EVOLUTION OF INTRAMUSCULAR FATTY ACID COMPOSITION DURING LAMB MEAT STORAGE IN HIGH OXYGEN OR VACUUM PACKS

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Introduction

Vacuum (VP) and modified atmosphere packs containing high oxygen levels (MAP) are commonly used to maximise the shelf life of meat. The main advantage of MAP is that it imparts a bright-red colour that consumers find attractive. On the contrary, VP provides purple-red colours that consumers associate with loss of quality. For this reason, the use of VP in retail marketing is limited. However, VP provides longer microbiological shelf-life than MAP and it is probable that the absence of oxygen could minimise lipid oxidation of unsaturated fatty acid. From a nutritional point of view, lipid oxidation implies a loss of quality in meat not only by hydroperoxide accumulation but also changes in fatty acid composition during refrigerated storage. Previously lipid oxidation intensity has been only studied by Thiobarbituric Acid Reactive Substances (TBARS) accumulation (Lauzurica *et al.*, 2005), but evolution of fatty acid composition in lamb meat has not been studied yet. The aim of this study was to compare the evolution of intramuscular fatty acid (FA) composition during lamb meat storage in MAP and VP.

Materials and Methods

Nine weaned male Manchego breed lambs were fattening from an initial live weight of 13.2 ± 0.5 to a slaughter weight of 26.2 ± 0.3 kg, and then were slaughtered in a commercial abattoir. After a 24h chilling period (4ºC) the right *longissimus dorsi* muscle (LD) was dissected and cut in 4 slices which were randomly assigned to 0, 14, 21 and 28 days of MAP storage (70% O_2; 30% CO_2). Similarly, left LD was dissected and cut in 4 slices which were randomly assigned to 0, 14, 21 and 28 days of VP. Muscle slices were kept in darkness at 2 ± 1 ºC during storage. Intramuscular fat was extracted from LD at each time of storage (Hanson and Olley, 1963). FA methyl esters were formed according to Morrison and Smith (1964) and then analysis of samples by gas chromatography was performed. Data were statistically analysed using the MIXED procedure of the Statistical Analysis System package (SAS, 1996).

Results and Discussion

Table 1 shows the FA profile of MAP and VP samples at each time of storage.

Significant interaction was observed between packaging type and storage time for monounsaturated FA (MUFA), polyunsaturated FA (PUFA), PUFAn6 and PUFA/SFA ratio. MAP samples had the highest change in FA profile during storage, increasing SFA (10%) and MUFA (7%) after 28 days of storage respect to initial values whereas PUFA and PUFA n-6 decreased (40% and 38% respectively) in the same period. In VP samples, there was also a change in FA profile but moderate, because only an increase in SFA (5%) and a decrease on PUFA n-6 (10 %) was significant. Lipid oxidation is a process in which molecular oxygen reacts with FA to form hydroperoxides, attacking easily the double bonds in fatty acids. Thus, MAP containing high oxygen promoted lipid oxidation, principally in PUFA, whereas VP maintained profiles more constant. Cayuela (2003) concluded previously in pork that samples in high oxygen atmosphere showed higher levels of lipid oxidation, monitored by measuring TBARS, than vacuum packed ones during time of storage. From a nutritional point of view, due to a decrease in PUFA, PUFA/SFA ratio decreased significantly in MAP from 0.43, which came closest to the nutritional recommendation of 0.45 (Department of Health, 1994), to 0.23, whereas VP samples did not modify their ratio during refrigerated storage. Not only did higher loss of nutritional quality of MAP samples occur during storage, but also a reduction in the safety of the MAP samples occurred because higher lipid oxidation implies higher hydroperoxides accumulation. These results could suggest the need for studying the use of antioxidants when lamb meat is stored in MAP.

Conclusions

Modified atmosphere packaging containing high oxygen levels promoted fatty acid oxidation in lamb meat during storage, which implied changes in fatty acid profile, decreasing PUFA percentage and increasing SFA and MUFA percentages. Vacuum packing was shown to be the best method for lamb fatty acid profile preservation during 28 days of storage.

Table 1: Fatty acid profile (mg of FA per 100 mg of total FA) of MAP and VP samples during time of storage.

	Time	Packaging (P)						Sig.		
	(T)	MAP	SE		VP	SE	S_p	P	T	P*T
SFA (%)	**0**	41.67	0.63	z	41.20	0.66	ns	ns	***	ns
	14	42.56	0.65	y	42.11	0.79	ns			
	21	43.53	0.69	xy	41.76	0.65	ns			
	28	45.99	0.73	x	43.47	0.73	*			
S_t		***			*					
MUFA (%)	**0**	40.61	0.87	y	41.77	0.87	ns	ns	***	**
	14	43.77	0.89	y	42.09	0.98	ns			
	21	44.61	0.91	y	42.19	0.89	ns			
	28	43.41	0.94	x	41.35	0.91	ns			
S_t		***			ns					
PUFA (%)	**0**	17.72	1.09	x	17.94	1.09	ns	*	***	**
	14	13.68	1.12	y	16.33	1.28	ns			
	21	11.89	1.16	yz	15.80	1.12	*			
	28	10.56	1.21	bz	16.58	1.16	a **			
S_t		***			ns					
$PUFA_{n6}$ (%)	**0**	14.34	0.95	x	15.70	0.95	ns	*	***	*
	14	11.68	0.98	y	13.88	1.13	ns			
	21	10.27	1.02	yz	13.25	0.98	*			
	28	8.94	1.07	bz	14.19	1.02	a **			
St		***			*					
$PUFA_{n3}$ (%)	**0**	1.41	0.25		1.87	0.25	ns	*	ns	ns
	14	1.60	0.19		2.09	0.22	ns			
	21	1.35	0.17		2.16	0.17	*			
	28	1.01	0.19	b	2.00	0.18	a **			
St		*			ns					
PUFA/SFA	**0**	0.43	0.03	x	0.42	0.03	ns	ns	***	**
	14	0.32	0.03	y	0.38	0.03	ns			
	21	0.27	0.03	yz	0.38	0.03	*			
	28	0.23	0.03	bz	0.36	0.03	a **			
St		***			ns					

SFA: C10:0, C12:0, C14:0, C15:0, C16:0, C17:0, C18:0, C20:0; MUFA: C17:1, C16:1, C18:1; PUFA: C18:2n6, C18:2 *Cis-9 Trans-11*, C18:3n3, C20,3n6, C204n6, C20:5n3,C225n3, C226n3. SE: Standard error; Sig.: [1]Significance of the Model $y_{ijk} = \mu + P_i + T_j + P_iT_j + \varepsilon_{ij(k)}$; S_p: Significance of dietary supplementation of VE within each storage period; S_t: Significance of storage period within each dietary supplementation VE level; ns: no significant; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$; a.b Means in the same row with different superscripts differ significantly ($P < 0.05$).; x.y.z Means in the same column with different superscripts differ significantly ($P < 0.05$).

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