THE IMPROVEMENT OF LAMB MEAT SHELF LIFE THROUGH FEEDING WITH SUB-PRODUCTS OF *ROSMARINUS OFFICINALIS, L.*

G. Nieto*, B. Linares, P. Díaz, S. Bañón and M.D. Garrido

Department of Food Technology and Science and Human Nutrition. Veterinary Faculty, University of Murcia, Campus Espinardo, 30071 Murcia, Spain. Email: gnieto@um.es

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Introduction

The purpose of this study is to examine the possibility of producing lamb meat rich in components from the sub-products of rosemary which allow improved health measures, quality and shelf life. Lamb meat is usually commercialised without undergoing any transformation. Refrigerated lamb steaks packed in a protective atmosphere to prolong shelf life predominate the market. This delays microbiological and colour spoilage but increases lipid oxidation deterioration. Recent studies show the antioxidant, anti-microbial, anti-viral and anti-mutagenic effect of some natural antioxidants (rosemary, thyme, sage, etc) incorporated by means of animal feed (Tang *et al.*, 2001; O'Grady *et al.*, 2006). After the extraction of essential oils, the transformation of aromatic medicinal plants (rosemary, thyme, ..) generates a distilled excedant. This subproduct constitutes a potential source of natural antioxidants, most of which are directed at the food industry as protective agents against lipid oxidation (Hagerman *et al.*, 1998).

Materials and Methods

Thirty lambs of the Segureña breed were studied. Lambs were fed with milk and their normal foodstuff with added rosemary distilled leaf (w:w) until they reached 25kg live weight. Three groups were formed; R1 (10% rosemary), R2 (20% rosemary) and C (control). At 24 h *post mortem*, the *Longissimus dorsi* muscle was filleted, packed in a modified atmosphere ($70\%O_2$:$30\%CO^2$), and stored for a maximum of 21 days at 4ºC in natural lighting conditions. Meat spoilage was determined by measuring colour (Minolta Chromameter Reflectance II), the TBARs index (mg MDA/kg meat), microbiological activity (total viable, total psycrophiles, mould and yeast; log u.f.c/g), and sensory analysis at 0, 7, 14 and 21 days of storage.

Result and Discussion

TBARs values (Table 1) show delayed lipid oxidation in meat from lambs receiving rosemary dietary supplement as compared to the C group. This antioxidant effect was similar in R1 and R2 as has also been described by McCarthy *et al* (2001). L, a, b values showed that rosemary (R1 and R2) increased colour stability. From day 14 of storage higher a* values ($p<0.05$), implies less pigment oxidation and a better appearance, as has also been described by O'Grady et al (2006). This was contrasted with the sensory analysis (Table 2). Independently of the dosage used, a positive effect of rosemary was found on lean and fat colour and rancid odour. Neither putrid nor acid odour was detected in the samples. The antimicrobial effect of rosemary (Table 3) was moderate. A difference from C group with regard to R1 and R2, was observed only in the total mesophiles .A similar effect has been seen by Govaris *et al*, (2005) in studies on turkey breast.

Table 1: Average values and SD of TBArs (TBA), L*, a* and b* coordinates in lamb at 0, 7, 14 and 21 days under retail conditions.

	Level	Day 0	Day 7	Day 14	Day 21
TBA	C	0.02 ± 0.01	4.32 ± 2.24 ^{a}	8.43 ± 1.86 ^{a}	10.29 ± 0.75 ^{a}
	R1	0.01 ± 0.01	1.18 ± 1.31 ^{b}	3.58 ± 3.53 ^{b}	4.85 ± 3.51 ^{b}
	R2	0.02 ± 0.01	0.88 ± 0.51 ^{b}	3.82 ± 2.90 ^{b}	5.23 ± 3.65 ^{b}
L*	C	41.50 ± 2.89	44.82 ± 2.58	49.84 ± 3.94	53.60 ± 2.93
	R1	40.71 ± 1.92	44.28 ± 2.72	45.77 ± 5.62	48.02 ± 7.51
	R2	42.21 ± 1.42	44.76 ± 1.97	48.34 ± 3.69	48.98 ± 4.81
a*	C	17.35 ± 1.50	16.383 ± 1.52	8.49 ± 4.01 ^{b}	4.16 ± 2.22 ^{b}
	R1	16.84 ± 1.11	17.68 ± 1.45	13.93 ± 4.43 ^{a}	10.71 ± 5.9 ^{a}
	R2	17.68 ± 0.90	16.61 ± 1.56	12.14 ± 4.45 ^{a}	9.10 ± 4.73 ^{a}
b*	C	6.72 ± 1.14	12.39 ± 2.29	13.99 ± 2.26 ^{a}	15.34 ± 2.07 ^{a}
	R1	6.64 ± 1.06	11.94 ± 0.78	11.64 ± 1.72 ^{b}	13.50 ± 3.17 ^{b}
	R2	7.24 ± 0.47	11.70 ± 0.68	12.55 ± 1.10 ^{ab}	13.99 ± 2.53 ^{ab}

C: Control; R1: 10% Rosemary; R2: 20% Rosemary. Means with different superscripts are significantly different ($p<0.05$).

Table 2: Average values and SD of sensory attributes in lamb at 0, 7, 14 and 21 days under retail conditions.

	Level	Day 0	Day 7	Day 14	Day 21
RO	C	1.00 ± 0.00	1.65 ± 1.41	4.05 ± 1.06 [a]	4.70 ± 0.78 [a]
	R1	1.00 ± 0.00	1.37 ± 0.74	1.87 ± 1.15 [b]	1.93 ± 1.32 [b]
	R2	1.00 ± 0.00	1.14 ± 0.37	2.07 ± 1.53 [b]	1.64 ± 0.80 [b]
CM	C	5.85 ± 0.33	4.35 ± 1.27	2.95 ± 1.18	1.05 ± 1.11 [b]
	R1	4.68 ± 0.45	4.75 ± 0.65	3.56 ± 1.01	3.37 ± 1.06 [a]
	R2	6.00 ± 0.00	5.35 ± 0.62	3.71 ± 1.15	3.21 ± 1.46 [a]
FC	C	5.85 ± 0.33	4.55 ± 0.36 [b]	3.90 ± 0.81 [b]	2.35 ± 0.94 [b]
	R1	5.75 ± 0.46	4.93 ± 0.32 [ab]	3.87 ± 0.58 [a]	3.31 ± 0.70 [ab]
	R2	6.00 ± 0.00	5.21 ± 0.56 [a]	3.64 ± 0.62 [ab]	3.21 ± 0.56 [a]

C: Control; 10: 10% Rosemary; 20: 20% Rosemary.
Scoring scale: (1: minimum; 6: maximum). RO: rancid odour; CM: meaty colour; CF: fat colour

Table 3: Average total viable count (TVC), total psycrophile count (TPC) and mould and yeast (MLC) (log ufc/g) in lamb at 0, 7, 14 and 21 days under retail conditions.

	Level	Day 0	Day 7	Day 14	Day 21
TVC	C	4.12 ± 0.51 [a]	4.23 ± 0.55 [a]	4.45 ± 0.59 [a]	5.24 ± 0.61 [a]
	R1	2.42 ± 0.85 [b]	2.09 ± 0.99 [b]	2.76 ± 0.91 [b]	3.74 ± 0.76 [b]
	R2	2.28 ± 0.49 [b]	2.20 ± 1.08 [b]	3.38 ± 0.41 [b]	3.39 ± 0.46 [b]
TPC	C	3.06 ± 0.85	3.71 ± 0.72	4.57 ± 0.91	6.48 ± 0.55 [a]
	R1	2.57 ± 0.48	2.84 ± 0.59	3.75 ± 0.76	5.23 ± 0.82 [ab]
	R2	2.10 ± 0.90	3.15 ± 0.90	3.62 ± 0.22	4.55 ± 0.39 [b]
MLC	C	1.60 ± 1.10	2.02 ± 0.72	2.41 ± 1.42	3.94 ± 1.17 [a]
	R1	0.88 ± 0.79	1.12 ± 0.75	1.46 ± 0.91	2.77 ± 0.92 [b]
	R2	1.70 ± 0.56	1.08 ± 0.39	1.11 ± 0.50	1.72 ± 0.79 [b]

C: Control; 10: 10% Rosemary; 20: 20% Rosemary.
Means with different superscripts are significantly different ($p<0.05$).

Conclusions

The feeding of lambs with 10% or 20% rosemary distilled leaf improves the quality and shelf life of raw lamb meat packed in a modified atmosphere ($70\%O_2$:$30\%CO_2$) due to the fact that this delays the oxidation of fat and colour and microbiological spoilage, improving the appearance of the meat. As such this dietary supplementation of lambs, is advantageous.

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