Meat quality and tissue fatty acid profiles in rabbits fed diets supplemented with conjugated linoleic acid

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ABSTRACT: In this study the deposition of dietary CLA isomers in loin and hindleg meat, liver and fat, and the influence on performance and fatty acid (FA) profile were investigated in growing rabbits. CLA was supplied as synthetically produced oil at 5 and 10 g/kg diet for the whole fattening period (six weeks) or three weeks before the slaughter. CLA had no or limited effect on feed intake, growth, carcass traits and composition of meat. Treatment with CLA increased the proportion of saturated FA at the expense of monounsaturated FA in meat and liver. Supplementation of the diet with CLA increased ($P < 0.05$) CLA in lipids of meat from < 1 mg/g FA up to 36 mg/g FA. Adipose and hepatic tissue incorporated the highest (44 mg/g FA) and the lowest (14 mg/g FA) amount of CLA, respectively. The concentration of CLA in tissue lipids increased ($P < 0.05$) with increasing CLA content in the diet. Duration of CLA feeding had no effect on CLA deposition. Thus, dietary inclusion of CLA at higher concentration (10 g/kg) and feeding CLA-supplemented diet for a shorter period seems to be more suitable for production of CLA-containing rabbit meat. The ratio of the two most abundant isomers of CLA, *cis*-9, *trans*-11 and *trans*-10, *cis*-12 in tissues differed from that in the CLA-enriched diet. In all tissues the relative proportion of the former isomer was lower than in the diet. The experiment demonstrated that feeding synthetic CLA to rabbits is a means of enriching rabbit meat with CLA, which could provide a healthier product for human consumption.

Keywords: rabbits; conjugated linoleic acid; fatty acids; meat quality; performance

Conjugated linoleic acid (CLA) is a collective name for positional and geometric conjugated isomers of octadecadienoic acid (C 18:2). Over the past decades multitude health benefits have been attributed to CLA in animal experiments (see review of Belury, 2002). Several reports on the effects of dietary CLA in farm animals exist, showing its potential to improve performance and decrease body fat mass. In pigs CLA increased rate of gain (Thiel-Cooper et al., 2001; Lauridsen et al., 2005), improved feed efficiency (Bee, 2001; Ramsay et al., 2001; Wiegand et al., 2001; Lauridsen et al., 2005) and reduced backfat thickness (Bee, 2001; Thiel-Cooper et al., 2001; Wiegand et al., 2001). However, in several other investigations no growth-enhancing effect of CLA in pigs was observed (Stangl et al., 1999; Muller et al., 2000; Ramsay et al., 2001; Gatlin et al., 2002). Szymczyk et al. (2001) found that body weight gains and feed intake of broiler chickens were significantly reduced by dietary CLA. On the other hand, Bolukbasi (2006) reported an increase in weight gain and feed intake, whereas

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Sirri et al. (2003) found no influence of dietary CLA on productive performance in poultry. In pigs (Bee, 2000, 2001; Gatlin et al., 2002; Smith et al., 2002; Lauridsen et al., 2005), poultry (Husveth et al., 2005), rabbits (Corino et al., 2007), and rats (Czauderna et al., 2003b) dietary CLA significantly increased the proportion of saturated fatty acids (SFA) at the expense of monounsaturated fatty acids (MUFA) in intramuscular and depot fat. This could be attributed to the depression of the activity of stearoyl-CoA desaturase by CLA (Belury, 2002). Commercially available CLA preparations are obtained by alkaline isomerization of linoleic acid and usually consist of two main isomers: *cis*-9, *trans*-11 and *trans*-10, *cis*-12 in approximately 1:1 ratio. Conversely, the *cis*-9, *trans*-11 CLA is the main CLA occurring naturally in foodstuffs (Martin and Valeille, 2002).

Rabbits are important laboratory animals, susceptible to atherogenic agents. Therefore several studies aimed at the effect of CLA on the development of atherosclerosis in rabbits fed diets enriched with cholesterol (Lee et al., 1994; Kritchevsky et al., 2000, 2004). In studies with New Zealand White rabbits Corino et al. (2002, 2003, 2007) concluded that the response of rabbits to dietary CLA depends on animal age and length of CLA feeding, as well as on the level of supplementation. The aim of the present study was to investigate the deposition of CLA isomers in tissues, and alterations in performance, meat quality and tissue fatty acid (FA) profiles in medium-size broiler rabbits fed diets supplemented with CLA.

MATERIAL AND METHODS

Animals and diets

Forty Hyplus rabbits of both sexes, weaned at 35 days of age, were housed individually in stainless mesh cages. The environmental temperature was kept at 16°C and the humidity was about 65%. The rabbits had *ad libitum* access to granulated feed and water. Ingredients and chemical composition of the basal diet is shown in Table 1. Rabbits of experimental groups were fed diets supplemented with a commercial CLA preparation (Luta-CLA® 60 from BASF, Germany) at 5 and 10 g/kg. CLA was added at expense of rapeseed oil, thus the diets were isoenergetic. Rabbits fed CLA-oil at 5 g/kg received CLA-supplemented diet for the whole fattening period (42 days), or from the 22nd to 42nd day after weaning. Thus, there were four feeding groups: control, 5 g CLA/kg for 21 or 42 days, and 10 g CLA/kg for 21 days. The CLA-oil contained *cis*-9, *trans*-11 CLA, *trans*-10, *cis*-12 CLA, other CLA isomers, oleic, palmitic and stearic acid at 319, 304, 16, 243, 64 and 39 mg/g of FA determined, respectively. Consumption of feeds was measured individually. Animals were weighed in one-week intervals. Rabbits were slaughtered at 77 days of age.

Table 1. Ingredient and determined chemical composition of the experimental rabbit diet*

Ingredients (g/kg)		Chemical composition (g/kg)	
Alfalfa meal	300	Dry matter	906
Wheat bran	260	Crude protein	166
Barley	145	Crude fibre	161
Oat	60	Fat	41
Sugarbeet pulp	40	Ash	73
Sunflower meal, extracted	130		
Soyabean meal, extracted	20		
Rapeseed oil	15		
Mineral supplement**	20		
Vitamin supplement	10		

*CLA-oil was supplemented at 5 and 10 g/kg at the expense of rapeseed oil

**limestone, dicalcium phosphate and salt

Carcass measurements

Hot carcass weight including head, liver, kidney and perirenal fat, was measured 15–30 min after slaughter. The carcass was chilled at 4°C and drip loss was measured during the period 0–24 h *post mortem*. Dressing percentage was calculated as a proportion of chilled carcass weight from live weight. The carcass was divided into a fore and hind part by cutting between the last thoracic and the first lumbar vertebra (Blasco and Ouhayoun, 1996).

Sampling and analyses

Loin and hindleg meat, hepatic tissue and perirenal fat were sampled, stored at –40°C and analyzed. Meat dry matter (DM) was determined by oven drying at 105°C, and fat by extraction with petroleum ether in a Soxtec 1043 apparatus (Tecator Comp., Sweden). Protein in meat was determined using a Kjeltec Auto 1030 Analyzer (Tecator Comp., Sweden). Hydroxyproline was determined by acid hydrolysis according to Diemair (1963).

FA composition of meat, liver and adipose tissue was determined after chloroform-methanol extraction of total lipids (Folch et al., 1957). Alkaline *trans*-methylation of FA was performed according to ISO 5509 (2001). Gas chromatography of methyl esters was performed using a HP 6890 chromatograph (Agilent Technologies, Inc.) with a programmed 60 m DB-23 capillary column (150 to 230°C). Fatty acids were identified on the basis of retention times corresponding to standards. Standards PUFA 1, PUFA 2, PUFA 3 and 37 Component FAME Mix (Supelco, Bellefonte, PA, USA) were used. Standard of vaccenic acid and conjugated methyl ester of linoleic acid was purchased from Sigma-Aldrich, Ltd. (Prague, Czech Republic). CLA isomers in Luta-CLA® 60 and rabbit tissues were determined using a HPLC instrument Shimadzu (VP series) equipped with three silver-impregnated ChromSpher 5 Lipids 250 × 4.6 mm (Varian) columns, in conjunction with a guard column 10 × 3 mm, containing the same stationary phase. Hexane with 0.56 ml/l acetonitrile was the mobile phase. The isocratic system was operated at 27°C on a column with a flow rate of 1 ml/min. Isomers *trans*-10, *cis*-12 and *cis*-9, *trans*-11 were identified on the basis of retention times (the former isomer was eluted first). Identification of other CLA isomers was based on comparison of the UV spectra of methylesters of CLA (Czauderna et al., 2003a). Peaks of absorbance at 231.9, 234.3 and 235.4 were characteristic of isomers *trans-*,*trans*-CLA, *cis-*,*trans-*/*trans-*,*cis*-CLA and *cis-*,*cis*-CLA, respectively.

Statistic analysis

Data were statistically analyzed by one-way analysis of variance using the GLM procedure of SAS, version 8.2 (SAS Institute, Cary, NC, USA.). Differences ($P < 0.05$) were identified by the Scheffe's test. Rabbits were housed individually, thus a rabbit was the experimental unit.

Table 2. Growth, feed intake and feed conversion in rabbits* fed a control diet and diets supplemented with CLA-oil** at 5 and 10 g/kg (mean values and residual mean square errors)

CLA-oil	0	5 g/kg		10 g/kg	RMSE
Days of CLA feeding	–	1–42	22–42	22–42	
Initial weight (g)	643	624	662	660	76
Final weight (g)	2 492	2357	2 439	2 433	215
Weight gain (g)	1 849	1 733	1 777	1 773	182
Feed intake (g)	5 205	4 785	4 862	5 118	526
Feed/gain (kg/kg)	2.82	2.76	2.74	2.89	0.35
CLA-oil intake (g)	–	23.9[a]	15.5[b]	31.5[c]	2.7

*10 rabbits/treatment

**the experiment lasted for 42 days; see Material and Methods section for details

[abc]values in the same row with different superscripts differ ($P < 0.05$)

Table 3. Carcass measurements in rabbits* fed a control diet and diets supplemented with CLA-oil** at 5 and 10 g/kg (mean values and residual mean square errors)

CLA-oil	0	5 g/kg		10 g/kg	RMSE
Days of CLA feeding	–	1–42	22–42	22–42	
Hot carcass weight (g)	1 435	1 346	1 391	1 404	128
Chilled carcass weight (g)	1 381	1 292	1 336	1 340	122
Drip loss (%)	3.76	4.01	3.95	4.56	0.29
Dressing (%)	55.4	54.8	54.8	55.1	2.2
Fore part weight (g)	652	596	605	613	65
Hind part weight (g)	597	567	586	580	62
Perirenal fat (g)	17.5	17.0	15.2	17.1	3.0

*10 rabbits/treatment

**the experiment lasted for 42 days; see Material and Methods section for details

RESULTS

Although CLA reduced feed intake by 1.7–8.1% and weight gains by 3.9–6.3%, differences were not significant (Table 2). Results of carcass measurements are presented in Table 3. There was no significant treatment effect on carcass composition, dressing percentage, drip loss and perirenal fat weight. CLA significantly increased the concentration of protein in hindleg meat by 4.6–6.1% (Table 4). Concentrations of dry matter, fat and hydroxyproline were not influenced. Dietary supplementation with CLA increased the proportion of SFA at the expense of MUFA in muscle and liver lipids (Table 5, 6). The effect of CLA on the proportion of SFA was significant ($P < 0.05$) in the loin meat of rabbits fed CLA-oil at 10 g/kg, and in the liver of rabbits fed CLA-oil at 5 g/kg for six weeks, or at 10 g/kg for three weeks. The MUFA proportion was significantly decreased in all rabbits

Table 4. Chemical composition of loin and hindleg meat of rabbits* fed a control diet and diets supplemented with CLA-oil** at 5 and 10 g/kg (mean values and residual mean square errors)

CLA-oil	0	5 g/kg		10 g/kg	RMSE
Days of CLA feeding	–	1–42	22–42	22–42	
Loin					
DM (g/kg)	253	254	253	254	7
Protein (g/kg)	216	217	215	217	6
Fat (g/kg)	8.5	9.1	8.9	8.2	2.3
Hydroxyproline (g/kg)	0.76	0.72	0.75	0.76	0.08
Hindleg					
DM (g/kg)	259	265	266	269	11
Protein (g/kg)	196[a]	208[b]	205[b]	206[b]	7
Fat (g/kg)	39.3	32.2	35.0	37.6	7.9
Hydroxyproline (g/kg)	1.39	1.47	1.43	1.39	0.12

*10 rabbits/treatment

**the experiment lasted for 42 days; see Material and Methods section for details

[ab]values in the same row with different superscripts differ ($P < 0.05$)

Table 5. Fatty acid profile (mg per g of fatty acids determined) of loin and hindleg meat of rabbits* fed a control diet and diets supplemented with CLA-oil** at 5 and 10 g/kg (mean values and residual mean square errors)

Sample	Loin					Hindleg				
CLA-oil	0	5 g/kg		10 g/kg	RMSE	0	5 g/kg		10 g/kg	RMSE
Days of treatment	–	1–42	22–42	22–42		–	1–42	22–42	22–42	
Saturated fatty acids										
12:0	0.9	1.0	1.2	1.1	0.3	2.0	2.0	1.9	1.7	0.6
14:0	17.1	18.4	21.1	21.4	3.2	21.8^{a}	21.8^{a}	25.3^{b}	24.0^{ab}	2.7
15:0	4.9	5.3	5.2	4.9	0.5	5.3^{ab}	5.8^{a}	5.6^{a}	5.2^{b}	0.3
16:0	247.1	245.1	258.8	259.5	16.0	242.9	247.5	255.2	253.1	16.8
17:0	5.5^{a}	6.9^{b}	6.4^{ab}	6.0^{ab}	0.4	5.6^{a}	7.1^{b}	6.1^{ab}	6.2^{ab}	0.9
18:0	67.8^{a}	81.6^{b}	80.8^{b}	87.3^{b}	6.5	57.8^{a}	77.1^{b}	71.3^{b}	74.4^{b}	6.5
Other SFA	6.3	5.0	6.7	9.8	3.5	5.0^{a}	1.3^{b}	1.8^{b}	4.2^{a}	1.5
Total SFA	349.6^{a}	363.3^{ab}	380.2^{ab}	390.0^{b}	19.3	340.4	362.6	367.2	368.8	21.9
Monounsaturated fatty acids										
14:1	1.7^{a}	0.5^{b}	0.6^{b}	0.8^{b}	0.5	2.3^{a}	0.7^{b}	0.8^{b}	1.1^{b}	0.7
16:1	28.7^{a}	8.2^{b}	10.4^{b}	12.5^{b}	6.6	35.5^{a}	10.2^{b}	12.9^{b}	16.0^{b}	8.1
18:1 n-9	272.3^{a}	242.4^{b}	241.5^{b}	246.5^{b}	11.4	299.8^{a}	267.4^{b}	265.3^{b}	271.4^{b}	12.6
18:1 n-7	18.2	17.6	16.8	17.0	1.3	16.8^{a}	15.4^{b}	15.0^{b}	14.6^{b}	0.8
20:1 n-9	3.5	3.5	3.8	3.3	0.4	4.6^{a}	4.2^{ab}	4.3^{ab}	3.8^{b}	0.4
Other MUFA	1.3	1.1	1.0	1.9	1.0	0.9	0.9	0.9	1.1	0.3
Total MUFA	325.7^{a}	273.3^{b}	274.1^{b}	282.0^{b}	15.5	359.9^{a}	298.8^{b}	299.2^{b}	308.0^{b}	15.7
Polyunsaturated fatty acids										
18:2n-6	217.8^{a}	242.4^{b}	229.4^{ab}	211.5^{a}	13.7	224.6^{ab}	237.0^{a}	233.0^{ab}	216.7^{b}	13.4
CLA	0.9^{a}	22.5^{b}	19.1^{b}	30.0^{c}	3.7	0.5^{a}	15.3^{b}	20.9^{b}	36.4c	3.9
18:3 n-3	35.4^{a}	39.2^{ab}	37.2^{ab}	31.7^{b}	4.8	51.7	49.8	51.2	47.5	4.3
20:2 n-6	3.2	3.5	3.6	3.2	0.5	2.7^{ab}	2.9^{ab}	3.1^{a}	2.5^{b}	0.4
20:3 n-6	4.6^{a}	3.0^{b}	3.5^{ab}	3.4^{b}	0.8	1.5	1.4	1.7	1.3	0.4
20:4 n-6	35.1^{a}	29.0^{ab}	29.2^{ab}	25.1^{b}	6.7	9.5	11.3	12.3	9.5	3.0
20:5 n-3	2.7	2.0	1.9	3.1	2.0	0.5	0.5	0.5	0.3	0.3
22:4 n-6	9.8	8.6	8.2	7.1	1.6	2.8	3.7	3.7	2.9	0.9
22:5 n-3	10.2	9.3	8.8	6.9	3.8	3.2	4.0	4.1	3.4	1.0
22:6 n-3	1.3	1.0	1.4	1.0	0.5	0.4	0.5	0.7	0.5	0.3
Other PUFA	3.7	2.9	3.4	5.0	2.8	2.3^{a}	12.2^{b}	2.4^{a}	2.2^{a}	2.4
Total PUFA	324.7^{a}	363.4^{b}	345.7^{ab}	328.0^{ab}	27.4	299.7^{a}	338.6^{b}	333.6^{b}	323.2^{ab}	20.1

*10 rabbits/treatment

**the experiment lasted for 42 days; see Material and Methods section for details

^{abc}values in the same row within section with different superscripts differ ($P < 0.05$)

Table 6. Fatty acid profile (mg/g of fatty acids determined) of liver and adipose tissue of rabbits* fed a control diet and diets supplemented with CLA-oil** at 5 and 10 g/kg (mean values and residual mean square errors)

Sample	Liver					Perirenal fat				
CLA-oil	0	5 g/kg		10 g/kg	RMSE	0	5 g/kg		10 g/kg	RMSE
Days of treatment	–	1–42	22–42	22–42		–	1–42	22–42	22–42	
Saturated fatty acids										
12:0	0.3^{a}	0.2^{ab}	0.1^{b}	0.2^{ab}	0.1	1.8^{a}	2.6^{ab}	3.2^{b}	2.1^{ab}	1.0
14:0	8.3^{a}	4.2^{b}	4.4^{ab}	3.6^{b}	3.1	20.1^{a}	20.8^{a}	25.1^{b}	21.9^{a}	2.1
15:0	3.0	2.5	2.3	2.2	0.6	5.3^{a}	6.1^{b}	6.2^{b}	5.2^{a}	0.4
16:0	222.9^{a}	168.0^{b}	182.1^{b}	171.9^{b}	28.6	233.9	216.5	220.4	231.1	22.0
17:0	7.2^{a}	9.2^{ab}	9.7^{b}	10.2^{b}	1.6	5.7^{a}	7.0^{b}	6.6^{ab}	6.4^{ab}	0.4
18:0	143.2^{a}	228.1^{b}	246.8^{bc}	288.5^{c}	32.3	53.1^{a}	63.0^{ab}	57.6^{ab}	65.2^{b}	7.9
Other SFA	2.7^{a}	8.0^{b}	3.6^{a}	4.4^{a}	2.0	5.0	4.9	6.3	3.2	2.7
Total SFA	387.6^{a}	420.2^{ab}	449.0^{b}	481.0^{c}	40.5	324.9	320.9	325.4	335.4	29.3
Monounsaturated fatty acids										
14:1	0.5^{a}	0.2^{b}	0.2^{b}	0.2^{b}	0.2	2.1^{a}	0.6^{b}	0.8^{b}	1.0^{b}	0.7
16:1	13.3^{a}	3.8^{b}	4.0^{b}	4.4^{b}	2.7	33.4^{a}	8.7^{b}	12.1^{b}	14.4^{b}	8.0
18:1 n-9	213.0^{a}	153.9^{b}	151.9^{b}	146.8^{b}	32.2	308.9	296.2	297.2	292.2	13.2
18:1 n-7	16.2^{a}	10.3^{b}	9.6^{b}	10.1^{b}	1.9	16.9^{a}	15.6^{b}	15.7^{b}	15.1^{b}	0.8
20:1 n-9	6.0^{a}	3.7^{b}	4.0^{b}	3.3^{b}	1.1	5.3^{a}	4.8^{ab}	5.0^{ab}	4.4^{b}	0.5
Other MUFA	1.2	1.5	1.5	2.8	1.6	0.8	0.7	1.0	0.7	0.4
Total MUFA	250.7^{a}	173.4^{b}	171.2^{b}	166.6^{b}	36.4	367.4^{a}	326.6^{b}	331.8^{b}	327.8^{b}	15.0
Polyunsaturated fatty acids										
18:2 n-6	262.3	296.2	281.9	269.0	38.9	236.3^{ab}	251.7^{a}	249.0^{ab}	228.2^{b}	17.1
CLA	0.6^{a}	11.5^{bc}	9.6^{b}	14.4^{c}	3.5	0.5^{a}	29.7^{b}	22.9^{c}	43.7^{d}	5.0
18:3 n-3	19.6^{a}	18.6^{ab}	15.1^{ab}	13.3^{b}	4.2	62.5	64.1	63.0	58.8	5.3
20:2 n-6	11.5	11.5	12.9	10.2	2.8	2.4^{a}	2.2^{ab}	2.4^{a}	1.8^{b}	0.4
20:3 n-6	6.6^{a}	5.0^{b}	5.0^{b}	3.4^{c}	1.1	0.4	0.3	0.4	0.3	0.1
20:4 n-6	43.5	43.4	38.9	29.3	12.1	1.4^{a}	0.8^{b}	1.0^{b}	0.8^{b}	0.2
20:5 n-3	0.9^{ab}	1.9^{a}	0.6^{b}	1.0	1.0^{ab}	0.2	0.2	0.2	0.2	0.1
22:4 n-6	6.5^{ab}	6.6^{a}	5.9^{ab}	3.5^{b}	1.4	0.7	0.6	1.1	0.5	0.8
22:5 n-3	4.9	5.9	5.1	4.8	1.0	1.0	0.8	0.9	0.8	0.2
22: 6 n-3	1.8	1.8	1.7	2.4	1.4	0.1	0.1	0.1	0.1	0.0
Other PUFA	3.5	4.0	3.1	1.0	2.9	2.2	2.0	1.8	1.7	0.5
Total PUFA	361.7	406.4	379.8	352.4	58.2	307.7^{a}	352.5^{b}	342.8^{b}	336.8^{ab}	24.0

*10 rabbits/treatment

**the experiment lasted for 42 days; see Material and Methods section for details

^{abcd}values in the same row within section with different superscripts differ ($P < 0.05$)

Table 7. CLA isomers (mg/g of total CLA) in CLA-oil*, loin and hindleg meat, liver and perirenal fat of rabbits fed diets supplemented with CLA-oil (mean values and residual mean square errors)

Sample	CLA-oil* (g/kg diet)	Days of CLA feeding	CLA isomers				
			Σ *t,t*	*c*-9,*t*-11	*t*-10,*c*-12	Σ *c,c*	other CLA
CLA-oil**	–	–	3.5	499.1	476.3	10.9	10.2
Loin	5	1–42	6.9[a]	464.9[a]	466.4[a]	9.8	52.0
	5	22–42	7.1[a]	476.2[a]	476.6[a]	9.8	30.3
	10	22–42	7.0[a]	474.0[a]	459.5[a]	7.4	52.1
		RMSE	3.5	42.4	38.5	4.5	52.3
Hindleg	5	1–42	7.3[a]	435.2[a]	534.3[b]	10.4	12.8
	5	22–42	7.3[a]	429.8[a]	537.0[b]	10.8	15.1
	10	22–42	6.9[a]	438.9[a]	531.5[b]	10.7	12.0
		RMSE	1.1	16.3	13.4	1.0	25.4
Liver	5	1–42	15.9[b]	458.0[a]	489.8[ab]	6.4	29.9
	5	22–42	17.0[b]	458.0[a]	477.8[ab]	7.8	39.4
	10	22–42	22.5[b]	460.0[a]	461.6[a]	7.9	48.0
		RMSE	7.4	55.6	48.1	5.3	54.2
Fat	5	1–42	6.4[a]	386.4[b]	535.8[b]	10.6	60.8
	5	22–42	6.4[a]	393.7[b]	540.2[b]	9.9	49.8
	10	22–42	6.0[a]	400.6[b]	540.8[b]	11.0	41.6
		RMSE	0.9	38.1	60.6	3.1	77.0

*the experiment lasted for 42 days; see Material and Methods section for details

**the CLA-oil contained *cis*-9, *trans*-11 CLA, *trans*-10, *cis*-12 CLA, other CLA isomers, oleic, palmitic and stearic acid at 319, 304, 16, 243, 64 and 39 mg per g of FA determined, respectively

[ab]means in the same column with different superscripts differ ($P < 0.05$)

receiving CLA. Dietary CLA significantly increased the proportion of PUFA in lipids of loin in rabbits fed CLA-oil at 5 g/kg for six weeks, and in lipids of hindleg meat of rabbits fed CLA-oil at 5 g/kg. The PUFA proportion was significantly increased in perirenal fat of rabbits fed CLA-oil at 5 g/kg, but not in lipids of the liver. Supplementation of the rabbit diet with CLA increased the CLA concentration in meat from < 1 mg/g FA up to 30 mg/g FA in the loin, and 36 mg/g FA in the hindleg. Adipose and hepatic tissue incorporated the greatest and the lowest amount of CLA, respectively. In all tissues CLA concentration significantly increased with an increasing CLA percentage in the diet. Effect of the length of CLA feeding (3 vs 6 weeks) in rabbits fed CLA-oil at 5 g/kg on CLA concentration in tissues was not significant, except for CLA concentration in perirenal fat, which was lower in rabbits fed CLA for six weeks.

CLA-oil contained by 4.8% more *cis*-9, *trans*-11 CLA than *trans*-10, *cis*-12 CLA (Table 7). On the contrary, in lipids of hindleg meat, liver and perirenal fat the latter isomer was present at higher concentration. Minor CLA isomers represented 6.08%, 2.95%, 6.49%, and 6.75% of total CLA in the loin and hindleg meat, liver and perirenal fat, respectively. Only 2.46% of these isomers were present in the CLA fraction of the CLA-oil used. Significant differences occurred in amount of different CLA isomers in analyzed tissues. Hepatic lipids contained relatively more *trans*-, *trans*- isomers than lipids of other tissues. The highest proportion of *trans*-10, *cis*-12 CLA was in lipids of hindleg meat and perirenal fat.

DISCUSSION

In the present study no improvement in weight gain and feed conversion of rabbits due to dietary inclusion of CLA were observed, which is consistent with results of Lee et al. (1994) and Corino et al. (2002, 2003, 2007). Also, carcass measurements and chemical composition of meat were only marginally affected, illustrating that the main effect of CLA feeding to rabbits were alterations of the FA profile of the meat. Dietary CLA increased the proportion of SFA at the expense of MUFA in muscle and liver lipids of rabbits, which was observed also in other animal species: pigs (Bee, 2000, 2001; Gatlin et al., 2002; Smith et al., 2002; Lauridsen et al., 2005), poultry (Husveth et al., 2005), rabbits (Corino et al., 2007), and rats (Czauderna et al., 2003b). Effect of CLA on the MUFA proportion was more pronounced than on SFA and PUFA proportion. CLA supplementation significantly increased CLA concentration in meat, liver and fat in all CLA-fed rabbits. Contrary to expectation, the proportion of CLA in FA hepatic lipids was elevated less than in meat lipids. As expected, concentration of CLA in tissues significantly increased with increasing dietary CLA content (5 vs. 10 g/kg). However, duration of CLA feeding before slaughter (3 vs. 6 weeks) had no effect on CLA deposition in tissues with exception of CLA concentration in perirenal fat. Thus, dietary inclusion of CLA at higher concentration (10 g/kg) and feeding CLA-supplemented diet for a shorter period (three weeks before slaughter) seems to be more suitable for production of CLA-containing rabbit meat. Small amounts of CLA in tissues of control rabbits (0.5 to 0.9 mg/g FA) may result from metabolism of unsaturated FA in the caecum and ingestion of caecotrophs.

The ratio of the two most abundant isomers of CLA, *cis*-9, *trans*-11 and *trans*-10, *cis*-12 in tissue lipids differed from that in the CLA-enriched diet. In all tissues the relative proportion of the former isomer was lower than in the CLA-oil. Rabbits differ in this respect from growing pigs (Bee, 2001; Thiel-Cooper et al., 2001), sows (Bee, 2000), laying hens (Yang et al., 2003), broilers (Suksombat et al., 2007) and rats (Czauderna et al., 2003b). In these animal species a higher incorporation was observed for *cis*-9, *trans*-11 CLA than for *trans*-10, *cis*-12 CLA. CLA isomers are readily metabolized via multiple metabolic pathways involving β-oxidation, elongation and desaturation (Belury, 2002). CLA fractions Σ *cis*-9, *trans*-11, Σ *cis*-, *cis*-, and other CLA thus may include conjugated FA other than C 18:2. Metabolism of CLA and selective deposition of CLA isomers may explain differences in relative composition of CLA in the four tissues.

CLA has been reported to have several beneficial physiological effects, e.g. been antiadipogenic, antidiabetogenic, anticarcinogenic and antiatherosclerotic (Belury, 2002). Short-time health-promoting effects of CLA are inconclusive in humans (Bhattacharya et al., 2006), questionable results, however, might reflect ethical and methodological limitations for the development of randomized controlled clinical trials, rather than different molecular mechanisms of CLA action in animals and humans. Thus, incorporation of CLA into tissue lipids could mean potentially healthier rabbit products. Beef and dairy products are currently the major sources of human dietary CLA intake. Biological effects of CLA are isomer specific. The *trans*-10, *cis*-12 CLA, which was the main CLA isomer in lipids of hindleg meat, liver and perirenal fat of rabbits in this study, is more effective at lowering adipose tissue mass than the *cis*-9, *trans*-11 CLA (Belury, 2002). The increase in SFA of rabbit meat is not advantage from the point of view of a more healthy meat, atherogenic FA (myristic and palmitic, see Clarke et al., 1997), however, were increased only marginally.

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