EFFECT OF FEEDING SAGE BY-PRODUCT ON THE LIPID PROFILE AND OXIDATIVE STABILITY OF LIGHT LAMB MEAT

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Abstract – Spanish sheep producers are seeking for dietary strategies to improve meat lipid profile. Sage distillation by-product (SDB) contains high levels of n-3 PUFAs and polyphenols with antioxidant and/or antimicrobial potential in meat. The objective was to determine if feeding SDB improved the lipid profile and protected retail lamb meat against oxidation. Light lambs given basal or SDB diet and raised in two rearing systems (ewe grazing vs indoor) were compared. It was needed to extend n-3 PUFA-promoting diet to ewes (grazing) and weaned lambs (SDB) to increase total and n-3 PUFA in intramuscular fat. The SDB-diet had no positive effects on oxidative stability, on the contrary, lipid oxidation, rancidity and discoloration were higher in retailed meat with increased PUFA.

Key Words – dietary salvia, fat saturation, meat oxidation.

I. INTRODUCTION

Nutritional implications of saturated fats have growing interest for lamb meat consumption. Spanish sheep producers are seeking for dietary strategies involving local sustainable resources to improve meat lipid profile. Sage distillation by-product (SDB) is a cheap and available material with good sensory and nutritional properties for sheep, contains high levels of n-3 polyunsaturated fatty acids (PUFAs), particularly α-linolenic acid, as well as different polyphenols including phenolic acids, terpenes and flavonoids, whose consumption may have antioxidant and/or antimicrobial potential in meat [1]. SDB is not used in lamb feeding but it has seen that dietary use of similar by-products of rosemary and thyme had no negative effects on lamb performance and showed great potential for improving lipid profile [2] and meat stability [3]. Therefore, supplementing lamb diet with SDB could serve a dual purpose, on the one hand, to improve the FA profile of meat, and, on the other hand, to obtain a technological stabilizing effect (antioxidant and/or antimicrobial). In any case, ewe diet should be also taking into account when using PUFA-promoting diets in lambs, since graze-fed ewes produce milk with high levels of linolenic acid that may modify suckling lamb fat [5]. The objective was to determine if dietary supplementation of weaned lambs with SDB improved lipid profile and protected retail meat against oxidation.

II. MATERIALS AND METHODS

A factorial model was designed completely at random including ten lambs × four dietary treatments. Pregnant ewes (*Segureña* breed) were respectively assigned for two different rearing systems: (i) fed indoor on barley grain (50% w:w) and lucerne pellets (50% w:w); and (ii) grazed eight hours daily in Mediterranean Shrubland including trees, brushes and herbs. Lambs from each ewe group were weaned (13±1 kg live weight) and then fed two experimental diets: (i) grain concentrate (basal-diet); and (ii) grain concentrate elaborated with 100 g SDB per kg^{-1} feed (SDB-diet) (*Salvia lavandulifolia* Vahl.). The content of fatty acids (GC-FID) and sage polyphenols (HPLC-DA) were checked in lamb feed. Lambs were fed indoor *ad libitum* for 80±5 days and slaughtered at 108±14 days of age (25±2 kg live weight). Once meat was obtained, intramuscular fat and lipid profile (GC-FID) were determined in fresh meat. For the stability study, thiobarbituric acid reactive substances (TBARS), Hue angle, lean discoloration and rancid odour (quantitative descriptive sensory analysis) were determined in loin fillets packed in 70/30 O_2/CO_2 (v:v) atmosphere and stored at 2 ± 1 ºC (800 lx) for 6 days simulating retail display conditions.

III. RESULTS AND DISCUSSION

Feeding SDB mainly involved an increase in intramuscular fat unsaturation when suckling lambs were raised with graze-fed ewes (Table 1). In this case, the SDB-diet allowed increase by almost 3% the total proportion of meat PUFAs but did not improve n-6/n-3 ratio. In contrasts, ewe grazing clearly resulted in a lamb meat of lower n-6/n-3 ratio, regardless lambs given SBD or not, which confirmed that ewe diet modulates the composition of intramuscular lamb fat. Extending n-3 PUFA-promoting diet to pregnant and lactating ewes (grazing) and weaned lambs (feeding SDB) was required to increase total and n-3 PUFA in meat. This synergism between ewe grazing and the SDB-diet was expected, as both dietary treatments aimed to increase n-3 PUFA intake at different stages of lamb life and their effects on the meat should

be accumulative. An important issue to be addressed is the lesser meat stability as a consequence of increasing fat unsaturation. The SDB-diet was clearly ineffective in protecting lamb meat against deterioration under pro-oxidizing retailing conditions. On the contrary, lipid oxidation and lean discoloration was more intense in retailed meat with increased PUFA, which leaded to an incipient rancidity. Our results suggests that SDB polyphenols, with rosmarinic acid being the main bioactive compound, might have a little deposition rate in sheep muscle. This has been explained because rosmarinic acid, a well-known radical scavenger, is a hydrophilic molecule with less chance than other polyphenols to across cell membranes for exerting their antioxidant biological activities in muscle [5].

Table 1. Effects of diet on the intramuscular fat content, lipid profile and oxidative stability of light lamb meat.

	Indoor ewes			Grazing ewes				Diet effects		
	Basal diet		SDB diet	Basal diet		SDB diet				
								Lamb	Ewe	L x E
	M		M	M		M	SEM			
Intramuscular fat	2.3		2.2	2.2		2.25	0.2			
Lipid profile										
Σ SFA	40.3		41.2	40.0		39.7	0.3			
Σ MUFA	42.1	b	42.0	b	45.1	a	41.7	b	0.5	*		*
Σ PUFA	17.6	a	16.8	ab	14.7	b	18.6	a	0.5			**
Σ n-6/ Σ n-3	7.6	a	8.4	a	5.6	b	6.4	b	0.4		***	
Meat stability (6 days)										
TBARS	3.7	c	5.2	ab	4.2	bc	6.0	a	0.3	*		
Rancid odour	1.9	ab	2.1	ab	1.8	b	2.3	a	0.0	*		
Hue angle	24.4	ab	25.2	ab	23.3	b	28.1	a	0.8	*		
Redness	3.7		3.6	3.8		3.3	0.1			

M: mean; SEM = Standard Error of the Mean.
Means with different superscripts are different for * (P<0.05), ** (P<0.01) and *** (P<0.001).
Units: Intramuscular fat (g 100 g^{-1} meat); Fatty Acids (g 100 g^{-1} total identified FAME); TBARS: (mg MDA kg^{-1} meat) Hue angle: (CIELab); rancid odour and redness scores (sensory scale from 1 to 5).

IV. CONCLUSION

The dietary method based on SDB should be improved to ensure that meat lipid profile can be improved regardless of ewe rearing system. European Union legislation does not authorize antioxidants addition to unprocessed meat cuts, therefore, SDB-based diets should be accompanied of antioxidant strategies, involving, if possible, local natural resources, in order to extend the shelf life of *Segureño* lamb meat.

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