Effect of dietary polyunsaturated fatty acids on lipid composition of kidney tissue in Rams

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Abstract

The aim of this study was to investigate the effects of feeding dietary protected linseed (LIN), fish oil (FO) and a 50:50 mix of the two sources (LINFO) on lipid composition of kidney tissue. Twelve rams were housed individually and received similar fat levels (50g/kg/DM) from different fat sources. The rams were fed a basal diet of a 70:30 mixture of haylage and concentrate. The rams were randomly allocated to each of three protected fatty acid (FA) sources**;** LIN, FO and LINFO. After 12 weeks, rams were fasted for 18 hours and taken to the abattoir. Kidney tissue samples were collected for fatty acid analysis. The concentration of C18:3 *n*-3 in the kidney of rams offered diet containing LIN was significantly greater (P=0.002) than those observed in rams given the FO and LINFO diets. The concentration of C20:5 *n*-3 and C22:6 *n*-3 in the kidney of rams offered diets containing FO and LINFO diets were significantly increased (p<0.001) than rams receiving the LIN diet. In conclusion, dietary LIN, FO and LINFO altered the fatty acid composition of lipids of kidney tissue of rams.

Keywords: Ram kidney; Dietary Fish oil; Linseed; Tissue fatty acid profile

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1. Introduction

In recent years awareness of the importance of the fatty acid composition of ruminants meat and milk products has increased, with a particular emphasis on *n*-3 polyunsaturated fatty acids, for example, α-linolenic acid (C18:3 *n*-3), eicosapentaenoic acid (EPA; C20:5 *n*-3) and docosahexaenoic acid (DHA; C22:6 *n*-3), as these can have beneficial effects on animal performance and reduce the risk of coronary heart disease in humans (9). However, one of the critical challenges is that ruminal microorganisms modify the dietary fatty acid profile through isomerization and biohydrogenation of unsaturated fatty acids, resulting in the production of *trans*-isomers and saturated fatty acids (1,4). Studies in which ruminant animals were fed unprotected sources of C18:3 *n*-3 have demonstrated high levels of biohydrogenation in the rumen (6,13,15) and it was recommended by (3) that some form of protection of PUFA against the effects of microorganisms in the rumen was required. The aim of this study was to investigate the efficacy of dietary fat sources evaluated for their susceptibility to biohydrogenation in improving the lipid composition of Kidney tissue.

2. Materials and Methods

2.1. Experimental animals and diets

Twelve rams were housed individually and received similar fat levels (50g/kg/DM) from different fat sources. The rams were allocated into three treatment groups of four rams per treatment. The rams were fed a basal diet of a 70:30 mixture of haylage and concentrate. The three treatment diets were prepared by supplement the basal die as follows: Fish oil contained 65 g/kg protected fish oil. Its specification: 50% oil, C20:5 *n*-3 (165 g/kg, C22:6 n-3 (110 g/kg).

Protected linseed containing 91g linseed/kg DM high in concentration of α-linolenic acid (C18:3 *n*-3). Linseed-Fish oil: - at 50/50 mixture containing 46 g linseed /kg DM + 32 g fish oil /kg DM (50:50).

2.2. Collection of samples for lipid analysis

At the end of the experiment, rams (four rams per treatments) were fasted for 18 hours and taken to the abattoir. Post-mortem kidney tissue samples were collected for fatty acid analysis.

2.3. Gas Liquid Chromatography of Fatty Acid Methyl Esters (FAME)

Fatty acid methyl esters were analyzed by gas chromatography using

a Hewlett Packard HP 6890 plus GC, an Agilent 7683 series auto injector and equipped with a Varian CPSl88 fused silica capillary column (100 x 0.25mm film thickness). Helium was used as a carrier gas at a constant flow rate of 0.5/min and injection was used. The oven temperature was at 160º C then programmed to increase gradually from 160 °C to 220 °C at a rate of 1.5°C/min, hold for 10 min then increase from 220 °C to 230 °C at a rate of 5.0 °C/min. The fatty acids were identified by comparison with a marine FAME reference mixture (Restec, Dorset, UK). Fatty acids were identified on the basis of their retention time within the capillary column. Data was collected on a Varian workstation and the % area below each of the peaks was calculated and expressed as a % of total peak area. Quantities of individual fatty acids were calculated as g/kg of total fatty acids using the peak areas.

2.4. Statistical analysis

Comparison of kidney tissue PUFA content between treatments was by one-way Anova using (Genstate 9, Lawes Agricultural Trust).

3. RESULTS

3.1. Experimental diets

The composition of experimental diets and the intakes of individual and total fatty acids are presented in Table 1. As expected, the linseed diets contained the highest concentrations of C18:3 *n*-3. The mean intake of C18:3 *n*-3 in rams offered the linseed diet was 31.2 g/d; this was 14 and 1.5 times greater than values for the fish oil and linseed–fish diets respectively. The intakes of the EPA (C20:5 *n*-3) and DHA (C22:6 *n*-3) by rams receiving the fish oil and linseed-fish oil diets were on average 1.8 and 0.7g/d respectively, whilst their intakes were negligible for the linseed supplemented diet.

Table 1. Raw materials and chemical composition of diets containing three different fat sources, and the daily intakes of fatty acids

	linseed	Fish oil	linseed-fish oil
Fatty acid intake (g/d)			
C18:3 *n*-3	31.2	2.2	23.1
C20:5 *n*-3	0.2	1.8	0.7
C22:6 *n*-3	0.0	0.6	0.2
Total fatty acid	65.9	56.0	47.8

3.2. Fatty acid composition of kidney tissue

Table.2 The effects supplementation of a 70:30 haylage and concentrate diet with either linseed, fish oil or a 50:50 mixture of linseed and fish oil for fatty acid composition on the kidney of rams (n = 4).

	linseed	Fish oil	linseed-fish oil	SED	Significance
FA composition (g/100g TFA)					
C18:3 *n*-3	2.4[a]	1.1[b]	1.6[b]	0.27	P = 0.002
C20:5 *n*-3	3.3[a]	18.4[b]	18.0[b]	1.14	P < 0.001
C22:6 *n*-3	1.2[a]	5.4[b]	5.0[b]	0.17	P < 0.001

Mean values with different superscripts are significantly different, SED = standard error of the difference, TFA = total fatty acids.

The fatty acid of composition of kidney tissue from rams fed the three lipid supplements is reported in Table 2. As expected, the concentration of C18:3 *n*-3 was significantly higher (P = 0.002) in kidney tissue of rams fed the diets containing linseed. The mean values for C18:3 *n*-3 were 2.4, 1.1 and 1.6 g/100g fatty acid for linseed, fish oil and linseed-fish oil diets, respectively. The concentration of C20:5 *n*-3 was highest in rams offered fish oil and linseed-fish oil diet compared to linseed diet the mean values for C20:5 *n*-3 were 3.3, 18.4 and 18 g/100g fatty acid kidney tissue (P < 0.001) for rams offered linseed, fish oil and linseed-fish oil diets, respectively. The concentration of C22:6 *n*-3, in rams offered fish oil and linseed-fish oil diets was significantly greater (P<0.001) compared to that in the kidney tissue of rams fed the linseed diet. Mean values were for C22:6 *n*-3 (1.2, 5.4 and 5.0) for rams fed the linseed, fish oil and linseed-fish oil diets, respectively.

4. DISCUSSION

Linseed and Fish oils are a rich source of *n*-3 PUFA, eicosapentaenoic (EPA) and docosahexaenoic (DHA) acids. Strong evidences suggest that *n*-3 PUFA reduces cardiovascular diseases risk and this is partly mediated by its potent triglyceride-lowering effects (5,11), despite a wealth information regarding the effect of *n*-3 PUFA on different organ in mammalian species, there are relatively no data regarding levels of fatty acids in kidney tissues.

The main effects of diet on fatty acid composition of kidney tissue are given in Table 2. The increases in the concentration of C18:3 *n*-3 with the major increase in dietary concentration of C18:3 *n*-3 occurring with the linseed diet. These increases agree with results of (3) and Yu and Wange (17) *et al*., 2008 who supplemented lambs with linseed oil. The increase in the concentration of C20:5 *n*-3 and C22:6 *n*-3 on feeding fish oil is similar to other studies with poultry, pigs and cattle (2,8,10,12,16). The combination diet linseed-fish oil had intermediate level of C18:3 *n*-3, C20:5 *n*-3 and C22:6 n-3 between the linseed and fish oil diets. In agreement with other reports (7), the fatty acid content was independent of the lipid type included in the diet.

In the present experiments, Gas chromatography based analysis of the composition of experimental diets revealed higher content of α-linolenic acid in linseed oils used, whereas, the levels of EPA and DHA in the linseed relatively low (Table1).

Conclusions

The dietary LIN increased significantly the C18:3 *n*-3 in kidney tissue. However, the synthesis of EPA and DHA from dietary C18:3 *n*-3 seems to be limited, and thus the EPA and DHA enriched lamb meat contributes only in a small amount to the recommended daily intake for human diet.

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