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Scientific Journal of Animal ScienceJournal homepage: www.Sjournals.com**Original article****Fatty acid profile and lipid oxidation of lamb meat reared in arid area indoors and grazing outdoors in south west of Algeria****M. Elaffifi^{a,*}, K. Boudroua^a, J. Mourot^b**^aLaboratory of Food Technology and Nutrition, Mostaganem University.^bINRA, UMR 1348 PEGASE 35590 Saint-Gilles, France.

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ABSTRACT

The aim of this study is to compare the fatty acid profile and flavor of lamb meats originating from grazing (A) and concentrate (C) diets. Twenty four lambs of Rumbi breed were used. One hundred and five days after rearing and slaughter process, left side samples of longissimus dorsi (LD) were taken from carcasses to be treated and analyzed. The fatty acids of lamb meat A and C were characterized respectively by 1.39 vs 0.41% of polyunsaturated fatty acids (PUFA n-3) ($p < 0.001$) and 3.59 vs 4.64% PUFA n-6 ($p < 0.05$), 40.51 vs 46.95% of monounsaturated fatty acids (MUFA) and 54.45 vs 48.00% of saturated fatty acids (SFA). The n-6/n-3 and LA/ALA ratios were decreased significantly in meat from grazing than concentrate 3.20 vs 14.31 and 2.79 vs 12.08 respectively. The PUFA have a high propensity to oxidize, which in turn may affect lipid stability. The malondialdehyde (MDA) showed higher concentrations (31.11 vs 26.06 nmol.g^{-1}) at all times of the oxidation kinetics in meat (A) than (C). Considering the consumers' interest in organic food products, a special attention for better meat storage is necessary to reach good health benefits.

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1. Introduction

In Algeria, as well as all North African countries, pastures are considered to be a major source of nutrition for small ruminants, mainly in the highlands (Abdelguerfi et al., 2004). Spring grass from spontaneous plants and perennial weeds in arid area as Halophytes, Psammophyte and Sagebrush steppes grazed by animals could enhance the characteristics of the intramuscular fat (Wood et al., 2008; Prache et al., 2011). More specifically, the PUFA n-3 increases in young shoots contrary to wilted grass like hay as well as a concentrate diet. To meet the nutritional recommendations for consumers; it would be desirable to increase the levels of polyunsaturated FA in red meat. However, some reactions such as the oxidation of PUFA affect flavor during storage (Sato et al., 2010). These sensory characteristics have not been determined before for local meat.

2. Materials and methods

2.1. Animals and diets

Twenty-four male lambs from Rumbi breed, approximately 2 months old, with live weight 12.25 ± 2 kg, were allotted into two groups. The first group was put out to pasture from 25 February to 12 June 2011 in Horchaia west of Algeria province (latitude $33^{\circ} 19'$, 8N, longitude $0^{\circ} 5.8$ W [1200m]). These lambs were allowed to graze freely both the young and the leafy spring grass until the haymaking season. The grazing system is on a rotational warm bold basis. Grass kinds included *Salsola vermiculata*, *Aristida pungens*, *Retama raetam*. The analyzed grass samples (Table 1) were chosen randomly from about all the grazed territories. The second group (C) was housed indoors, and was fed ad libitum after adaptation to a standard feed composed of (60% corn, 22 soybean meal, 17% bran and 1% minerals).

2.2. Slaughter and sampling

After 105 days, the lambs were slaughtered, processed, and eviscerated in a local commercial slaughterhouse. After 24h of sweating in a cold room at $+4^{\circ}\text{C}$, left side samples of LD were removed from each carcass and were transported in an icebox to the Laboratory of Food Technology. All the samples were prepared and packed in aluminum and stored at -18°C for further analysis.

2.3. Measurement and analysis

Total lipids (TL) from each sample (diet or meat) were extracted and methylated using Folch et al., (1957) and Morrison et Smith, (1964) methods respectively. The methyl esters of fatty acids were separated and quantified by a gas chromatograph (Perkin -Elmer Auto System XL). The oxidative stability was determined using a modification of the method described by Monahan et al. (1992) by assaying 2-thiobarbituric acid-reactive substances (TBARS).

2.4. Statistical analysis

The data was analyzed using a statistical analysis system (SAS) software (GLM) procedure (SAS Institute, 1989), and expressed as means and standard deviations (SD). The parametric values were compared with a one-way analysis of variance (ANOVA) and Bonferroni test.

3. Results

3.1. Diet composition

The SFA content was much more prevalent in the grass than in the concentrate diet. Less Total Lipid and MUFA were found in the grass. Besides, the PUFA were clearly higher in the grass ($p < 0.01$), most importantly in the form of the alpha linolenic acid (ALA) which was 16 times higher in grass ($p < 0.001$), occurring to the detriment of linoleic acid (LA) (Table 1).

Table 1
Fatty acid profile of diets.

	A	C
TL (% of DM) ¹	3.28	4.73
SFA (%)	32.91	17.00
MUFA (%)	11.16	28.25
PUFA (%)	55.93	54.75
LA (%) ²	18.42	50.99
ALA (%) ³	35.17	2.19

¹Total lipids, ²Linoleic acid, ³Alpha linolenic acid.

3.2. Meat fatty acids

The distribution of fatty acids (expressed in percentage of total FA) is given in (Table 2). The TL content of meat from (A) was lower than (C) ($p < 0.05$). This meat was dominated by SFA ($p < 0.001$), but it has presented a low content of MUFA. Additionally, the PUFA n-3 were found at appreciable levels ($p < 0.001$). A slight significance was observed in the total n-6 FA in favor of concentrate meat.

Table 2
Fatty acid composition of meat (in % of identified FA).

	A	C	SD	Effect
Total Lipids	12.16 ^b	16.44 ^a	3.03	*
C18:0	18.67	19.23	0.39	NS
C18:1 n-9c	35.98 ^b	42.79 ^a	4.82	***
C18:2 n-6c	2.74	3.40	0.47	NS
C18:3 n-3	0.96 ^a	0.26 ^b	0.49	***
C20:0	0.17 ^a	0.12 ^b	0.04	**
C20:3 n-6	0.05	0.02	0.02	NS
C20:4 n-6	0.51	0.31	0.14	NS
C20:4 n-3	0.14 ^a	0.00 ^b	0.10	**
C22:4 n-6	0.01 ^b	0.07 ^a	0.04	*
C22:5 n-3	0.21 ^a	0.04 ^b	0.12	***
C22:6 n-3	0.03	0.00	0.02	NS
SFA	54.45 ^a	48.00 ^b	4.56	***
MUFA	40.51 ^b	46.95 ^a	4.56	***
PUFA	5.05	5.05	0.00	NS
n-6	3.59 ^b	4.64 ^a	0.74	*
n-3	1.39 ^a	0.41 ^b	0.69	***
LA/ALA	3.20 ^b	14.31 ^a	7.86	***
n6/n3	2.79 ^b	12.08 ^a	6.57	***

^{a,b} Means in the same line with different superscripts are significantly different. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, NS $p > 0.05$.

3.3. Lipid oxidation

The MDA levels in meat from pasture, as shown in Figure 1, were slightly higher compared to meat from the concentrate diet at all times of the oxidation kinetics, except at $t = 60$ min (19.71 vs 30.18 nmol.g^{-1} meat).

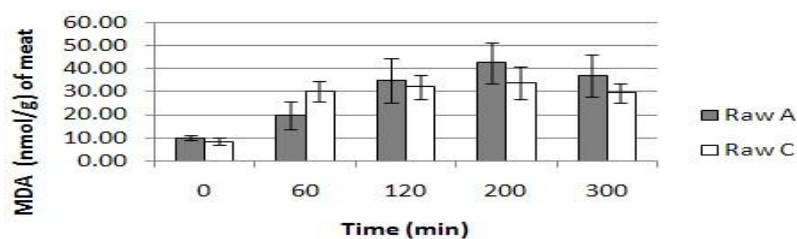


Fig. 1. Lipid oxidation of raw meat.

4. Discussion

4.1. Diet composition

The grass diet showed a different composition compared with concentrate. This was mainly due to maturity and variety of the botanical species as explained by Gilliland et al. (2002). This has provided as a consequence a different fatness level and influenced positively the meat fatty acid composition especially PUFA n-3 in accordance with Arousseau et al. (2004).

4.2. Meat fatty acids

The variability of fat tissue was affected by dietary lipids as a source of energy, and novo synthesis as a metabolic pathway. As a result, the fat amount in meat from grass was due to the low energy from poor vegetation (Popova, 2006). A lot of fat deposition in meat from concentrate was in response to the high feeding level (Shen et al., 2012). The SFA results were similar to those published by Arousseau et al. (2004). Nevertheless, MUFA were slightly lower especially the oleic acid (C18:1 n-9c) 35.98% in (A) vs 42.8% in (C) ($p < 0.001$) in accordance with Popova (2006). These contradictory findings were probably related to the FA metabolism, the season, or the breeding system. Furthermore, the ALA and its long chain PUFA counterparts (eicosapentaenoic acid EPA, docosapentaenoic acid DPA) increased significantly ($p < 0.001$) despite the rumen hydrogenation process, this is linked to the richness of grass in n-3 lipids (McAfee et al., 2010). The LA showed no significance between the two groups, although the total n-6 FA presented a light difference ($p < 0.05$) in favor of the concentrate diet, probably because of the complete inhibition of C18:1 to C18:0 hydrogenation. Dufey and Colomb (2008) reported that FA concentrations were linear in terms of the total fat content, but their slopes were different depending on diet. Consequently, the LA/ALA and n-6/n-3 ratios decreased much more in meat from (A) compared to (C) meeting the nutritional recommendations of the World Health Organization.

4.3. Lipid oxidation

The results as have been presented above are likely due to the richness of meat in PUFA, especially n-3 (Yang et al., 2002). This is positively related to the heme iron that speeds up the oxidation process at different rates. However, Mouty et al. (2002) reported that there was no change in the lipid peroxidation of the muscle in spite of an important n-3 PUFA increase in grass feed, because of the antioxidant activity including vitamin E and polyphenols in grass, playing a positive role on the oxidative stability of raw meat.

5. Conclusion

It is concluded that grazing allows the production of light lamb with higher n-3 PUFA despite the phenomenon of biohydrogenation. However, the rancid deterioration factor is responsible for a loss of quality during a long storage period. Hence, a thorough analysis of the antioxidants in diet deposited in meat would be necessary. Finally, it is to be stressed that the LA/ALA and n-6/n-3 ratios resulting from this trial which are intrinsic quality parameters, have promoted the meat from pasture.

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