SUCKLING LAMBS MEAT QUALITY INFLUENCED BY OIL-SUPPLEMENTED EWE DIET

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Forty eight lactating Churra ewes were used to investigate the influence of feeding four dietary vegetable oils (hydrogenated palm oil (Control), olive oil (OL), soybean oil (SO) and linseed oil (LI)) on carcass and meat quality of suckling lambs. After lambing, all lambs stayed with their dams and were raised exclusively on maternal milk until slaughter at 11 kg live weight. Animal performance and carcass quality were evaluated. Muscle colour (L*, a*, b*) and lipid oxidation (TBARS) were measured in M. *longissimus* at 24 hours, 5 days and 8 days after slaughter. Animal performance and carcass characteristics of suckling lambs were not affected by ewe diet composition. However, muscle colour parameters were affected by treatment. Lambs suckling ewes in OL group showed higher a* values at 24h, 5 and 8 days ($P<0.05$) than those in groups Control and SO. The effect of ewe feed composition only affected lipid muscle oxidation 8 days after slaughter, the greatest TBARS values being observed for lambs from LI group ($P<0.05$), and the lowest for OL lambs. Therefore, the type of oil feed to lactating ewes affect colour and lipid stability of suckling lambs.

Keywords: meat quality, vegetable oils, supplementation, sucking lambs

INTRODUCTION

Traditionally, in the Mediterranean countries of EU, most of dairy sheep farms produce suckling lambs. Castilla y León is the Spanish region with the largest sheep stock (more than 4 millions), and other 4 millions of lambs and ewes are annually slaughtered for human consumption. Most of these (ca. 50-60 %) are suckling lambs with ages between 25-45 days and with a carcass weight of less than 7 kg, coming from milk production systems (Sañudo et al., 1998; Osorio et al., 2007).

Over the last decade, one of the options of enhancing the beneficial effects of animal products is through diet manipulation, such as the use of diets supplemented with vegetable oils (Elmore et al., 2005; Bessa et al., 2008, Manso et al., 2009). Moreover, most of the preceding studies compared lambs fed vegetable oils-supplemented diets, but little is known when the feeding regimen consists exclusively on maternal milk.

Bearing in mind that suckling lambs are functionally monogastric, ewe's milk composition may affect lamb meat quality. It is generally accepted that the fatty acid profile of adipose tissues from suckling lambs reflects the composition of ewe milk (Lanza et al., 2006; Osorio et al., 2007, 2008). In spite of the work reported above, how feeding suckling lamb with different milk sources will affect some other major lamb quality traits such as meat discolouration and lipid oxidation is not well understood.

The susceptibility of meat to oxidize process depends on several factors, one of the most important being the level of highly oxidize substrates, such as polyunsaturated fatty acids in the phospholipids fraction of cell membranes, where lipid oxidation is initiated (Luciano et al., 2009). However, the stability of the meat oxidation is the result of the balance between pro-oxidants and antioxidants. Vegetable oils are also source of dietary antioxidants such as tocopherols, carotenoids, ascorbic acid and phenolic compounds which can counteract the increased susceptibility of meat to oxidative deterioration arising from increased levels of polyunsaturated fatty acids in the intramuscular fat.

The aim of this trial was to evaluate the effect of vegetable oil in ewe's diet on suckling lamb meat characteristics such as, lipid oxidation and meat discolouration and its changes during ageing period.

MATERIALS AND METHODS

Animals

Forty-eight pregnant Churra ewes were selected before lambing and were housed and, after a 10-day adaptation period, they were divided in four treatments (12 sheep per treatment). At that moment, each group received a different feeding strategy until weaning.

The feeding strategy used in each one of the four treatments included four dietary vegetable oils, distributed as follows: hydrogenated palm oil (Control), olive oil (OL), soybean oil (SO) and linseed oil (LI). Ewes were fed 2.1 kg of a TMR plus barley straw (10%) throughout the experiment distributed in two meals daily. After lambing, all ewes stayed with their respective lambs for the whole experimental period. A total of 72

Churra breed suckling lambs were involved in the experiment (prolificness=1.5). Lambs were raised exclusively on maternal milk. During the experimental period, milk samples from each ewe were taken once a week and all lambs were weighed twice a week, average daily weight gain being estimated as the regression coefficient (slope) of live weight against time (Bodas et al., 2009). Lambs were slaughtered when they reached a live weight of 11-12 kg at a commercial EU-licensed abattoir. Distance to the abattoir was 5 km and animals were slaughtered within 1h from arrival. Carcasses were immediately transferred to a cooler at 4ºC and after 24 hours, dressing proportion was calculated as the relation between cold carcass weight and live weight.

Analyses

At 24 hours *post mortem*, carcasses were halved and from the left side the *longissimus thoracis et lumborum* muscle was excised. pH value was measured in the *m. longissimus thoracis* using a Metrohm 704 pH-meter with a 'penetration' pH-electrode.

Meat colour was measured at the surface of the *m. longissimus* corresponding to the 6^{th} rib section using a Minolta CM-2500d spectrophotometer and the CIE L*a*b* colour space, using the D65 iluminant and 10º standard observer. Colour measurement was taken after a 60-minute blooming period. Triplicate readings were made on non-overlaping zones of the sample and average values were calculated. The remaining *longisimus thoracis et lumborum* muscle was divided into two sections, packed with polyethylene film and subjected to a 5-days or 8-days of ageing period at 4ºC, respectively. After each storage period, colour measurements were recorded as described above. In addition, the extent of lipid oxidation was assessed by measuring 2-tiobarbituric acid reactive substances (TBARS), following the method described by Marachielo et al. (1999).

Statistical analysis

All data were analysed using the ANOVA procedure of SPSS 14.0, with ewe's feeding strategy as the sole source of variation. Differences between group means were assessed using Duncan's multiple range test ($P < 0.05$).

RESULTS AND DISCUSSION

As shown in Table 1, there were no differences in body weight at slaughter, average daily gain, or carcass yield between the treatments. These results were expected since the diets offered were iso-energetic and iso-nitrogenous. Moreover, the ewe milk production and its fat and protein content did no differ among groups (Bodas et al., 2009).

Table 1: Weight and carcass characteristics of sucking lambs.

	Treatment					
	Control	**Olive**	**Soybean**	**Linseed**	**rsd**	**P**
Initial weight (kg)	4.14	4.74	4.25	4.05	0.944	ns
Slaughter weight (kg)	11.6	11.5	11.4	11.2	0.83	ns
Slaughter age (days)	28.2	25.1	28.1	28.3	6.91	ns
Average daily gain ($g \cdot an.^{-1} \cdot day^{-1}$)	274	280	259	258	53.2	ns
Hot carcass weight (kg)	6.11	6.10	6.05	5.91	0.564	ns
Cold carcass weight (kg)	5.95	5.94	5.90	5.81	0.553	ns
Carcass dressing percentage (%)	51.1	51.8	51.5	51.8	2.46	ns

ns: differences not significant.

Colour and lipid deterioration during ageing period are presented in Table 2. Although no significant changes were found attributable to oil used in ewe diet in colorimetric parameters measured at 24 hours *post mortem* and after 5 days of storage, OL group tended ($p<0.1$) to show higher redness (a*) values than SO group whereas LI and Control group showed intermediate and not different values.

After 8 days of ageing, a similar trend was observed for a* values, but a tendency was also recorded for lightness (L*), where SO and OL treatments presented the highest and the lowest values respectively.

Table 2: Colour of m. *longissimus thoracis et lumborum* at 24 hours, 5 and 8 days, as well as lipid oxidation at 5 and 8 days.

	Treatment					
	Control	**Olive**	**Soybean**	**Linseed**	**rsd**	**P**
Colour m. *longissimus* (24 h)						
L*	45.5	44.7	45.3	45.7	3.38	ns
a*	5.60^{ab}	6.50^{a}	4.82^{b}	6.18^{ab}	1.984	+
b*	10.1	11.3	9.9	10.7	1.69	ns
Colour m. *longissimus* (5 days)						
L*	44.5	43.6	45.6	44.5	3.95	ns
a*	2.55^{ab}	3.80^{a}	1.89^{b}	3.00^{ab}	2.098	+
b*	12.8	12.8	12.7	12.7	0.81	ns
TBARS 5 days	0.143	0.079	0.137	0.157	0.1444	ns
Colour m. *longissimus* (8 days)						
L*	45.8^{ab}	43.6^{b}	46.2^{a}	44.0^{ab}	3.55	+
a*	3.94^{ab}	5.01^{a}	3.38^{b}	4.28^{ab}	1.910	+
b*	13.6	13.9	13.5	13.3	1.15	ns
TBARS 8 days	0.921^{ab}	0.604^{b}	0.849^{ab}	1.088^{a}	0.4806	*

*, $p<0.05$; +: $p<0.1$; ns: differences not significant.
a,b: columns with different superscripts refer significant differences among treatments.

Regarding lipid oxidation, the lack of statistically differences in TBARS values after 5 days of storage could be a consequence the individual variability within groups, because the value observed for the OL group was numerically lower than for the other groups.

However, statistically differences between groups were observed after 8 days of storage. TBARS values in meat from suckling lambs from OL treatment were lower as compared to those from LI group ($p<0.05$). Control and SO groups showed intermediate and not different values. These results could be attributed to milk fatty acid composition, whose content in polyunsaturated fatty acids was significantly higher for SO and LIN groups (6.12% and 5.59% respectively) than those obtained for Control and OL groups (4.02% and 3.59% respectively) (Bodas et al., 2009). In like manner, several works (Lanza et al. 2006; Osorio et al., 2006; Scerra et al., 2007) have reported significant differences in fatty acid composition of suckling lamb meat, depending on fat composition of the corresponding milk source.

However, far from what could be expected, Control group, whose milk content in polyunsaturated fatty acids was similar to that found in OL group, showed TBARS values not different to that observed in SO and LIN groups. The lower TBARS values measured in meat from Olive group are in agreement with several studies showing the protective effect against lipid oxidation of olive oil diet supplementation as compared to other vegetable oils diet supplementation (Nuernberg, et al., 2005; Paiva-Martins, F. et al., 2009) In this sense, DeJong et al. (2009) reported that olive oil reduced the formation of 2-thiobarbituric reactive substances (TBARS) in pre cooked beef (63-83%), because of the strong antioxidant activity of several compounds such as hydrosy-tyrosol, tyrosol, caffeic acid and p-coumaric acid. This antioxidant pool can, thus, counteract the increased susceptibility of meat to lipid oxidation due to the high concentration of unsaturated fatty acids usually associated with unsaturated vegetable oils diet.

Regardless dietary treatment, lipid oxidation increased in meat across storage period. Notwithstanding this, for all times, values were below the threshold value for rancidity of 2 mg MDA/kg (Watts, 1962).

CONCLUSIONS

Our results show that there is a relationship between ewes' management and the colour and lipid susceptibility to oxidize of their offspring. Meat from lambs suckling

ewes supplemented with olive oil showed more stability to colour and lipid deterioration over ageing period, than that from lambs suckled by ewes fed diets supplemented with palm, soybean or linseed oil.

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