OXIDATIVE STABILITY OF MEAT FROM LAMBS FINISHED ON DIFFERENT CONCENTRATE DIETS

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Abstract – The effects of finishing diets with different fatty acid compositions on the storage stability of lamb meat were investigated. Twenty-four male lambs were allocated to one of four concentrate rations for 54 days pre-slaughter: a barley/maize-based concentrate, a Megalac (saturated fat) containing concentrate, a protected linseed containing concentrate, or a citrus pulp and maize distiller grains-based concentrate. Minced *M. semimembranosus* was stored under 80%O_2:20%CO_2 at 4°C with lighting, for up to 14 days. The colour deteriorated and lipid oxidation increased significantly over time (*P<0.001*) while diet did not have any significant effect on colour stability or lipid oxidation.

Key Words – antioxidant, fatty acids, modified atmosphere packaging

I. INTRODUCTION

Modification of animal diets has been used to obtain a healthier muscle fatty acid composition. However, increasing the healthy polyunsaturated fatty acids (PUFAs) in muscle can result in quality deterioration due to susceptibility of PUFAs to oxidation. Oxidative reactions in meat can be lowered by the presence of antioxidants to offset endogenous muscle pro-oxidants [1, 2]. In this study, meat patties from lambs fed different fat sources were stored in high oxygen modified atmosphere packaging (MAP), to restrict the growth of spoilage microorganisms and to promote fresh meat colour; however, a high O_2 content can also increase lipid oxidation. The objective of this study was to assess the colour and lipid stability during storage of meat assumed to have different fatty acid compositions arising from different pre-slaughter diets. It was hypothesized that each diet would have a unique effect on the rate of oxidation and shelf stability of the meat.

II. MATERIALS AND METHODS

Twenty four male lambs grazed at pasture from birth were assigned (age 6 months; 33.98 ± 4.3 kg) to one of four concentrate rations for 54 days pre-slaughter: (A) a barley/maize cereal-based concentrate, (B) a saturated fat (Megalac) containing concentrate, (C) a protected linseed containing concentrate or (D) a citrus pulp and maize distiller grains-based concentrate. After slaughter and 24 h chilling of carcasses, *M. semimembranosus* (SM) was excised from the carcasses, aged for 8 days under vacuum and stored at -20°C. Prior to analysis, SM was thawed overnight at 4°C, trimmed of external fat and connective tissue, minced to form patties, packed in MAP (80% O_2: 20% CO_2) and stored at 4°C with illumination. Lightness, redness, yellowness, hue angle, chroma, and 2-thiobarbituric acid reactive substances (TBARS) were measured after 0 (2 h post blooming), 3, 7, 10 and 14 days of storage. Results were reported as mean ± standard error of the mean. All data were analyzed using the General Linear Model of Minitab 16 where diet, time and their interaction were considered as fixed effects, and individual animal as a random effect. Multiple comparisons of the means were performed using Tukey's adjustment.

III. RESULTS AND DISCUSSION

The colour of the lamb meat patties deteriorated over 14 days of refrigerated storage (Table 1; *P<0.001*) in all groups, while diet did not have any significant effects (*P>0.05*). Significant interactions between diet and time for L*, a* and H* were observed (*P<0.05*). When compared with day 0, the SM of the C group tended (*P=0.067*) to decrease in a* and showed a significant increase in H* and in L* at days 7, 10 and 14, respectively, while for other groups a significant

change occurred at day 10 for a* and day 14 for H*, but L* remained the same to the end of storage. The increase in TBARS with time of storage (*P<0.001*) in all the groups is in agreement with previous studies [1, 3] and was expected, especially since the SM samples were minced, packed under high oxygen atmosphere and exposed to light at storage. In this study, diets did not significantly affect the muscle TBARS levels, in contrast to other studies which found that muscle from linseed-fed lamb was more susceptible to lipid oxidation than that of Megalac-fed lamb muscle [3]. A significant interaction between diet and time was observed for TBARS (*P=0.004*). For each diet, when TBARS in lamb at day 0 was compared to other days of storage a significant increase occurred at day 7 for A or C, while it occurred at days 10 and 14 for D and B, respectively. When TBARS were compared for each storage day, no significant differences were found due to dietary treatment. In previous studies, linseed supplementation resulted in increase in muscle content of peroxidizable PUFA, while Megalac in the diet led to increase in muscle content of saturated fatty acids [3]; however, linseed also contains antioxidants that can counteract the higher susceptibility to oxidation associated with an increased level of muscle PUFA [4]. Similarly, when a citrus pulp-containing concentrate diet was compared with control concentrate diet alone as feed for lambs, a higher muscle oxidative stability was observed in the citrus pulp-fed lambs, despite the increase in muscle PUFA, due to the protective effects of antioxidant compounds derived from citrus pulp [2, 5].

Table 1. Effects of diets and time of storage on the colour and lipid stability of minced *semimembranosus* muscle stored in MAP

	Diet				**Time**					**SEM[2]**	***P-values***		
	A	B	C	D	0	3	7	10	14		Diet	Time	Diet* Time
L*	47.1	45.6	47.7	45.0	44.8^{c}	44.2^{c}	46.2^{bc}	47.6^{ab}	48.8^{a}	0.28	0.178	<0.001	0.043
a*	11.3	12.4	11.3	12.3	15.9^{a}	14.7^{ab}	13.5^{b}	9.1^{c}	6.1^{d}	0.38	0.356	<0.001	0.009
b*	10.8	10.6	11.2	10.5	13.0^{a}	12.6^{a}	9.2^{b}	9.3^{b}	9.8^{b}	0.19	0.705	<0.001	0.316
C*	15.9	16.5	16.7	16.3	20.5^{a}	19.4^{a}	16.4^{b}	13.7^{c}	11.8^{d}	0.36	0.827	<0.001	0.552
H*	45.1	41.7	46.7	41.2	39.4^{cd}	40.6^{d}	34.6^{c}	45.9^{b}	58.0^{a}	0.94	0.222	<0.001	0.005
TBARS[1]	4.87	3.01	4.67	3.33	0.72^{d}	2.55^{c}	4.25^{b}	5.51^{ab}	6.66^{a}	0.268	0.298	<0.001	0.004

[1]mg MDA/kg meat; [2]standard error of the mean; [abcd]Means with different superscripts within Diet or Time are significantly different at *P<0.05*.

IV. CONCLUSION

Finishing diets that potentially increase the PUFA content in muscle did not have a deleterious effect on the colour or lipid stability of minced lamb stored in MAP. The antioxidant compounds transferred from the diets to the muscle could play role in increasing the oxidative resistance of high PUFA containing muscle.

ACKNOWLEDGEMENTS

The financial support of the Food Institutional Research Measure of the Irish Department of Agriculture, Food and the Marine (project 11/SF/310) and of the Teagasc Walsh Fellowship programme is gratefully acknowledged.

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