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The effects of different amounts and types of fat on meat fatty acid composition in sheep*

A. Potkański[1], M. Szumacher-Strabel[1], A. Cieślak[1], J. Kowalczyk[2], M. Urbaniak[1] and M. Czauderna[2]

[1]Department of Animal Nutrition and Feed Management,
August Cieszkowski Agricultural University
Wołyńska 33, 60-637 Poznań, Poland
[2]The Kielanowski Institute of Animal Physiology and Nutrition,
Polish Academy of Sciences
05-11- Jabłonna, Poland

ABSTRACT

The effect of different fat sources and amounts in diets on the fatty acid composition of meat was estimated in an experiment on 24 lambs. The basal diet consisting of meadow hay and concentrate (60:40) for control animals was supplemented for experimental animals with 6% linseed oil, rape seed oil, or hydrogenated rape seed oil. Feeding lambs with the 6% addition of linseed oil, rape seed oil or hydrogenated rape seed oil to the diet had no significant influence on total saturated fatty acid content in meat. The addition of 10% hydrogenated rape seed oil significantly ($P<0.05$) decreased the level of miristic acid in meat. Addition of rape seed oil increased ($P<0.05$) the level of stearic acid in comparison with groups that received linseed or hydrogenated rape seed oil. Statistically significant ($P<0.05$, $P<0.01$) increases in total n-3 polyunsaturated fatty acids (PUFA) in comparison with the control group were found when rape seed or linseed oils were added to the diet. Rape seed oil also caused a significant ($P<0.01$) increase in total n-6 PUFA in comparison with groups receiving linseed or hydrogenated rape seed oils. The results obtained in the experiment demonstrate that feeding lambs diets supplemented with fats of vegetable origin can alter the fatty acid composition of meat, with potential benefits to human health.

KEY WORDS: fat, fatty acids, MUFA, PUFA, meat, lamb

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INTRODUCTION

In response to nutritional guidelines recommending reduction in saturated fats in human diets, farmers have to develop new products containing unsaturated fats to satisfy the demand of the more health-conscious consumer (During et al., 2000). The body fat of farm animals is partly synthesized from dietary carbohydrates, partly from dietary fatty acids. In ruminants, polyunsaturated fatty acids are hydrogenated mainly to saturated fatty acids by rumen microorganisms and then absorbed and deposited in adipose and muscle tissue. It is relatively easy to change the fatty acid composition of lamb and veal, whereas adult ruminants can only be enriched significantly with polyunsaturated fatty acids (PUFA) by manipulation of diet composition (Jakobsen, 1999; Voigt and Hagemeister, 2001). Although animal and epidemiological studies have implicated dietary fat as a factor in cancer, recent prospective epidemiological data in humans have cast doubt on the possibility of a strong relationship. In summary, clear evidence points to the need to reduce intakes of saturated fatty acids in the diet (Grundy, 1999).

The objective of the experiment was to determine the effect of supplementing lamb diets with fats of different vegetable origin on fatty acid composition in the produced meat.

MATERIAL AND METHODS

The experiment was carried out on 24 lambs fattened from 22 to 40 kg body weight. The animals were divided into four groups and fed a basal diet consisting of meadow hay and concentrate (60:40) fed *ad libitum* to the control group; the concentrate for the experimental groups was supplemented with 6% of linseed oil, rape seed oil or hydrogenated rape seed oil in dry matter (Table 1). All animals had free access to water.

TABLE 1

Composition of the concentrate, %

Components	Control group	Experimental groups
Fat (linseed oil, rape seed oil or hydrogenated rape seed oil)	0	6
Wheat meal	60	60
Rapeseed meal	18	18
Wheat bran	20	14
Minerals	2	2

At the end of the fattening period, the lambs were slaughtered and the contents of individual fatty acids in the *longissimus dorsi* muscles of the lambs were determined using the HPLC procedures of Heinig et al. (1998), modified by Czauderna et al. (2001).

The obtained data were analyzed using SAS procedures (User's Guide, 1990).

RESULTS

Feeding 6% of linseed oil, rape seed oil or hydrogenated rape seed oil to lambs had no significant influence on total saturated fatty acid (SFA) content, although a decreasing tendency was observed when linseed oil and hydrogenated rape seed oil were added. Treatment effects on fatty acid composition of meat are shown in Table 2. Addition of 6% hydrogenated rape seed oil decreased

TABLE 2

Fatty acid content in *M. longissimus dorsi* of sheep fed diets supplemented with different vegetable origin fat, μg/g of lyophilized samples

Meat	Control		Rape seed oil		Linseed oil		Hydrogenated rape seed oil	
	mean	CV	mean	CV	mean	CV	mean	CV
Miristic acid	70.9^{a}	52.8	59.1	16.8	48.5	32.2	42.5^{a}	22.1
Palmitic acid	1173.4	46.3	1538.3	23.2	802.4	38.9	883.7	22.2
Stearic acid	944.3	39.3	1302.3^{ab}	21.1	736.7^{a}	40.4	851.5^{b}	23.4
Total SFA	2422.1	40.2	3272.6	22.4	1747.5	36.2	1921.2	21.6
Total MUFA	2901.4	42.7	4010.1^{a}	17.3	2675.0^{a}	41.4	2461.3	43.6
Total PUFA n-3	137.8^{A}	22.0	202.7^{ABa}	19.4	152.7^{ab}	23.7	108.1^{Bb}	31.3
Total PUFA n-6	1496.8	36.4	2011.4^{AB}	25.2	1126.6^{A}	41.4	1017.6^{B}	35.6
Total PUFA +MUFA	4536.1	38.3	6224.2^{Aa}	16.1	3954.3^{a}	40.5	3587.0^{A}	39.8

means in rows with the same letter differ statistically significant ^{A,B,C} – $P< 0.01$; ^{a,b,c} – $P<0.05$

($P<0.05$) the level of miristic acid in lamb meat. Linseed and rape seed oils also decreased the level of miristic acid, but differences were not significant. Addition of rape seed oil increased ($P<0.05$) the level of stearic acid in comparison with groups that received linseed or hydrogenated rape seed oils. We also observed significant ($P<0.05$, $P<0.01$) increases in total n-3 PUFA in meat when rape seed or linseed oils were added to the diet in comparison with the control group. Rape seed oil also caused a significant ($P<0.01$) increase in total n-6 PUFA.

DISCUSSION

Fat modification promises success as a preventive measure. The extent of atherosclerosis and cardiovascular disease is related to the intake of fat and cholesterol. In particular, the amount of fat containing saturated fatty acids in the diet correlates more strongly with the incidence of cardiovascular disease than total fat intake (Windler, 2000). Although differences in total SFA when fat was added to sheep diet were not statistically significant, we noticed a decreasing tendency of total SFA content. Modification of meat fat to contain n-3 fatty acids has potential for improving consumer health. In the conducted experiment, increased concentrations of beneficial fatty acids in meat fat were obtained by feeding diets with rape seed or linseed oils. Differences in the effects of the added fats underscore the difficulties in understanding the effects of dietary fat on the fatty acid composition of fat deposited in muscles. Altering the composition of ruminant fats is difficult because of the hydrogenation of unsaturated fatty acids by microbes in the rumen (Harfoot, 1981). In the experiment of Stanford et al. (1999) lamb fatty acid composition was markedly influenced. Saturated fatty acids were reduced and PUFA were increased by increasing the amount of canola seeds in lamb diets. Conflicting results were obtained by Solomon et al. (1991). In their study, adding 6.5% whole rape seed to lamb diets increased the total level of SFA. The results of the present study demonstrate that the addition fats to lamb diets alters fatty acid composition, with potential benefits to human health.

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STRESZCZENIE

Wpływ dodatku tłuszczu na skład kwasów tłuszczowych mięsa jagniąt

Zainteresowanie konsumenta produktami o określonym składzie spowodowało intensyfikację badań nad określeniem optymalnego składu dawek dla zwierząt przeżuwających, które zwiększałyby koncentrację pożądanych składników pokarmowych w odpowiednich proporcjach w uzyskiwanych produktach, np. mięsie. Celem przeprowadzonego doświadczenia było określenie wpływu dodatku 6% tłuszczu (oleju lnianego, oleju rzepakowego lub uwodornionego oleju rzepakowego) na skład i poziom kwasów tłuszczowych w mięsie jagniąt, jako potencjalnych czynników zapobiegających rozwojowi wielu chorób cywilizacyjnych. Materiał doświadczalny stanowiły 24 jagnięta o początkowej masie ciała 22 kg i tuczonych do 40 kg. Dodatek 6% uwodornionego oleju rzepakowego statystycznie istotnie ($P<0,05$) obniżył poziom kwasu mirystynowego w mięsie jagniąt. Olej rzepakowy obniżył poziom ($P<0,05$) kwasu stearynowego w porównaniu z grupami otrzymującymi dodatek oleju lnianego lub uwodornionego oleju rzepakowego. Stwierdzono statystycznie istotny wzrost poziomu n-3 PUFA w grupach otrzymujących dodatek oleju rzepakowego lub lnianego oraz wzrost poziomu n-6 PUFA w grupie jagniąt otrzymujących dodatek oleju rzepakowego w porównaniu z dwiema pozostałymi grupami.