates as bedding, diversifying the components (Newberry, 1995). The influence of straw as an environmentally-enriching element has been studied in other species, chiefly pigs and cows (see review by Tuytten, 2005). There are relatively few studies that analyse this effect in lambs. Cooper and Jackson (1996), Færevik et al. (2005) and Day et al. (2006) studied feeding behaviour, production performance and the preferences of these animals for straw, respectively.

They did not find any significant differences between treatments in relation to production performance variables. In this study, lamb productivity was within the expected ranges for commercial fattening in both treatments (Sañudo et al., 1998). The results obtained coincide with those of Day et al. (2006) who compared the presence of straw bedding and a plastic slatted floor. The lamb meat was of an acceptable commercial quality in terms of its pH_{ult} values which were always within the established limits for quality meats (<6). However, a study carried out with swine in a straw-enriched environment found greater growth percentages and heavier carcasses in animals housed with straw (Beattie et al., 2000).

Cortisol level is a recognised indicator for evaluating stress responses in animals (Baldock and Sibly, 1990). In general, lambs fattened in classification centres under intensive conditions tend to present increased adrenocortical activity compared to animals in non-confined systems (Rivero, 2007). In our study, the levels of cortisol at the end of the fattening period were higher in lambs without straw, which suggests that these animals were initially influenced by acute and later chronic stressors. This statement coincides with the findings of Miranda-de la Lama et al. (2010b).

In our study, the presence of straw affected the behaviour of lambs. These findings are in disagreement with the results of the study carried out by Wolf et al. (2010). These authors, however, found that lambs show a clear preference for woodchip bedding. Throughout the fattening stage, there was a greater frequency of stereotypic behaviour amongst the lambs without straw than there was amongst those with straw available (pÒ0.05). These results suggest that, in a poor environment, lambs tend to redirect their foraging motivation to repetitive, apparently meaningless behaviours. These results are in agreement with those of Cooper and Jackson (1996). In this study, lambs directed their feeding activity towards unusual substrates such as bars, wool and slats.

In our study, the lambs showed an increase in affiliative interactions throughout the whole of the fattening stage, indicating greater group cohesion. However, the lambs fattened without straw revealed a greater frequency of affiliative behaviour from half way through the fattening stage to the end of this stage. Possibly, lambs without straw concentrate more intensely on social relationships due to their poor physical environment. Another possible reason is that the agonistic interactions observed may be preceded, in some way, by affiliation. Kelly et al. (2000) state that it is normal for animals under intensive housing conditions to direct their behaviour towards their fellow penned animals.

In general, the absence of cereal straw during fattening affects the behaviour and adaptive response of lambs. However, the absence of straw is a stressor that does not affect production and quality variables. These findings would point to production variables being less sensitive to stress than behavioural or physiological variables.

V. CONCLUSION

The results obtained confirm the hypothesis that environmental enrichment can improve animal welfare by encouraging the ontogeny of the natural behaviour of the species and, consequently, its welfare. The use of cereal straw is a practical way of achieving environmental enrichment aimed at improving welfare.

ACKNOWLEDGMENTS

Study financed by the Spanish *Ministerio de Ciencia e Innovación* (CICYT). Projects AGL-2008/02088 & AGL2009/10794). We are grateful for the collaboration of Mercazaragoza and Oviaragón and to the members of the SAEA & the Product

Quality Research Group of the University of Zaragoza, in particular to Erica Muela, for their assistance in collecting samples and in performing analyses.

REFERENCES

1. Miranda-de la Lama G.C., Villarroel M., Liste G., Escós J., Maria G.A. (2010a) Critical points in the pre-slaughter logistic chain of lambs in Spain that may compromise the animalôs welfare. Small Rumin Res. 90:174-178
2. Fraser D., Phillips P.A., Thompson B. K., Tennessen T. (1991) Effect of straw on the behaviour of growing pigs. Appl Anim Behav Sci 30:307-318
3. SAS (1998) Userôs guide: statistics. Release 6.03. Cary, N.C., U.S.A
4. Newberry R. C. (1995) Environmental enrichment: Increasing the biological relevance of captive environments. Appl Anim Behav Sci 44:229-243
5. Tuyttens F.A.M. (2005) The importance of straw for pig and cattle welfare: A review. Appl Anim Behav Sci 92: 261-282
6. Cooper J., Jackson R. (1996) A comparison of the feeding behaviour of sheep in straw yards and on slats. Appl Anim Behav Sci 49(1):99-99
7. Færevik G., Andersen I. L., Boe K. E. (2005) Preference of sheep for different types of pen flooring. Appl Anim Behav Sci 90:265-276
8. Day J.P., Boland T. M., Crosby T.F. 2006. The effect of plastic slatted floor or straw bedding on performance, liver weight and liver copper concentrations in intensively reared lambs. Livest Sci 100:270-275
9. Sañudo C., Sierra I, Olleta J. L., Martin L., Campo M. M., Santolaria P., Wood J. D., Nute G. R. (1998) Influence of weaning on carcass quality, fatty acid composition and meat quality in intensive lamb production systems. Anim Sci 66:175-187
10. Beattie V.E., OôConnell N.E., Moss B.W. (2000) Influence of environmental enrichment on the behavior, performance and meat quality of domestic pigs. Livest Sci 65:71-79
11. Baldock N.M., Sibly R.M. (1990) Effects of handling and transportation on the heart rate and behavior of sheep. Appl Anim Behav Sci 28:15-39
12. Rivero L. (2007) The effect of these double transports with different times from stay of the classification lambs on the animal welfare and meat quality in lambs at warm time. Msc. Thesis. International Centre for Advanced Mediterranean Agronomic Studies (CIHEM). Zaragoza, Spain
13. Miranda-de la Lama G.C., Rivero L., Chacón G., Garcia-Belenguer S., Villarroel M., María G.A. (2010b) Effect of the pre-slaughter logistic chain on some indicators of welfare in lambs. Livest Sci 128:52-59
14. Wolf B.T.; Molloy H.R.B.; Trayte M.J.; Rose M.T. (2010) Behaviour of growing lambs housed on straw or woodchip bedding materials and their preference for floor type. Appl Anim Behav Sci 124:45-50
15. Kelly H.R.C., Bruce J.M., English P.R., Fowler V.R., Edwards S.A. (2000) Behaviour of 3-week weaned pigs in straw-flow, deep straw and flatdeck housing systems. Appl Anim Behav Sci 68:269ï 280