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The effect of fish oil in calf diets on the fatty-acid content of *Musculus thoracis* intramuscular fat

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ABSTRACT

The experiment examined the effect of fish oil in calf diets on the fatty acid profile in the fat of 16 Black-and-White bull calves allotted to 2 groups of 8 animals from 7 to 90 days of age. The animals of the control group were given *ad libitum* a diet consisting of ground cereals, soyabean meal and minerals supplemented for the experimental group (FO) with 4% of fish oil. At 90 days of age the calves were slaughtered and samples of meat from *Musculus thoracis* were analysed for fatty acid content. Differences in total fat appeared to be not significant (P>0.05) between the groups. A significant increase in n-3 FA and decrease in the n-6/n-3 ratio was found in the meat fat of group FO animals. Supplementation of the diet with fish oil increased the proportion of $C_{20:1}$ n-9, $C_{20:4}$ n-3, $C_{20:5}$ n-3, $C_{22:4}$ n-6, $C_{22:5}$ n-3 and $C_{22:6}$ n-3, whereas the proportions of $C_{18:0}$ decreased significantly.

KEY WORDS: calf, fish oil, *Musculus thoracis,* eicopentasenoicate, docosahexaenoicate

INTRODUCTION

The long-chain n-3 fatty acids, eicozapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are required for many metabolic processes in humans and play an important role in prevention of heart disease and cancer in humans (Givens, 2000). The richest source of EPA and DHA are fish oils.

It has been reported that supplementing fish oil to animal diets appears to be a way of significantly increasing the n-3 PUFA content of meat (Ashes et al., 1992). The aim of the present study was to determine the effect of fish oil in calf diets on the fatty-acid profile of meat fat.

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MATERIAL AND METHODS

The experiment was carried out on 16 Black-and-White bull calves, randomly allotted into two feeding groups of 8 animals. Calves of the control group (C) were fed *ad libitum* a concentrate mixture containing, %: ground barley 40.5, ground wheat 27-30.5, wheat bran 10-13, soyabean meal 13-15.5, minerals 3, supplemented with 4% fish oil for the experimental group (FO). Mixture compositions, daily rations, energy and protein value of feeds were formulated according to IZ-INRA (2001) standards. The calves were fed individually from day 7 to 90 of life, for the first 56 days they also received a milk replacer. At the end of the experiment the calves were slaughtered, samples of meat from the *Musculus thoracis* were taken for fat analysis. Proximate analysis of feeds and meat components was carried out according to AOAC (1990) methods, the fatty-acid profile was estimated in extracted fat using gas chromatography (Varian 3400, 105 m column). The results were analysed using the one-way analysis of variance procedure of the SAS (Enterprise Guide, 2002) package. The differences were assumed to be not significant ($P>0.05$).

RESULTS

The nutrient and fatty-acid contents and profiles in feeds are given in Table 1.

Table 1. Nutrient and fatty-acid contents and profiles in feeds

Item	Milk replacer	Mixtures	
		control	fish oil
Dry matter, g kg^{-1}	97.33	87.45	88.66
Crude protein, g kg^{-1} DM	19.95	14.10	17.41
Fat, g kg^{-1} DM	19.86	1.62	4.99
Ash, g kg^{-1} DM	8.07	4.56	5.29
Fatty acids, % of total fat			
C14	3.96	0.29	5.16
C16	30.68	17.35	26.39
C18	4.10	1.67	3.22
C18:1	31.29	15.44	27.06
C18:2 n-6	16.71	58.94	25.41
C18:3 n-3	0.57	5.16	1.35
C20:5 n-3 EPA	0.00	0.00	1.33
C22:6 n-6 DHA	0.00	0.14	3.10
SFA	50.98	19.49	35.70
UFA	48.93	80.41	64.26
PUFAn-6/n-3	29.40	11.12	4.45

Differences in final body weight, average daily gain or concentrate intake between groups (Table 2) did not reach statistical significance ($P>0.05$).

Supplementation of the diet with fish oil had no significant ($P>0.05$) effect on total fat, SFA, UFA, PUFA content but resulted in a significant increase in n-3

PUFA (P=0.003). Fat in the meat from group FO animals contained more $C_{20:1}$ n-9, $C_{20:4}$ n-3, EPA, DHA and $C_{22:5}$ n-3 and DHA and a lower n-6/n-3 ratio compared with the fat from the control group (P<0.05). In the experimental group, significant decreases in the proportions of $C_{22:4}$ n-6 and $C_{18:0}$ were also found (Table 3).

Table 2. Fattening parameters of calve s

Item	Groups		SE
	control	FO	
Initial body weight, kg	42.81	48.75	1.92
Final body weight, kg	92.56	91.94	3.29
Daily weight gain, kg			
from 7 to 56 day	455.18	397.32	32.80
from 7 to 90 day	611.06	529.29	33.62
Concentrate mixture intake, kg	68.90	65.17	5.17
Intake of mixture/kg of daily weight gain, kg	1.39	1.48	0.07

P>0.05

Table 3. Fatty-acid composition of *Musculus thoracis* fat, % of total fat

Fatty acids	Groups		SE	P
	C	FO		
$C_{14:0}$	1.07	1.26	0.14	0.5
$C_{16:0}$	17.17	17.99	0.55	0.47
$C_{18:0}$	12.04	10.46	0.32	0.008
$C_{18:1}$	24.99	25.78	1.27	0.77
$C_{18:2}$ n-6	18.86	15.66	0.99	0.11
$C_{18:3}$ n-3	0.53	0.58	0.03	0.57
$C_{20:0}$	0.18	0.15	0.01	0.35
$C_{20:1}$ n-9	0.30	0.55	0.04	0.0001
$C_{20:4}$ n-3	0.08	0.97	0.15	0.0003
$C_{20:5}$ n-3 (EPA)	0.38	2.75	0.44	0.003
$C_{22:4}$ n-6	0.70	0.33	0.06	0.0009
$C_{22:5}$ n-3	0.84	1.50	0.14	0.012
$C_{22:6}$ n-3 (DHA)	0.23	0.86	0.11	0.0009
SFA	31.89	31.07	0.78	0.62
UFA	57.15	58.10	0.46	0.32
PUFA	29.20	28.73	1.70	0.90
PUFA n-3	2.06	6.66	0.79	0 .0036
PUFA n-6	27.14	22.08	1.56	0.11
PUFA n-6/n-3	13.30	4.11	1.37	< 0.0001

differences are not statistically significant at P>0.05

DISCUSSION

In the present study, supplementing the diet with fish oil had no effect on growth performance and total fat content in meat, but highly increased the proportions of n-3 dietary fatty acids (EPA and DHA) in meat. Similar results were also reported by Jenkins and Kramer (1990). Ashes et al. (1992) suggests that ruminal microflora could not hydrogenate EPA and DHA to any significant extent when fish oil preparations were incubated with strained rumen liquor. Byers and Schelling (1988)

reported that changes in dietary PUFA from fish oil in the rumen are slow because of limited hydrolysis of fats. A high increase in n-3 FA was also due to increased levels of $C_{20:4}$ n-3 and $C_{22:5}$ n-3, which are metabolites of $C_{18:3}$ n-3 in the synthesis of EPA and DHA. This suggests that ruminants may be able to synthesize EPA and DHA from their precursor of α-linolenic acid, although the conversion efficiency is relatively low (Givens et al., 2000). PUFA n-6 tended to decrease, but the difference was not significant. However, the content of $C_{22:4}$ n-6 decreased as well as the ratio of n-6/n-3 FA ($P<0.001$), which is advantageous from the human dietetic point of view. A decrease in stearic acid in group FO was observed ($P<0.01$), suggesting that EPA and DHA could bypass ruminal hydrogenation.

In can be concluded that feeding calves a diet supplemented with fish oil increases the supply fatty acids to the small intestine and influences the fatty acid composition of meat fat. Fish oil resulted in an increase in muscle long-chain n-3 FA content, a decrease in the n-6/n-3 ratio, and improved nutritional value of veal for human consumption.

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STRESZCZENIE

Wpływ oleju rybnego w żywieniu cieląt na profil kwasów tłuszczowych tłuszczu śródmięśniowego *Musculus thoracis*

Doświadczenie przeprowadzono na 16 buhajkach rasy cb (2 grupy po 8 cieląt) od 7 do 90 dnia życia. Cielęta żywiono do woli mieszanką treściwą zawierającą śruty zbożowe, poekstrakcyjną śrutę sojową, składniki mineralne, a w grupie doświadczalnej dodatkowo 4% oleju rybnego. Do 56 dnia cielęta otrzymywały także preparat mlekozastępczy. W 90 dniu buhajki ubijano i pobierano próbki mięsa z *Musculus thoracis*. Dodatek oleju rybnego nie miał wpływu na ogólną zawartość tłuszczu, zwiększył natomiast zawartość EPA i DHA ($P<0,003$), a także ogólną zawartość PUFA n-3 w tłuszczu mięsa. Istotnemu obniżeniu uległ także wskaźnik n-6/n-3 ($P<0,001$).