EFFECT OF RATION STRUCTURE ON THE CONTENT OF *OMEGA-3* POLYUNSATURATED FATTY ACIDS AND *CLA* OF MUSCLE AND ADIPOSE TISSUE IN LAMBS

Mierlita D.[*], Pădeanu I.[**], Dăraban S.[***], Maerescu Cristina[*], Hâlma Elena[*], Lup F.[*]

[*]Universitatea din Oradea; dadi.mierlita@yahoo.com
[**]Universitatea de Stiinte Agricole si Medicina Veterinara a Banatului, Timisoara;
[***]Universitatea de Stiinte Agricole si Medicina Veterinara, Cluj-Napoca.

Abstract

The purpose of this study was to investigate the effect of dietary supplementation on pasture fattening lambs subjected, concentrated, hay and saponified fats on fatty acid profile of intramuscular fat (longissimus dorsi and biceps femoris) and deposit (subcutaneous and kidney), with reference particular the PUFA n-3 and conjugated linoleic acid (isomer C18:2 cis-9, trans-11). These diets were tested: pasture without supplementation ration (P), P diet supplemented with concentrates (PC), PC diets supplemented with hay (PCF), PCF diet but concentrates was introduced in the structure of saponified fat (sunflower oil-4%) (PCFG). Irrespective of the feed ration to lambs in all four groups, both intramuscular fat and in the warehouse, palmitic acid and stearic predominated (C16:0 and C18:0) in the SFA, oleic acid (C18:1 n-9) MUFA group and linoleic acid (C18:2 n-6) PUFA group. Fattening lambs on pasture (P), significantly increased the proportion of n-3 PUFA and CLA (isomer c9, t11-CLA) in intramuscular fat and lower deposit and n-6/n-3 ratio, resulting in a healthier product for consumers. Both lambs dietary supplementation with concentrates (PC) and respectively concentrated and hay (PCF) had a negative effect on meat fatty acid profile, but significantly increased the rate of weight gain and carcass quality. The introduction of saponified fat protected against browning in concentrated mixture fermentation (PCFG), allowed to maintain performance has improved bio and profile of fatty acids from meat, according to specific dietary recommendations of man which is comparable to that obtained from lambs on pasture (P). In conclusion, fatty acid composition in intramuscular fat deposits and can be modified for human health benefits by grazing lambs, and that the introduction of saponified fat in the diet structure.

Key words: muscle and adipose tissue, Omega-3, CLA, grazing lambs

INTRODUCTION

Fatty acid profile of fat deposit intramuscular and may be affected by several factors such as diet, race, sex, age and weight at slaughter (Aharoni et al., 1995, Rule et al., 1995, Wood and Enser, 1997, Nurnberg et al., 2005, Collar and Aktumsek, 2011). The most important factor in handling the role of fatty acid profile of lamb meat is food. Metabolic studies have shown that the total amount of fat in food determine serum cholesterol levels, but importance is the type of fat (Sanders, 2003). In addition to controlled clinical trials have shown that replacing saturated fats and high in trans fats with unsaturated fats and especially n-3 fatty acids is more effective in preventing cardiovascular disease than reducing fat consumption (Renaud and Lanzmann-Petithory, 2002, Hu and Willett, 2002; Sanders, 2003).

Feeding strategies may lower proportion of saturated fat and increase the share of n-3 polyunsaturated fatty acids and CLA (conjugated linoleic acid) in intramuscular fat, which would improve the quality of lamb meat.

The largest proportion of n-3 PUFA and CLA is found in the deposit intramuscular fat and pasture fed animals (Mitchell et al, 1991; Dannenberger et al., 2005). Dita based and focused mainly on corn, increase the proportion of linoleic acid on fat structure. Lipids from ruminants are the richest sources of CLA, especially the brown acid (C18:2 *cis*-9, *trans*-11) which is the most important isomer of CLA. This isomer, which represents over 80% of CLA in ruminant food products (Ha et al., 1990), proved very important for human health because it inhibits cancer cell proliferation (Schultz et al., 1992, Belury et al., 1995), inhibits the accumulation of body fat (Park et al., 1997), and antioxidant effect antidiabetogenic (Ip et al., 1994).

CLA isomer *cis*-9, *trans*-11, is formed in the rumen by incomplete biohidrogenate dietary fatty acids, especially C18:2 n-6, but a substantial fraction of the amount of CLA in tissues derived from desaturation C18:1 *trans*-11 under the action of Δ^9-desaturaza enzyme that acts on adipose tissue (Santora et al., 2000, Bauman et al., 2001).

However, there is little information on dietary supplementation strategies for fattening lambs on pasture exposed. The purpose of this study was to investigate the effect of dietary supplementation on pasture fattening lambs subjected, concentrated, hay and saponified fats on fatty acid profile of intramuscular fat (*longissimus dorsi* and *biceps femoris*) and deposit (subcutaneous and kidney), with reference particular the PUFA n-3 and conjugated linoleic acid (isomer C18:2 *cis*-9, *trans*-11).

MATERIAL AND METHOD

The study was conducted at the University of Oradea, the lambs of the race Tsigay (20 lambs/group) were randomly assigned to one of four feed rations tested:

• **P**: grazing, ration without supplementation;

• **PC**: grazing and fodder supplement combined ration provided *ad libitum* on pasture;

• **PCF**: PC ratio supplemented with hay provided *ad libitum* on natural pasture;

• **PCFG**: PCF ratio in structure but fat saponified mixed fodder was introduced at a rate of 4% (% by weight of combined fodder). As a source of fat was used sunflower oil saponified as described by Perez EP (2009).

Total lipid extraction was performed according to Folch et al., (1957) using a 2:1 mixture (v:v) chloroform:methanol. Lipid extracts were converted into fatty acid methyl esters (FAME) by saponification with sodium hydroxide (NaOH) and methylation with methanol-BF3 (Morison and Smith, 1964). Separation and quantification of fatty acid methyl esters was done using a Shimadzu gazcromatograf (GC-148) equipped with a facara ionization detector (FID) and equipped with a capillary column HP-88 (100 m, 0.25 mm id and 0.2 μ). We used helium as carrier gas. Injector and the detector temperature was set at 250^0C and 260^0C respectively. Oven program was as follows: 70^0C for 2 min., then was raised up to 150^0C with a gradient of 10^0C/min. followed by a plateau of 3 min., then was again raised to 235^0C with a gradient of 4^0C/min. was maintained for 20 min. at 235^0C. Identification and quantification of fatty acids was done by comparing the individual retention times with those of a standard reference Sigma (Sigma Reference Standards) (Sulpeco 37, Poole, UK). Was used as internal standard methyl ester nonadecanoic acid (C19:0). Fatty acids were expressed as a percentage of total methyl esters identified.

Statistical data processing was done according to the relationship: $Y_i = \mu B_i + \varepsilon_i$, where μ is the mean value, B_i - the effect of different diets (P, PC, PCF, PCFG) and ε_i - residual error. Comparison mean values was performed using Duncan test.

RESULTS AND DISSCUSIONS

All feed and mixed fodder have been especially good sources of linoleic acid (C18:2), but the pasture was rich in α-linolenic acid (C18:3) (40.61% of total FAME), these results are consistent with those specified in the literature (eg. Cabiddu et al., 2005; Hurtaud et al., 2007, Gomez-Cortes et al., 2009). Dietary supplementation with concentrate lambs, which are sources of monounsaturated fatty acids (MUFA) resulted in a significant increase in the level of MUFA both intramuscular fat and the deposit (fig. 1 and 2).

The use of hay in feed concentrates with fat content did not influence carcass fatty acids, even though fat has a high fan in saturated fatty acids (SFA). Saponified fats in food have resulted in weight loss and increased MUFA ratio in intramuscular fat composition and kidney SFA, while the subcutaneous fat was established a reverse trend.

The proportion of MUFA and PUFA higher intramuscular fat and the deposit, the lambs in the feed was supplemented with concentrated and saponified fat than those fed only on pasture, are in agreement with previous findings in studies established fattened steers (Williams et al., 1983; Marmer et al., 1984; Steen et al., 2010). Lambs fed on pasture (P) and those in food which have been introduced saponified fat (PCFG) recorded a higher percentage of polyunsaturated fatty acids (PUFA) in both intramuscular fat and in the deposit.

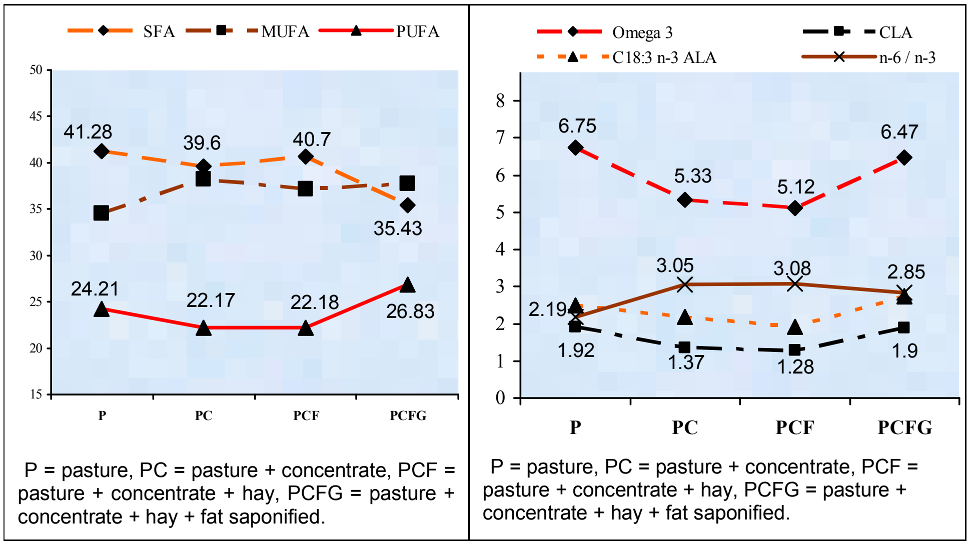


Fig. 1. Influence of diet on the structure of FA profile of intramuscular fat (m. *longissimus dorsi*).

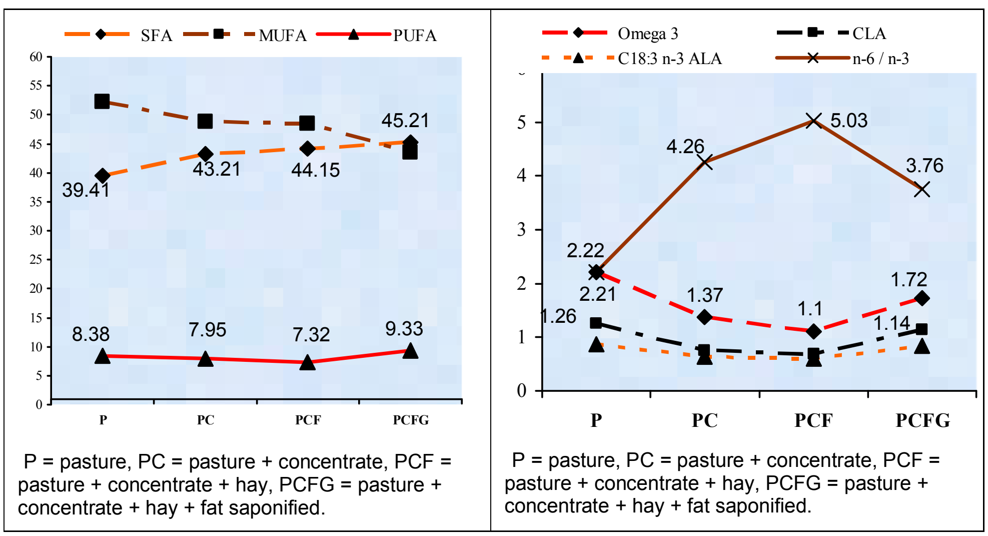
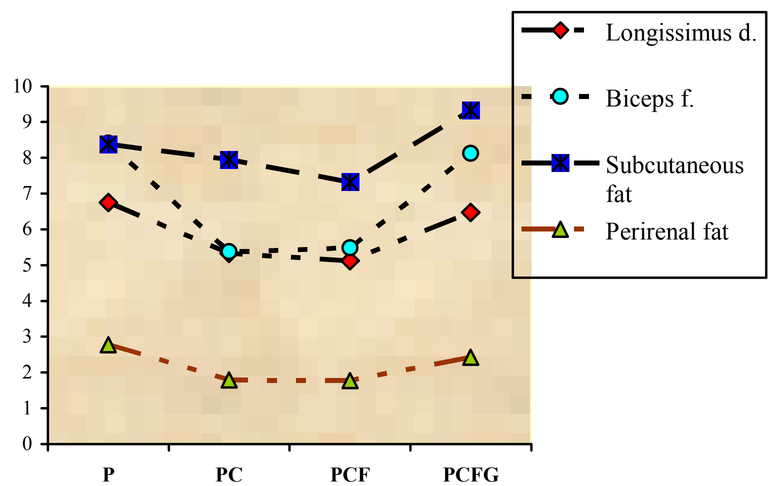


Fig. 2. Influence of diet on the structure of FA profile of fat storage (subcutaneous fat).

The proportion of n-6 PUFA was higher in lambs whose food was supplemented with concentrates, hay and saponified fat (PC, PCF and PCFG) and between lambs in these groups generally were not significant differences. In contrast to these results, Scerra et al., (2007) found no significant differences between the pasture and the lambs fed rations based shelter concentrated on the content in C18:2 n-6 intramuscular fat. However Cividini et al. (2008) states that C18: 2 n-6 fatty acids is one of the main cereal, is therefore present in high proportion in meat lambs fattened on grain and concentrates. Lambs who have used food concentrates (PC, PCF) had significantly lower proportions in the case of n-3 PUFA, especially C18:3 n-3 than lambs fed only pasture. Introduction saponified fats in food lambs had a positive influence on intramuscular fat content and fatty deposits in n-3 and especially in C18:3 n-3, whose weight was higher by up to 51.4% (where m. *biceps femoris*). Despite bio hydrogenation browning of linoleic acid (C18:3 n-3), which is found in large amounts in the grass, it has accumulated in higher proportion in intramuscular fat from lambs on pasture without dietary supplementation or diet was supplemented saponified fat. It can be concluded that dietary supplementation with concentrate and hay increased the rate of linoleic acid bio hydrogenation browned food, reducing its level in intramuscular fat.

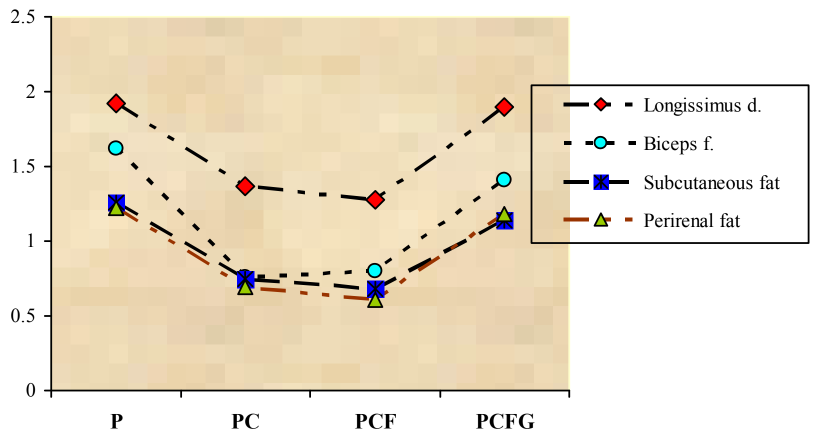
Lambs who have used food concentrates (PC, PCF) had significantly lower proportions in the case of PUFA n-3, especially C18:3 n-3 than lambs fed only pasture. Introduction saponified fats in food lambs had a positive influence on intramuscular fat content and fatty deposits in n-3 and especially in C18:3 n-3, whose weight was higher by up to 51.4% (where m. *biceps femoris*) (fig. 3). It can be concluded that dietary supplementation with concentrate and hay increased the rate of linoleic acid biohidrogenare browned food, reducing its level in intramuscular fat.



P = pasture, PC = pasture + concentrate, PCF = pasture + concentrate + hay, PCFG = pasture + concentrate + hay + fat saponified.

Fig. 3. PUFA Omega-3 content of fat intramuscular and storage.

The increase of C18:3 in intramuscular fat and the deposit is considered beneficial to consumer health, but this increase has led to lower melting point and increase the amount of iodine, which would increase the risk of peroxidation of PUFA (Gill et al , 1995; Warnants et al., 1996). The proportion of *cis*-9, *trans*-11 CLA in intramuscular fat and the deposit was higher in lambs fed on pasture and food which were used saponified fat, with no difference between the other two treatments. The proportion of c9, t11-CLA in adipose tissue (subcutaneous and kidney) was about 2 times higher in lambs fed on pasture and food which were introduced saponified fat (1.22% and 1.18% respectively), compared to those whose diet was supplemented with concentrate and hay (0.69 and 0.61% respectively) (fig. 4).



P = pasture, PC = pasture + concentrate, PCF = pasture + concentrate + hay, PCFG = pasture + concentrate + hay + fat saponified.

Fig. 4. Content of CLA (conjugated linoleic acid) fat intramuscular and storage.

Lower in PUFA content of depot fat (subcutaneous and kidney) compared with the intramuscular (*longissimus dorsi* and *biceps femoris*) and metabolic differences may be due to the synthesis and deposition of fatty acids, depending on the location of body fat. This hypothesis was confirmed by Wood et al., (2008), who reported that ruminants tend to store important polyunsaturated fatty acids in human health, rather than muscle tissue in adipose tissue deposit. In all four treatments, the ratio PUFA/SFA in intramuscular fat, recorded values between 0.53 and 0.76, which are much larger than those mentioned in similar studies aimed at improving the ability of the fatty acid profile intramuscular fat lambs by dietary supplementation pasture-fattened fish meal, rapeseed meal (Enser et al., 1998, Cooper et al., 2004), full-fat soybeans (Ponnampalam et al., 2001) or fish oil (Wachira et al., 2002 ; Demirel, 2000). In this study exceeded even worth 0.45 for the ratio PUFA/SFA, suitable for human diet, indicating lack of selection and also lack the skills race pans for meat production.

In conclusion, the diet consists only of the pasture (P) and the saponified fat supplemented (PCFG), have provided high levels of long chain fatty acids n-3 and low ratios of n-6/n-3 in intramuscular fat. In contrast, lambs fed diets supplemented with concentrates (PC) or concentrates and hay (PCF) made fatter carcass and fat composition were observed in higher proportions of long chain fatty acids n-6 and higher ratios n-6/n-3. In terms of nutritional profile of fatty acids in fat from pasture-grazed lambs and those in which food was used saponified fat, seems more appropriate, due to higher proportions of n-3 PUFA, CLA and report n-6/n-3 lower (Santos Silva et al., 2002).

CONCLUSIONS

The results of this study showed that fattening lambs on pasture without dietary supplementation, even if provided an increase of lower weight gain has a positive influence on fatty acid profile of meat (higher proportions of PUFA Omega-3 and c9, t11 -CLA) resulting in a healthier product for consumers. Positive effects on fatty acid profile of meat-based diet was supplemented pasture, saponified fat and concentrated with a hay, when in addition there have been significant increases in weight gain and carcass quality.

In fattening lambs on concentrates to improve the fatty acid profile of meat, specific recommendations according to human diet, dietary supplementation should be protected from digestion brown fat, high in acid linolenic and linoeloic. These fats have secured a favorable report on meat intake and n-6/n-3 FA significantly increased PUFA n-3 (α-linolenic acid in particular) and *cis*-9, *trans*-11 CLA. Similar effects on meat fatty acid profile were recorded and lambs on pasture, without supplementation of the diet, but weight gain and carcass quality obtained significantly reduced.

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