COMPARATIVE EFFECTS OF DEHYDRATED ALFALFA VERSUS CARDOON MEAL ON TISSUE FATTY ACID PROFILES IN LAMBS

Saheed A. Salami[1,2*], Bernardo Valenti[1], Giuseppe Luciano[3], Michael N. O'Grady[2], Joseph P. Kerry[2] and Alessandro Priolo[1]

[1]Di3A, Animal Production Science, University of Catania, Catania, Italy;

[2]School of Food and Nutritional Sciences, University College Cork, Cork, Ireland;

[3]DSA3, Animal Production Science, University of Perugia, Perugia, Italy.

*Corresponding author email: s.salami@umail.ucc.ie

Abstract - The fatty acid (FA) composition in *longissimus muscle* and liver were examined in lambs fed a concentrate diet containing 15% dehydrated alfalfa (ALFD, *n* = 8) or 15% cardoon meal as a complete substitute for dehydrated alfalfa (CMD, *n* = 7). Muscle and liver from lambs fed ALFD exhibited a higher proportion (*P* < 0.05) of vaccenic acid and rumenic acid. ALFD lowered the content of stearic acid and *n*-6/*n*-3 polyunsaturated FA (PUFA) ratio in the muscle and liver, respectively. Dietary dehydrated alfalfa presents a more desirable FA composition in lamb muscle and liver compared to cardoon meal. Moreover, lamb liver is a richer source of PUFA with a more desirable PUFA/saturated FA and *n*-6/*n*-3 PUFA ratios compared to muscle.

Key Words – muscle, liver, unsaturated fatty acids

I. INTRODUCTION

Cardoon meal (CM) is a by-product obtained after the extraction of oil from the seeds of cultivated cardoon (*Cynara cardunculus* L.). A recent study demonstrated that CM can satisfactorily replace up to 15% dehydrated alfalfa (ALF) in a commercial concentrate diet without adverse effect on lamb performance (Salami *et al.*, unpublished data). Indeed, animal diets play a major role to determine the nutritional composition of fatty acids (FA) in edible animal tissues. Alfalfa fed in various processed forms (fresh, hay, silage) has been documented to enrich lamb muscle and offal with lower saturated FA (SFA) and higher polyunsaturated FA (PUFA) contents compared to dietary wheat straw [1, 2]. However, there is no information on the effect of dietary CM on meat quality. Typically, CM may contain residual content of phenolic compounds and lipids rich in oleic and linoleic acids [3]. We hypothesised that increased intake of these bioactive compounds from diets containing CM could favourably influence the FA profiles in edible animal tissues. Thus, this study compared the effect of dietary inclusion of ALF or CM on the FA composition of lamb muscle and liver.

II. MATERIALS AND METHODS

A total of fifteen cross-bred Sarda x Comisana lambs [initial body weight 20.13 ± 2.07 kg] were randomly assigned to a commercial concentrate diet containing 15% dehydrated alfalfa (ALFD, $n = 8$) or 15% CM as a complete substitute for ALF (CMD, $n = 7$). The animals were adapted to the experimental diets for 9 days and further fed for 75 days pre-slaughter. The liver was excised from each carcass immediately after slaughter, packed under vacuum and stored at -80°C until analysis. The carcasses were stored at 4°C for 24 h after which they were halved and the entire *longissimus muscle* (LM) was removed from the right side, packed under vacuum and stored at -80°C until further analysis. Gas chromatographic (GC) analyses of feed, muscle and liver lipids were performed with a Trace Thermo Finningam GC equipped with a flame ionisation detector and a 100m column. Data were analysed by one-way ANOVA using SPSS software. The significance of treatment effect was considered when $P \leq 0.05$ and a trend for significance was declared when $0.05 < P \leq 0.10$. Principal component analyses of muscle and liver FA were performed using PRIMER-v6 software (PRIMER-E Ltd., Plymouth, UK).

III. RESULTS AND DISCUSSION

ALFD-fed lambs ingested higher content ($P < 0.05$) of 18:3 *n*-3 and lower 18:0, 18:1 *n*-9 and 18:2 *n*-6 contents compared to CMD-fed lambs. The relative amount of these ingested FA is a significant nutritional factor that regulates ruminal lipid metabolism and *de novo* lipogenesis that determine the eventual composition of FA in animal tissues [4]. Total SFA in the muscle was not affected by diets but tended ($P = 0.07$) to be higher in the livers of CMD-fed lambs. The concentration of 12:0, 14:0 and 16:0 was not altered by dietary treatment in both muscle and liver. However, CMD increased 18:0 concentration in the muscle ($P < 0.05$) and a similar trend was observed ($P = 0.07$) in the liver. Dietary treatment influenced the proportion of *trans* monoene isomers (mainly belonging to 16:1 and 18:1) and 18:2 isomers in the muscle and liver. More importantly, muscle and liver from lambs fed ALFD exhibited a higher proportion of *trans*-11 18:1 and *cis*-9 *trans*-11 18:1 that are known for their potential health benefits in human. Diet did not affect 18:2 *n*-6 in the muscle while the proportion of this FA was higher ($P < 0.05$) in the liver of CMD-fed lambs. Contrarily, ALFD exhibited a tendency ($P = 0.07$) to increase the 18:3 *n*-3 content in the muscle but not in the liver. Muscle long-chain PUFA were not affected by diets. However, ALFD favoured higher ($P < 0.05$) 20:5 *n*-3 and 22:5 *n*-3 contents while CMD increased 22:4 *n*-6 and 22:5 *n*-6 contents in the liver. Additionally, livers from ALFD-fed lambs were enriched with a greater concentration of mono-unsaturated FA (MUFA) and *n*-3 PUFA in contrast to a lesser amount of *n*-6 PUFA. The *n*-6:*n*-3 PUFA ratio was lower in the liver ($P < 0.05$) and muscle ($P = 0.05$) of ALFD-lambs. However, the odd- and branched- chain fatty acids (OBCFA) and PUFA:SFA ratio were comparable between diets in both muscle and liver.

Principal component analyses revealed that muscle exhibits a distinct FA profile compared to the liver while diets fairly discriminate the FA profiles in the muscle and liver. In comparison to the muscle, lamb liver contains a higher content of total PUFA (3-fold), *n*-6 PUFA (3-fold), *n*-3 PUFA (5-fold), OBCFA (2-fold) and PUFA:SFA ratio (3.5-fold) but a lower amount of MUFA (2-fold) and *n*-6:*n*-3 PUFA (2-fold). The PUFA/SFA ratio (liver *vs*. muscle; 0.81 *vs.* 0.25) in the liver was greater than the minimum value of 0.45 recommended for dietary fats [5]. Similarly, the *n*-6:*n*-3 PUFA ratio (liver *vs*. muscle; 5.01 *vs.* 8.54) in the liver was relatively closer to the maximum recommended value of 4.0 [5] than that of muscle. These findings support previous observation that ruminant liver is a viable source of PUFA coupled with a desirably lower *n*-6:*n*-3 PUFA ratio compared to muscle [6].

IV. CONCLUSION

From a human nutrition perspective, results indicate that dietary inclusion of ALF presents a more desirable FA profile in lamb muscle and liver compared to dietary CM. Lamb liver is a richer source of PUFA with a more desirable PUFA:SFA and *n*-6:*n*-3 PUFA ratios compared to muscle.

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