

# EFFECT OF ENRICHED HOUSING ON SENSORY QUALITY AND FATTY ACID COMPOSITION IN FINISHING FEED-LOT LAMBS: THE USE OF FEEDER RAMPS

L.A. Aguayo-Ulloa <sup>1</sup>, M. Pascual-Alonso <sup>1</sup>, M.M. Campo <sup>1</sup>, J.L. Olleta <sup>1</sup>, M. Villarroel <sup>2</sup>, M. Pizarro<sup>3</sup>, G.C. Miranda-de la Lama <sup>4</sup>, C.A. Fugita <sup>1</sup> and G.A. María <sup>1</sup>

<sup>1</sup> Department of Animal Production and Food Science, Faculty of Veterinary Science, University of Zaragoza, Spain

<sup>2</sup> Department of Animal Science, E.T.S.I.A. Polytechnic University of Madrid, Spain

<sup>3</sup> Peruvian University of Cayetano Heredia, Perú

<sup>4</sup> Group of Animal Welfare and sustainable Production, Department of Food Science, Metropolitan Autonomous University, UAM-Lerma, State of México, México

**Abstract** –We analysed the effect of enriched housing in finishing lambs on instrumental and sensory meat quality and fatty acid composition. Sixty lambs (male, 65 days old, 17.2±0.2 kg), were divided in two treatments and housed indoors for 5 weeks in 6 pens (10 lambs/each, 0.95m<sup>2</sup>/lamb, 3 replicates). Controls lambs were housed in pens, similar to conventional feed-lots. Enriched pens had straw as forage and bedding, one platform with ramps leading to the feed hopper and a play ramp. Enriched lambs had a higher ADG, heavier carcasses, higher fattening scores, lower values of meat pH<sub>24</sub> and lower values of texture than control lambs (P<0.05). Overall liking was higher for enriched lambs than controls (P<0.05). Tenderness was most related with overall liking (P<0.0001). Meat from enriched lambs had more stearic (C18:0) fatty acids, and a higher proportion of SFA (P<0.05). Enriched lambs performed better, which was probably related to improved meat quality. The results of this study are encouraging and reflect how housing enrichment can improve meat quality.

**Key Words** – Environmental enrichment, Intensive lamb production, Meat quality

## • INTRODUCTION

The intensification of lamb production has increased with the inclusion of feed-lot system at cooperative classification centres (CC). Their integration in the supply chain simplifies the process for the farmer, resolving labour problems, improving the homogeneity of the product and favouring the creation of new brands. However, the intensification of lamb production gives rise to new welfare problems, such as social mixing and environmental novelty [2, 4]. The working hypothesis proposes that enriching the environment favours adaptation to the novel environment (i.e CC) and improves final product quality. The aim of this study was to analyse the effect of full functional environmental enrichment using several items (feeder and play ramps and cereal straw) on meat quality variables, sensory evaluation and fatty acid profile during the final phase of fattening in lambs.

## • MATERIALS AND METHODS

Sixty *Rasa Aragonesa* male lambs, 65 days of age (17.2 ± 0.2 kg live weight), were divided into two treatments (enriched or standard), and housed for 5 weeks in 6 pens (2.9mx 3.3m, 0.95m<sup>2</sup> density / lamb, 10 lambs / pen in 3 replicates per treatment). The control group (CG) simulated CC intensive confinement, with no straw or additional items. The enriched group (EG) was given straw as forage and bedding, a platform with ramps to access the feed hopper (high) and a small additional ramp for play. Lambs were fed *ad libitum* with commercial concentrate and

consumption was recorded. Lambs were weighed at the beginning and end of the experiment to estimate average daily growth (ADG). Meat pH was measured 24 hr after slaughter (pH<sub>ult</sub>). Carcasses were evaluated in terms of conformation and fatness using the European classification system. The *M. longissimus* was removed and divided into three sections. The first section was used to determine fatty acid composition [3]. The second section was used to measure texture by Warner-Bratzler and the third section was used to evaluate sensory quality. Meat quality variables were analysed with a fixed effects model (type of environment), co-varying the instrumental meat quality variables with the weight of the cold carcass [5]

## • RESULTS AND DISCUSSION

Enriched lambs (EG) had significantly higher ( $P<0.05$ ) ADG (+18.3%), heavier carcasses (12.59 kg) and higher fattening scores (5.53) than CG lambs (11.88 kg and 5.03, respectively). The EG lambs also had significantly lower ( $P<0.05$ ) values of pH<sub>ult</sub> (5.53) than CG lambs (5.59), which is probably because they were able to maintain energy levels when faced with pre-slaughter events, such as handling, transport and stress. Shear force and toughness were significantly ( $P<0.05$ ) lower in EG lambs (3.55 and 1.29, respectively) than CG lambs (4.42 and 1.79, respectively). The use of ramps as a daily exercise in EG lambs could have influenced the characteristics of their muscle fibres. Moderate exercise has been related with greater muscle volume and a higher myofibrillar protein to total collagen ratio [1], producing more tender meat. Sensory evaluation of meat showed significant differences ( $P<0.05$ ) in favour to EG lambs (Table 1). Metallic flavour intensity was lower and lamb odour intensity and overall liking were higher in meat from EG lambs. A step-wise correlation analysis of sensory meat quality variables (Table 2) showed that overall liking was significantly related to several parameters ( $P<0.05$ ), but with a different order between treatments in the set of associated variables. Tenderness was a common most powerful parameter related ( $P<0.0001$ ) with overall liking.

Response variable	Control	Full enriched
Tenderness	6.04±0.25	6.03±0.24
Juiciness	5.14±0.12	5.32±0.12
Fibrosity	4.47±0.21	4.29±0.21
Lamb odour	5.48x±0.12	5.84y±0.12
Grass odour	3.57±0.11	3.03±0.11
Fat odour	3.57±0.15	3.67±0.15
Lamb flavour	5.9±0.1	5.98±0.1
Metallic flavour	3.68x±0.12	3.36y±0.12
Fat flavour	4.70±0.12	4.61±0.12
Bitter flavour	2.93±0.14	3.09±0.14
Spicy Flavour	2.71±0.12	2.64±0.12
Overall liking	4.70x±0.1	5.0y±0.1

Table 1 Least square means ( $\pm$ S.E.) of sensory meat quality variables in lambs in fully enriched or barren environments during the finishing phase of fattening

Scoring system based on a 10 semi-structured point scale (0 = low, 10 = high). x, y: different letters within rows represent significant difference between treatments ( $P<0.05$ )

### 1. Table 2 Step-wise multiple regression analysis of the relationship between overall liking and other sensory parameters in lambs in enriched or barren environments during the finishing phase of fattening

Step	Overall			1. Control			1. Full enriched		
	Var.	R <sup>2</sup>	P	Var.	R <sup>2</sup>	P	Var.	R <sup>2</sup>	P
1 <sup>st</sup>	TE	39	0.0001	TE	35	0.0001	TE	46	0.0001
2 <sup>nd</sup>	FB	46	0.005	JU	44	0.005	FM	57	0.0001

3 <sup>rd</sup>	FF	49	0. 05	FB	5 3	0. 05	FS	63	0.0 4
4 <sup>th</sup>	FM	51	0. 05	FF	5 6	0. 07	FF	67	0.0 5
5 <sup>th</sup>	JU	54	0. 07	FIB	6 2	0. 08	FC	69	0.2 8
6 <sup>th</sup>	FIB	55	0. 38	FC	6 3	0. 29	JU	70	0.3 9
7 <sup>th</sup>	OF	56	0. 41	OC	6 4	0. 47	FB	71	0.4 4
8 <sup>th</sup>	OC	56	0. 45				FG	72	0.4 4

TE: tenderness. FB: bitter flavour. FF: Fat flavour. FM: Metallic flavour. JU: Juiciness. FIB: Fibrousity. OF: Fat odour. OC: lamb odour. FS: Spicy flavour. OG: grass odour.

The fatty acid composition is shown in Table 3. In general, the major saturated fatty acids were palmitic (C16:0) and stearic (C18:0). Since EG lambs muscle contained a significantly higher proportion of stearic (C18:0), they had a higher proportion of SFA ( $P<0.05$ ). Variations in fat content have an effect on fatty acid composition, independent of species or breed and dietary factors. The content of SFA and monounsaturated fatty acids increases faster with the fatness level than the content of PUFA. Probably EG had more SFA since they were fatter. However, the proportion of PUFA was similar among treatments, although EG had forage straw available. Results suggest that lambs in an enriched indoor environment perform better and have improved meat quality.

Table 3 Fatty acid composition (percentage of total fatty acids) of intramuscular fat from lambs in a fully enriched or barren environment during the finishing phase of fattening

Trait	Control		Fully enriched	
	Mean <sup>a,b</sup>	SE <sup>a</sup>	Mean	SE
C10:0	0.12	0.005	0.11	0.005
C12:0	0.13	0.01	0.13	0.01
C14:0	2.30	0.1	2.28	0.1
C15:0	0.34	0.01	0.33	0.01
C16:0 (palmitic)	22.35	0.6	23.01	0.6
C16:1	1.41	0.07	1.46	0.07
C17:0	1.45	0.04	1.33	0.04
C17:1	0.85a	0.03	0.75b	0.03
C18:0 (stearic)	13.69a	0.31	14.7b	0.02
C18:1 <i>n</i> -9	36.89	0.4	36.96	0.44
C18:1 <i>n</i> -9 trans	4.15	0.2	4.35	0.2
C18:1 <i>n</i> -11	1.50	0.04	1.39	0.04
C18:2 <i>n</i> -6	6.35	0.36	5.82	0.36
C18:3 <i>n</i> -3	0.33	0.02	0.32	0.02
C20:3 <i>n</i> -3	0.13	0.01	0.13	0.01
C20:3 <i>n</i> -6	0.18	0.009	0.17	0.009
C20:4 <i>n</i> -6	2.21	0.12	1.92	0.12
C20:5 <i>n</i> -3 DPA	0.18	0.02	0.19	0.02
C22:6 <i>n</i> -3 DHA	0.12	0.01	0.12	0.14
SFA	40.82a	0.55	42.37b	0.55
PUFA	9.88	0.5	9.01	0.5
<i>n</i> -6	9.06	0.4	8.19	0.4
<i>n</i> -3	0.82	0.06	0.81	0.06
P:S	0.24	0.01	0.21	0.01
<i>n</i> -6: <i>n</i> 3	11.95	0.96	11.66	0.96
Minor SFAs detected	0.32	-	0.28	-
Minor PUFAs detected	0.43	-	0.41	3

<sup>a</sup> Means and standard errors; <sup>b</sup> Values in columns with different letters are significantly different (within trait) ( $P<0.05$ ); SFA: saturated fatty acids; PUFA: polyunsaturated fatty acids.

## • CONCLUSIONS

The results of this study are encouraging and reflect the importance of housing enrichment on meat quality. The better performance of enriched lambs was reflected by improved instrumental and sensory meat quality. In that respect, future research could consider the role of protein muscle structure in enriched lambs. The results of this study may be useful to promote strategies that are being developed to improve animal welfare standards for sheep in the EU.

## ACKNOWLEDGEMENTS

This research was financed by the Spanish Ministry of Economy & Competitiveness (CICYT), Project AGL- 2009/10794. We are grateful for the collaboration of the Cooperative Group Pastores (Oviaragón®) and to the Mercazargoza meat plant. Our thanks are given to the staff of the University Service for Animal Experimentation (SEA), especially to our carpenter Mr. Moisés Bueno. Thanks to the Spanish Ministry of Economy and Competitiveness for the Scholarship of the Research Personnel Training Program (FPI) for Mrs. Lorena Aguayo-Ulloa.

## REFERENCES

- Aalhus, J. L., Price, M. A., Shand, P. J. & Hawrysh, Z. J. (1991). Endurance-exercised growing sheep: II. Tenderness increase and change in meat quality. *Meat Science* 29: 57-68.
- Aguayo-Ulloa, L. A., Miranda-de la Lama, G. C., Pascual-Alonso, M., Fuchs, K., Olleta, J. L., Campo & María, G. (2012). Effect of feeding regime during finishing on lamb welfare, production performance and meat quality. *Small Ruminant Research* 111: 147-156.
- Bligh, EG. & Dyer, W. J (1959). A rapid method of total lipid extraction and purification. *Canadian Journal Biochemistry and Physiology* 37: 911- 917.
- Miranda-de la Lama, G. C., Villarroel, M., & Maria, G. A. (2012). Behavioural and physiological profiles following exposure to novel environment and social mixing in lambs. *Small Ruminant Research* 103: 158–163.
- Statistical Analysis System Institute, 1988. SAS/STAT User's Guide (Release 6.03). SAS Institute, Cary, NC.