EFFECT OF LINSEED LEVEL AND FEEDING DURATION ON PERFORMANCE, CARCASS AND MEAT QUALITY IN CULL EWES

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Abstract - The effect of three linseed supplementation levels (LSL: 5, 10, or 15%) and three feeding durations (FD: 30, 50 or 70 days) were analysed on productive, carcass and meat quality parameters using 72 cull ewes, 8 for each LSL and FD (3 x 3). Animal live weight and body condition score (BCS) were recorded and the average daily consumption of concentrate and average daily gain were estimated. Hot carcass weight (HCW) was assessed and carcass yield (CY) was calculated. Tissue composition was performed by dissection of the shoulder. Subcutaneous fat thickness (SFT), loin area, chemical and fatty acid (FA) composition, pH and meat colour were determined. Both LSL and FD influenced productive parameters and carcass and meat quality, being FD more important than LSL, except in FA composition. LSL significantly improved BCS after 30 days of feeding. However, FD only had a significant effect on HCW and CY, where the longer FD, the higher values. Both LSL and FD increased SFT. The longer the intake, the darker and less red the meat was. Therefore, linseed diet supplementation could be considered in cull ewes depending on the final market requirements and the price of feeding and carcass or meat.

Keywords – Finishing, diet supplementation, growth rate, instrumental quality

I. INTRODUCTION

Ovine meat sector, as many other sectors associated with livestock, have many challenges. Raising animals should be sustainable with the environment, profitable to the farmers and to the other agents implicated in the process, also meeting animal welfare requirements. Furthermore, the final products should be healthy, nutritive and with an adequate sensory quality. One important alternative to get these aims could be increasing value to all the products that could be obtained from a specific production. Cull animals in any productive sector are, in general, poorly appreciated, having low market value. Any effort to generate more quality or valuable products from those animals should be a clear alternative for both researchers and producers. On the other hand, linseed has been demonstrated as a good product to increase energy of the ration and an important source of healthy unsaturated fatty acids. In some markets, cull ewes have a good acceptance [1] and reasonable prices. Therefore, an alternative way is to focus more on differentiation based on quality and consistency [2]. Not many studies have the objective of analyzing productive aspects and meat quality from cull animals and even less within a fattening period. This was the aim of this research.

II. MATERIALS AND METHODS

The study used 72 ewes of Rasa Aragonesa, a local medium wool breed, rustic type. Animals, older than 6 years, were randomly selected among Pastores Grupo Cooperativo® commercial flocks. Later, they were transported to the facilities of the Veterinary Faculty of Zaragoza (Spain). Cull ewes were divided into nine groups of 8 animals each, depending on linseed supplementation level (LSL): 5, 10 or 15%, and feeding duration (FD): 30, 50 or 70 days. Supplementation was administrated feeding the animals with commercial *Linum usitatissimum* whole flaxseeds. All the diets were balanced in energy and protein content. Concentrate and cereal straw were available *ad libitum*. The care and the use of animals followed the European guidelines [3].

Body condition score (BCS) and live weight were evaluated at the beginning and at the end of each FD period. The average daily gain (ADG), the average concentrate daily consumption (ADC) and the conversion index were calculated. When the correspondent FD was finished, animals were transported (< 3 hours) to an EU-licensed abattoir to be slaughtered after a resting period of 15-20 hours. Live weight at slaughter (LWS), hot carcass weight (HCW) and carcass yield (CY) were recorded or calculated. Then, the carcasses were kept at 0-4 °C overnight. The left side of the carcass was transported at 2-6 °C to the Meat Quality Laboratory of the Veterinary Faculty of Zaragoza for sampling at 24 hours post-slaughter. The left shoulder was obtained and dissected to obtain the tissue composition [4]. The left *Longissimus lumborum* (LL) muscle was used to assess the muscle area at the 5th lumbar vertebra, using a digital planimeter *Placom Koizumi KP-82*. Subcutaneous fat thickness (SFT) was also measured on the 5th LL section. pH was measured with a portable *CRISSON 503* in the 4th thoracic vertebra region. To evaluate meat colour, a *Minolta CR200* reflectance spectrophotometer with an illuminant D65 and a 10° standard observer was used after 15 minutes of blooming in the *Longissimus thoracis* (LT) at the 8th vertebrae. Fatty acids, in LT, were extracted in chloroform:methanol. Methyl esters were obtained with KOH in methanol and analyzed by gas chromatography in a HP 6890 equipped with a flame ionization flame and an automatic injection system (HP 7683), and fitted with a SP 2380 column (100m x 0.25 mm x 0.20 µm) with N as a carrier gas and C19:0 as an internal standard. The effects of linseed supplementation level, feeding duration and their interactions on quality traits were assessed using the General Linear Model (GLM) procedure of the SPSS statistical package (15.0), with animal as random effect. The mean and standard error of the difference (SED) were calculated for each variable. When the main effect was significant, it was used the Duncan's Multiple Range Test, with the level for statistical significance set at $P \leq 0.05$.

III. RESULTS AND DISCUSSION

Live weight was not affected (Table 1) by the feeding, with only a 6 kg of average difference among treatments. Other study carried out with Mouton Vendeen lambs fed for 7 weeks with four LSL (0, 3, 6, or 9 %) [5] did not find an effect of LSL on growth performance. When protein is not a limiting factor for growth, or basal protein levels approach the animal's requirements, no performance increases are likely to occur [6] if the energy level is the same among treatments. Initial body condition score (BCS) did not differ among treatments (Table 1) reflecting the homogeneity of the groups. However, LSL and FD had a significant effect on final BCS. It was observed almost a one point increase on the BCS from 30 to 70d of feeding, being FD a more important factor than LSL itself. The BCS obtained after any supplementation was higher than 2.5, which is within recommendations for ewe's maintenance [7]. A score higher than 3 was only reached with the higher LSL or after 50 or 70 days, which would be suitable if the animals were for breeding [8]. On the other hand, the average daily gain was the highest at 50 days of FD, increasing from 30 days and decreasing afterwards. Simultaneously, the average daily consumption was lower at this same time, showing the maximum productive efficiency at this period.

HCW and CY were only affected by FD (Table 2). The longer FD the higher values with a CY higher than 55%, which could be considered as normal for ovine specie. Muscle area in LL section was not affected by any LSL or FD, but both influenced subcutaneous fat thickness (Table 2) with the highest value on higher LSL and/or longer FD. This trend was also observed in the shoulder fat percentage, being the muscle percentage inversely related. Other studies analyzing the effect of safflower supplementation also showed no significant differences on carcass yield and muscle area, and a greater fat thickness and fat content in comparison with no supplemented animals [9].

Fat could be positively associated with acceptability but a fat excess increases significantly the production costs and would decrease purchase intention, since the Mediterranean consumer usually prefer lean meat, specially in old animals [10].

Meat pH and color (Table 2) were not affected by LSL but they were by FD. pH values were within the normal ranges described for ovine, considering a value of 5.8 as a threshold for detrimental effects on quality [11]. Meat from the animals fed for 30 d was darker and has a higher redness and yellowness than longer FD. Color is influenced by multiple factors, including feeding and the observed values could be related with the observed increase in fat percentage. On Mediterranean countries, paler meats have a higher acceptability [12]. Thus, the meat from animals fed for 30d would be less acceptable in the market. There was a significant interaction between LSL and FD on intramuscular fat (Table 2). Fat percentage was significantly different in higher LSL and longer FD. For the animals fed with a 15% of linseed, fat percentage was higher for 50d than in shorter or longer FD. Only polyunsaturated fatty acids (PUFA) were affected (Table 3) by LSL, increasing PUFA%, *n*-3% and PUFA/SFA, and decreasing *n*-6/*n*-3 ratio. FD only affected *n*-6%, producing a significant reduction at 70d. Hydrogenation of *n*-3 PUFA was only dependent on the level of linseed but not on FD, probably due to the protection of the outer shell of the flaxseeds avoiding some microbiota action.

IV. CONCLUSIONS

In general, linseed supplementation enhanced productive and meat quality parameters. The studied periods of supplementation had a greater effect than the tested linseed doses. A 10% linseed seed inclusion and during 50 days would be recommended to optimize production indexes and some carcass and meat characteristics. In any case, the level of supplementation and the period would be adjusted regarding on the final market requirements, since fat quantity was increased with both factors.

V. ACKNOWLEDGEMENTS

To Pastores Cooperative Group, Esperanza Horcas and Antonio Oliván for its technical assistance and to Zaragoza University for the financial support UZ2011-CIE-229-378.

VI. REFERENCES

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Table 1. Effect of linseed supplementation level (LSL) and feeding duration (FD) on productive parameters.

	LSL			FD			SED	LSL	FD	LSL*FD
	5%	10%	15%	30d	50d	70d				
Initial LW	42.46	43.11	43.75	42.53	43.73	42.93	0.127	0.810	0.777	0.955
Final LW	51.98	50.68	51.86	50.89	51.02	52.56	0.203	0.861	0.791	0.983
Initial BCS	2.26	2.33	2.23	2.25	2.28	2.29	0.009	0.661	0.935	0.563
Final BCS	2.78a	2.87ab	3.19b	2.41a	3.15b	3.29b	0.012	0.045	<0.001	0.033
ADG	0.11	0.12	0.14	0.28b	0.78c	0.04a	0.002	0.303	<0.001	0.170
ADC	1.73	1,72	1.65	2.00c	1.49a	1.60b	0.004	0.382	<0.001	0.431
CI	-0.10	0.77	0.39	0.24	0.23	0.59	0.054	0.432	0.815	0.344

SED: Standard error of the difference; LW: Live weight (kg); BCS: Body condition score (1: emaciated - 5: obese); ADG: Average daily gain (kg/day); ADC: Average daily consumption (ADC); CI: Conversion index.
a b: different letters in the same row indicate significant differences ($P \leq 0.05$)

Table 2. Effect of linseed supplementation level (LSL) and feeding duration (FD) on carcass and instrumental meat quality.

		LSL			FD			SED	LSL	FD	LSL*FD
		5%	10%	15%	30d	50d	70d				
HCW (kg)		23.06	22.79	24.23	21.45a	23.35ab	25.25b	0.08	0.347	0.003	0.342
CY (%)		54.56	52.90	55.22	50.40a	53.29a	58.86b	0.13	0.391	<0.001	0.105
S^2 (cm)		105.39	105.29	98.65	95.58	106.91	107.25	0.54	0.608	0.185	0.615
SFT(cm)		3.85	3.64	5.00	3.13a	4.10ab	5.23b	0.04	0.059	0.005	0.108
TC (%)	M	57.68ab	57.96b	55.00a	59.86c	57.52b	53.35a	0.08	0.019	<0.001	0.420
	F	21.49	21.20	24.71	18.20a	21.81b	27.29c	0.12	0.067	<0.001	0.671
	B	16.59	16.96	16.07	18.05c	16.37b	15.20a	0.04	0.370	<0.001	0.948
	O	4.24	3.88	4.22	3.88	4.30	4.16	0.02	0.449	0.427	0.592
pH		5.54	5.50	5.52	5.48a	5.56b	5.53ab	0.01	0.416	0.026	0.856
Color	L*	35.98	35.76	35.91	37.40b	35.18a	35.00a	0.04	0.957	<0.001	0.870
	a*	16.73	17.02	17.10	17.85b	16.82a	16.16a	0.03	0.677	0.001	0.404
	b*	5.15	5.15	5.17	5.55b	4.91a	4.99a	0.01	0.996	0.030	0.568

SED: Standard error of the difference; HCW: Hot carcass weight; CY: Carcass yield; S^2: *Longissimus dorsi* area; SFT: Subcutaneous fat thickness; TC: Tissue composition; M: muscle; F: Fat; B: Bone; O: Others.
a b c: different letters, inside effect, within row indicate significant differences ($P \leq 0.05$).

Table 3. Effect of linseed seed level (LSL) and feeding duration (FD) on the intramuscular fatty acid composition (% total fatty acids) of *Longissimus thoracis* muscle.

	LSL			FD			SED	LSL	FD	LSL*FD
	5%	10%	15%	30d	50d	70d				
% SFA	47.30	47.77	45.98	47.42	47.07	46.60	0.04	0.067	0.583	0.762
% MUFA	43.05	41.43	42.32	41.71	42.23	42.82	0.04	0.153	0.407	0.587
% PUFA	6.75b	7.26ab	7.50a	7.32	7.31	6.91	0.01	0.020	0.201	0.387
% *n*-6 PUFA	4.18	4.10	4.02	4.22a	4.24a	3.86b	0.01	0.529	0.016	0.258
% *n*-3 PUFA	2.03b	2.49a	2.53a	2.35	2.44	2.27	0.01	0.001	0.511	0.476
n-6/*n*-3	2.09a	1.69b	1.62b	1.86	1.79	1.75	0.01	<0.001	0.310	0.184
PUFA/SFA	0.14b	0.15ab	0.16a	0.15	0.16	0.15	0.01	0.015	0.496	0.528

SED: Standard error of the difference; SFA: Saturated fatty acids; MUFA: Monounsaturated fatty acids; PUFA: Polyunsaturated fatty acids.
a, b, c: different letters, inside effect, within row indicate significant differences ($P \leq 0.05$);