Prevention of lipid oxidation of cooked lamb meat through feeding with by-products of *Rosmarinus officinalis,* L

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Abstract

Three groups of Segureña ewes were formed; R1 (10% rosemary), R2 (20% rosemary) and Control (C). Fillets from hindlegs lambs were cut at 1.5cm and cooked under a domestic grill until reach an internal muscle temperature of 75ºC, then were stored for a maximum of 4 days at 4ºC. TBARs index (mg MDA/kg meat), fatty acids composition (%), and sensory analysis at days 0, 2 and 4 of storage were determined. TBARs values showed certain delay on lipid oxidation evolution in meat from lambs feeding with rosemary dietary supplement as compared to the C group. This was contrasted with the sensory analysis. Independently of the dosage used, a positive effect of rosemary was found on WOF and rancid odour. In general there was not change in the fatty acid profile during storage. The feeding of lambs with 10% or 20% rosemary distilled leaves improves the quality and shelf life of cooked lamb meat due to retard fat oxidation.

Introduction

The value of lamb lies in their ability to utilize low-quality feeds, upgrading low-quality inputs to high-quality outputs (Moñino et al., 2008). Lamb meat has a higher level of polyunsaturated fatty acid (PUFA), that acts as a substrate which favours the beginning of the oxidative process in meat. Lipid composition constitutes the major determinant for susceptibility to oxidative changes and rancidity development leading to warmed-over flavours (WOF). Changes to legislation controlling the use of animal feed additives and the increasingly demand by the consumers of healthier meat products, have stimulates interest in bioactive secondary metabolites as alternative performance enhancers. In this line rosemary is a spice commercially available for use as an antioxidant in Europe and the United States (Bozin et al., 2007). Its extract contains antioxidant compounds, the most active being phenolics diterpenes such as carnosic acid, carnosol, rosmanol, epirosmanol, isorosmanol, methylcarnosate and rosmarinic acid (Zheng and Wang, 2001). The aim of the present work is to study the prevention of lipid oxidation of cooked lamb meat trough feeding with by-products of rosemary (*Rosmarinus Officinalis*,L).

Materials and methods

Thirty six Segureña ewes were randomly assigned into three homogeneous groups. One group was fed with unifeed as a control (C) and the diet of the other two groups were modified by substituting 10% (R1) and 20% (R2) the unifeed, respectively by distilled rosemary leaves (DRL). Ewesunder these diets were fed for eight months coinciding with gestation and lactation periods. Weekly animals were weighed until lambs reached the slaughter weight of (25 ± 2 Kg). At 24 h post-mortem, fillets from hindlegs were cut at 1.5 cm and cooked under a domestic grill until reach an internal muscle temperature of 75ºC, then were packed and stored for a maximum of 4 days at 4ºC under retail display conditions. Lipid oxidation as TBARs index (mg MDA/kg meat) and fatty acids composition (%) were determined at days 0, 2 and 4 days post-mortem.

A sensory analysis was performed on cooked lamb meat at the same analysis times. The panellists were selected and trained according to ISO 8586-1 (1993). The panel was formed by six people chosen from the University community. There were four training sessions. In the two first sessions, the flavour and odour descriptors of cooked lamb meat were studied; the next two sessions were concerned with identifying, selecting and quantifying attributes to evaluate the meat. A 5-point scale (1 minimun-6 maximum) was established. Sensory analysis was carried out according to ISO 4121 (2003). The descriptors used were: SP: lamb flavour; SR: rancid flavour; WOF: warmed up flavour; OP: cooked lamb meat odour, RO: rancid odour, WOFO: warmed up odour.

Statistic: The effects of level DRL was analysed by ANOVA (Scheffe means Test). Data were analysed by using the Statistix 8.0 for Windows (Analytical Software, New York, USA).

Result and discussion

TBARs values (Table 1) showed a delay in lipid oxidation on cooked meat from lambs feeding with rosemary dietary as compared to the C group in all the storage days ($p<0.05$). The use of DRL decreased the TBARS value in comparison to the control samples (C group), although its antioxidant effect was

diminishing along storage time in refrigerated meat ($p<0.05$). Both DRL levels (10, 20%) showed a similar antioxidant effect as shown the TBARS index in the Table 1. Some studies reported that feeding with a supplement of distilled rosemary leaves (Dal Bosco et al., 2005) or dehydrated (Botsoglou y col, 2007) showed an important effect on the delay of lipid oxidation level on chicken and piglet meat, as raw (Dal Bosco, 2005; Govaris, 2005; López Bote y col. 1998) and also cooked (Botsoglou, 2007).

Table 1. Average values and SD of TBARS (mg MDA/kg meat), in cooked lamb meat at 0, 2 and 4 days of storage at 4ºC

	Level	Day 0	Day 2	Day 4
TBARS	**C**	0.33 ± 0.22^{az}	2.20 ± 0.15^{ay}	2.94 ± 0.28^{ax}
	R1	0.11 ± 0.04^{bz}	1.52 ± 1.19^{by}	2.57 ± 0.43^{bx}
	R2	0.19 ± 0.12^{abz}	1.64 ± 0.23^{by}	2.61 ± 0.30^{bx}

C: Control; R1: 10% Rosemary; R2: 20% Rosemary. a,b,c: effect of level DRL; x,y,z: effect of storage day
Means with different superscripts are significantly different (*P<0.05*)

This TBARS´results were contrasted with the sensory analysis (Table 2). Independently of the dosage a positive effect of rosemary was found on rancid odour (day 2) and warmed up flavour (day 4) ($p<0.05$) During storage time cooked lamb meat reached typical oxidation features by loosing the proper atributtes because of the rancidity level and the warmed up characteristics of cooked lamb meat. The lamb odour in the cooked meat decreased while rancid and the warmed up odour increased along storage time($p<0.05$). In the same line the lamb flavour decreased mainly at 0 and 2 days post-mortem. Rancid and warmed up flavour increased until being strongly percevied ($p<0.05$). We observed certain effect of the DRL on RO and WOF parameters ($p<0.05$), at 2 and 4 days post-mortem, respectively. In the bibliography are really scarce the sensorial researches about shelf life of refrigerated cooked lamb meat.

Table 2. Average values and SD of sensory attributes in cooked lamb meat at 0, 2 and 4 days of storage at 4º

	Level	Day 0	Day 2	Day 4
MF	**C**	4.20 ± 0.76^{x}	2.62 ± 0.86^{y}	2.16 ± 0.76^{y}
	R1	3.83 ± 0.77^{x}	2.72 ± 0.75^{y}	2.31 ± 0.63^{y}
	R2	3.87 ± 0.94^{x}	2.62 ± 0.87^{y}	2.16 ± 0.80^{y}
RF	**C**	1.33 ± 0.56^{y}	2.14 ± 0.96^{x}	2.75 ± 1.13^{x}
	R1	1.18 ± 0.41^{y}	2.14 ± 1.04^{x}	2.54 ± 1.00^{x}
	R2	1.37 ± 0.82^{y}	2.27 ± 0.85^{x}	2.60 ± 0.89^{x}
WOF	**C**	1.22 ± 0.55^{x}	2.33 ± 1.02^{y}	3.18 ± 1.14^{az}
	R1	1.33 ± 0.54^{y}	2.37 ± 0.76^{x}	2.79 ± 0.89^{bx}
	R2	1.43 ± 0.74^{y}	2.39 ± 1.04^{x}	2.83 ± 1.04^{bx}
MO	**C**	4.00 ± 0.83^{x}	2.97 ± 0.92^{y}	2.35 ± 0.72^{z}
	R1	4.00 ± 0.69^{x}	3.20 ± 0.80^{y}	2.41 ± 0.58^{z}
	R2	6.04 ± 0.67^{x}	2.95 ± 0.72^{y}	2.35 ± 0.90^{z}
RO	**C**	1.45 ± 0.72^{y}	2.20 ± 0.73^{ax}	2.50 ± 1.04^{x}
	R1	1.16 ± 0.35^{y}	1.79 ± 0.85^{bx}	2.31 ± 0.93^{x}
	R2	1.16 ± 0.38^{z}	1.81 ± 0.62^{by}	2.47 ± 0.98^{x}
WOFO	**C**	1.31 ± 0.54^{z}	2.25 ± 1.17^{y}	2.97 ± 1.13^{x}
	R1	1.31 ± 0.58^{z}	2.35 ± 0.86^{y}	2.31 ± 0.63^{x}
	R2	1.25 ± 0.46^{z}	2.08 ± 0.71^{y}	2.81 ± 1.10^{x}

C: Control; 10: 10% Rosemary; 20: 20% Rosemary. Means with different superscripts are significantly different (*P<0.05*)
a, b, c: effect of level DRL· x,y,z: effect of storage day. Scoring scale: (1: minimum; 6: maximum). M: meaty flavour; RF: rancid flavour ; WOF: warmed over flavour ; MO: meat odour; RO: rancid odour; WOFO: warmed over odour.

Regarding the fatty acid composition (Table 3) were not notably different in MUFA, SFA and PUFA between the different groups (C, R1 and R2). On ly there are differences (($p<0.05$) between R1, R2 and control in MUFA at day 2.In R1 and R2 samples, MUFA percentage had a small decreasing during storage compared with control samples. Thus no distinct fatty acid profile differences. In contrast Velasco. (1999) showed that the fatty acid composition of the adipose depots of suckling animals depend on the composition of the dams milk.

On the other hand, the average PUFA/SFA (0.71 Control and 0.64 R1; 0.6 R2) and n-6/n-3 (3.42 Control and 3.33 R1; 3.15 R2) ratios of the intramuscular fats in the present study may be considered

appropriate, considering the values recommended for the human diets as a whole (0.45 for PUFA/SFA and < 4 for n-6/n-3) (Enser et al., 1998).

Table 3. Effects of dietary with DRL in cooked lamb meat on fatty acid composition (percentage of total fatty acids) of intramuscular fat at 0, 2 and 4 days of storage at 4ºC

	Level	Day 0	Day 2	Day 4
MUFA	**C**	45.20 ± 0.30^{x}	46.10 ± 0.21^{ay}	41.40 ± 0.40^{bz}
	R1	45.69 ± 0.20^{x}	44.69 ± 0.02^{by}	44.29 ± 0.30^{ay}
	R2	44.97 ± 0.25	44.91 ± 0.01^{b}	44.19 ± 0.57^{a}
SFA	**C**	32.95 ± 0.31	33.59 ± 0.35	32.83 ± 0.38
	R1	33.07 ± 0.40^{x}	33.38 ± 0.04^{x}	32.15 ± 0.61^{y}
	R2	34.42 ± 0.03^{x}	33.68 ± 0.21^{y}	32.04 ± 0.24^{z}
PUFA	**C**	21.85 ± 0.54^{z}	20.31 ± 0.35^{y}	25.75 ± 0.32^{ax}
	R1	21.23 ± 0.78^{y}	21.93 ± 0.52^{y}	23.56 ± 0.46^{bx}
	R2	20.59 ± 0.65^{z}	21.41 ± 0.52^{y}	23.77 ± 0.76^{bx}
PUFA/SFA	**C**	0.73 ± 0.08^{z}	0.60 ± 0.02^{y}	0.78 ± 0.07^{bx}
	R1	0.64 ± 0.04^{y}	0.65 ± 0.03^{y}	0.73 ± 0.09^{bx}
	R2	0.60 ± 0.03^{y}	0.63 ± 0.02^{y}	0.95 ± 0.02^{ax}
n-6/n-3	**C**	3.42 ± 0.31	3.43 ± 0.74	3.45 ± 0.64
	R1	3.33 ± 0.22	3.31 ± 0.55	3.35 ± 0.35
	R2	3.35 ± 0.35	3.36 ± 0.31	3.33 ± 0.75

C: Control; 10: 10% Rosemary; 20: 20% Rosemary. a, b, c: effect of level DRL. Means with different superscripts are significantly different ($P<0.05$).SFA: saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturatated fatty acid; n-6/n-3: (C18:2/C18:3).

Conclusions

The feeding of lambs with 10% or 20% rosemary distilled leaves improves the quality of cooked lamb meat due to delays the lipid oxidation by improving the odour and flavour meat. This positive effect was independent from the dosage used. This dietary supplementation in lambs is advantageous since we can add a natural antioxidant on meat.

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