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CHANGE OF THE BACKFAT FATTY ACID PROFILE OF CROSSBRED PIGS FED WITH THE FODDER WITH ADDITION OF SUNFLOWER OIL AND CONJUGATED LINOLEIC ACID

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Abstract

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The aim of the research was to compare the backfat fatty acid profile of pigs fed with sunflower oil (SFO) and conjugated linoleic acid (CLA) and animals not receiving SFO or CLA addition (control group). The experiment covered 116 crossbred pigs, divided into three groups: two experimental (n = 40) and control (n = 36). In the experimental groups animals were fed the fodder with addition of 2 % sunflower oil (SFO) or conjugated linoleic acid (CLA). The fatteners were kept and fed in uniformed conditions. The animals were slaughtered at 120 kg of body weight. The fatty acid profile was determined on backfat samples from each animal using gas chromatography. The pigs from experimental groups had higher content of saturated fatty acids (SFA) and hypercholesterolemic acids (OFA) and also lower content of unsaturated fatty acids (UFA, MUFA) and hypocholesterolemic acid (DFA) as compared to the animals from the control group, which was confirmed by statistical differences.

Key words: sunflower oil, conjugated linoleic acid, pigs, backfat

Introduction

Conjugated linoleic acid (CLA) is one of the supplements which impact the improving of pro-healthy values of pork. Many of pro-health benefits of this acid have been described so far, i.e.: stimulation of the immune system, anti-tumor activities, anti-atherosclerotic effects, regulation of the blood glucose level, effect against combats allergies and asthma (Bassaganya-Riera et al., 2002; Basu et al., 2000; Bawa, 2003; Hontecillas et al., 2002; Ip et al., 2003; Kritchevsky, 2000; MacDonald, 2000; McCarty, 2000; Panczenko-Kresowska and Ziemlański, 2001; Pfeuffer, 2001; Watkins and Seifert, 2000; Whigham et al., 2002). Many genetics factors, i.e. breed and environmental factors, including feeding (Raj et al., 2004) and also growth and development of experimental animals (Walkiewicz et al., 2001) influence fatty acid profile of pig tissues. The gender of pigs may impact on the carcass traits and the fatty acid profile (Koczanowski et al., 2004; Urbańczyk et al., 2002). The gilts backfat contained 1.20% less saturated and 1.59% more polyunsaturated fatty acids than the barrows backfat (Koczanowski et al. 2004).

Azain et al. (2000) in the research performed on the rats confirmed the reduction of the monounsaturated fatty acids amount in the adipose tissue of rodents receiving the supplementation of conjugated linoleic acid. Pieszka et al. (2004) observed that the decrease of triglycerides content, total cholesterol level and its HDL fraction in blood plasma occurred with the increase of CLA addition into diet.

Weber et al. (2001) in the experiment carried out to determine the effectiveness of conjugated linoleic acid supplementation into fodder as a factor to progress the growth of new born pigs indicated that addition of 0.6% CLA did not cause raise of the growth rate of piglets. Nevertheless Pieszka et al. (2003) did not state the negative impact of conjugated linoleic acid on the results of the growth of pigs.

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The aim of the research was to compare the backfat fatty acid profile of pigs fed with sunflower oil (SFO) and conjugated linoleic acid (CLA) and animals not receiving SFO or CLA addition (control group).

Material and Methods

The experiment was conducted in the Czech Republic in a Bonagro a.s. agricultural company. It covered 116 crossbred pigs (PLEBO hybrids Brno). They were divided into three groups: two experimental (n = 40) and control (n = 36).

Varied diets were used according to the following scheme: Group:

1 – Diet of 2.0% amount of sunflower oil (SFO)

2 – Diet of 2.0% amount of conjugated linoleic acid (CLA)

3 – Control diet (C)

At the beginning of the experiment the pigs were individually weighted, numbered and grouped by gender. The addition of diet 1 and 2 began at the moment when the weight of the pigs was 82 kg, averagely. The slaughter was carried out when the weight was 120 kg, averagely. Conditions for the maintenance, care and nutrition of all experimental fatteners were standardized. Diet was available *semi ad libitum*. Feed composition is shown in Table 1. It was prepared in Bonagro a.s.

The source of conjugated linoleic acid was Luta-CLA® 60 preparation made by BASF of CLA (C 18:2) containing min. 56%, including c9 t11 isomer min. 28% and t10 c12 isomer min. 28%.

Fatty acid profile was determined in the samples of backfat from each animal. Gas chromathography was used – Varian 3400 Gas Chromatograph, equipped with DB-23 capillary column.

The results were statistically processed – mean ($\bar{x}$) and standard deviation (s) were calculated. The significance of differences between tested groups was verified by Duncan's test. A computer program Statistica 8.0 PL (2008) was used.

Table 1
Content of the fodder, %

Components	Group		
	1 (SFO)	2 (CLA)	3 (C)
Wheat	10.0	10.0	10.0
Wheat bran	10.0	10.0	10.0
Soybean meal	10.0	10.0	10.0
Mikrop A1-CDP-19	2.6	2.6	2.6
Corn	65.4	65.4	67.4
Sunflower oil	2.0	-	-
Conjugated linoleic acid	-	2.0	-
Total	100	100	100

Results

The backfat fatty acid profile of pigs fed the fodder with addition of sunflower oil, conjugated linoleic acid and control group was given in a Table 2.

The lowest concentration of C10:0 acid (decanoic acid) appeared in a control group of animals (0.11%), the highest concentration in the case of individuals from the experimental groups (0.13%). Statistically high significant differences were observed between group 3 and 1, 2.

The lowest concentration of C12:0 (lauric acid) and C14:0 (myristic acid) characterized the control group of animals (0.11 and 1.96%, respectively), the highest occurred in the case of individuals from the group given conjugated linoleic acid (0.15 and 2.46%, respectively). The 1 group of pigs fed the diet with the share of SFO got the intermediate results. In case of both discussed acids, i.e. C12:0 and C14:0 statistically high significant differences between group 3 and 1, 2 and also between 1 and 2 were confirmed.

Similarly, the lowest concentration of C15:0 IS and C16:0 (palmitic acid) was noted in a control group of animals (0.13 and 35.22%, respectively). However, the highest was observed in the case of individuals from the group given the addition of sunflower oil (0.16 and 37.15%, respectively). The group of pigs fed with the addition of CLA obtained the result close to group 1 (SFO). Statistically high significant differences between the control group and the experimental groups were proved.

The highest concentration of C16:1n7c (palmitoleic acid) was shown in the individuals from the control group (1.72%), however the lowest (1.54%) was in the individuals from the group given sunflower oil. Between the mentioned groups of pigs statistically significant difference was confirmed.

In the case of the next three acids i.e. C18:0, C18:1n9c, C18:1n7c statistically high significant differences between group 3 and 1, 2 were observed. The lowest concentration of the C18:0 acid was in the control group of animals (21.09%). The highest concentration was in the group given conjugated linoleic acid (23.61%). The acids C18:1n9c and C18:1n7c in the highest concentration were in the control group (32.77 and 2.26%, respectively).

The highest concentration of C20:0 acid was proved in the group of animals given sunflower oil (0.41%), the lowest concentration in the control group (0.36%). It was confirmed by a statistically high significant difference between these groups.

The highest concentration of C20:1n9c was shown in the individuals from the control group (0.71 %). However, the lowest (0.58 and 0.60%) in the individuals from the group given conjugated linoleic acid and sunflower oil. Statistically significant differences between control group and experimental groups were proved.

Table 2
Fatty acid profile in backfat, %

Fatty acids	Statistical measure	Group			Total	Significance of differences	
		1 (SFO)	2 (CLA)	3 (C)		P≤0.05	P≤0.01
Number	n	40	40	36	116		
C10 : 0	$\bar{x}$ s	0.13±0.02	0.13±0.02	0.11±0.02	0.13±0.02	-	3-1.2
C12 : 0	$\bar{x}$ s	0.13±0.02	0.15±0.02	0.11±0.02	0.13±0.02	-	1-2.3; 2-3
C14 : 0	$\bar{x}$ s	2.28±0.26	2.46±0.25	1.96±0.18	2.24±0.31	-	1-2.3; 2-3
C15 : 0 IS	$\bar{x}$ s	0.16±0.03	0.15±0.04	0.13±0.03	0.15±0.04	-	3-1.2
C16 : 0	$\bar{x}$ s	37.15±2.24	36.66±2.18	35.22±1.74	36.38±2.21	-	3-1.2
C16 : 1n7c	$\bar{x}$ s	1.54±0.30	1.59±0.34	1.72±0.29	1.62±0.32	1-3	-
C18 : 0	$\bar{x}$ s	22.81±2.20	23.61±2.38	21.09±2.19	22.55±2.47	-	3-1.2
C18 : 1n9c	$\bar{x}$ s	28.69±2.53	28.10±2.60	32.77±2.73	29.75±3.30	-	3-1.2
C18 : 1n7c	$\bar{x}$ s	1.90±0.28	1.90±0.31	2.26±0.30	2.01±0.34	-	3-1.2
C18 : 2n6c	$\bar{x}$ s	3.97±1.82	4.03±1.46	3.33±1.09	3.79±1.52	-	-
C18 : 3n3c	$\bar{x}$ s	0.07±0.05	0.07±0.04	0.07±0.03	0.07±0.04	-	-
C20 : 0	$\bar{x}$ s	0.41±0.07	0.39±0.06	0.36±0.05	0.39±0.06	-	1-3
C20 : 1n9c	$\bar{x}$ s	0.60±0.08	0.58±0.07	0.71±0.14	0.63±0.11	-	3-1.2
C20 : 2n6c	$\bar{x}$ s	0.17±0.08	0.17±0.06	0.16±0.05	0.17±0.06	-	-

Statistically high significant differences between the tested groups of pigs were not confirmed in following acids: C18:2n6c, C18:3n3c and C20:2n6c.

In the Table 3 was given the total amount of saturated and unsaturated (mono and polyunsaturated) fatty acids and also their ratio in the backfat of pigs.

In the case of the saturated fatty acids (SFA), unsaturated fatty acids (UFA) and monounsaturated fatty acids (MUFA) statistically high significant differences between group 3 and groups 1, 2 were observed. The lowest concentration of the saturated fatty acids was in the control group (58.98%). In the share of unsaturated and monounsaturated fatty acids was the highest in the control group (41.02 and 37.46%, respectively) as compared to the experimental groups.

In two following tested groups of acids – polyunsaturated fatty acids (PUFA) and essential fatty acids (EFA) statistically significant differences were not proved.

Hypercholesterolemic acids (OFA) in the lowest concentration were in a control group (37.18%) as compared to the experimental groups of animals given the sunflower oil or conjugated linoleic acid.

Conversely, in a control group hypocholesterolemic acids (DFA) were in the highest concentration (62.11%).

The most wide ratio of acids: DFA: OFA (1.68%), MUFA: SFA (0.64%) and UFA:SFA (0.70%) characterized the control group of animals as compared to the experimental groups. On the other hand, in the case of acids PUFA: MUFA the control group had the narrowest of their ratio (0.10%).

Table 3
Amount of fatty acids in backfat, %

Fatty acids	Statistical measure	Group			Total	Significance of differences	
		1 (SFO)	2 (CLA)	3 (C)		P≤0.05	P≤0.01
Number	n	40	40	36	116	-	-
SFA	$\bar{x}$ s	63.06±4.09	63.55±3.96	58.98±3.60	61.97±4.36	-	3-1.2
UFA	$\bar{x}$ s	36.94±4.09	36.45±3.96	41.02±3.60	38.03±4.36	-	3-1.2
MUFA	$\bar{x}$ s	32.72±2.95	32.18±3.13	37.46±3.18	34.01±3.85	-	3-1.2
PUFA	$\bar{x}$ s	4.21±1.94	4.27±1.55	3.56±1.16	4.03±1.61	-	-
EFA	$\bar{x}$ s	4.04±1.87	4.10±1.50	3.40±1.12	3.86±1.56	-	-
OFA	$\bar{x}$ s	39.42±2.45	39.12±2.39	37.18±1.87	38.62±2.45	-	3-1.2
DFA	$\bar{x}$ s	59.75±2.50	60.06±2.44	62.11±1.91	60.59±2.52	-	3-1.2
DFA : OFA	$\bar{x}$ s	1.53±0.16	1.54±0.16	1.68±0.14	1.58±0.17	-	3-1.2
MUFA : SFA	$\bar{x}$ s	0.52±0.08	0.51±0.08	0.64±0.09	0.56±0.10	-	3-1.2
UFA : SFA	$\bar{x}$ s	0.59±0.10	0.58±0.10	0.70±0.10	0.62±0.11	-	3-1.2
PUFA : MUFA	$\bar{x}$ s	0.13±0.06	0.13±0.05	0.10±0.03	0.12±0.05	-	3-1.2
PUFA : SFA	$\bar{x}$ s	0.07±0.04	0.07±0.03	0.06±0.02	0.07±0.03	-	-
n 6	$\bar{x}$ s	4.14±1.89	4.20±1.51	3.49±1.13	3.96±1.58	-	-
n 3	$\bar{x}$ s	0.07±0.05	0.07±0.04	0.07±0.03	0.07±0.04	-	-
n 7	$\bar{x}$ s	30.14±2.88	33.88±3.41	7.33±12.74	24.35±13.79	1-2	3-1.2
n 9	$\bar{x}$ s	29.28±2.57	28.68±2.62	33.48±2.83	30.38±3.38	-	3-1.2
n 6 n 3	$\bar{x}$ s	69.25±19.64	70.63±33.38	53.43±11.84	64.81±24.71	-	3-1.2

In 6 above mentioned groups of acids (i.e.: DFA, DFA: OFA, MUFA: SFA, UFA: SFA and PUFA: MUFA) statistically high significant differences between the control and the experimental groups were proved.

Statistically significant differences were not confirmed in case of the PUFA: SFA ratio and also acids from n6 and n3 family.

The acids from n7 family were in the lowest concentration in the control group (7.33%), then in the group of animals given sunflower oil (30.14%) and conjugated linoleic acid (33.88%). It was confirmed by statistical differences between group 3 and 1, 2 ($P \leq 0.01$) and group 1 and 2 ($P \leq 0.05$).

In the case of acids from n9 family the highest of their concentrations was observed in the control group (33.48%) as compared to the experimental groups. Between the control and experimental groups statistically high significant differences were confirmed.

Similarly, between the control and experimental groups statistically high significant differences were confirmed in the case of n6:n3 acids ratio. Their lowest concentration was found in control group (53.43%).

Discussion

In the previous own research (Čechová et al., 2012) the authors observed, that pigs from the experimental groups given sunflower oil or conjugated linoleic acid addition had higher amount of polyunsaturated fatty acids (PUFA) and essential fatty acids (EFA) as compared to the animals from the control group, which was confirmed by statistical differences. However, in other research Wasilewski et al. (2011) did not confirm the effect of the addition of conjugated linoleic acid or sunflower oil on the fatty acid profile of pig tissues.

It should be remembered, that the adipose tissue with a high ratio of unsaturated fatty acids is greasy and soft (Larsen et al., 2009; White et al., 2009). In technological processes this is not always a desirable trait. Current efforts aim to obtain animals characterized by a high body meat content of an appropriate fatty acid profile. This is consistent with results of previous own studies of the authors (Čechová et al., 2012) carried out on the same animals. Also Jiang et al. (2010) proved that the addition of CLA to the feed for pigs has increased the content of lean meat (from 3.5 to 4.7%) and intramuscular fat.

Migdał et al. (1999) in their research proved that the ratio of unsaturated to saturated fatty acids and the amount of essential fatty acids in the loin and backfat depends on the pigs feeding, especially on the share of the fodders with high amount of linoleic and linolenic acids in the fodder doses.

Ostrowska et al. (2003) and Tischendorf et al. (2002) showed that the pigs given CLA supplementation had higher its level in the adipose tissue. The impact of conjugated linoleic acid on the backfat fatty acids composition was also confirmed by Bee (2000). Similarly, Thiel-Cooper et al. (2001) proved a linear increase of conjugated linoleic acid in subcutaneous fat of the pigs ($P \leq 0.001$).

Wasilewski et al. (2012) observed that the beneficial consequence of conjugated linoleic acid supplementation was the decrease of saturated fatty acids amount and the increase of unsaturated fatty acids amount in the adipose tissue (backfat) of the pigs as compared to the fatteners given sunflower oil. The monounsaturated fatty acids amount in the backfat decreased with increasing the conjugated linoleic acid or sunflower oil amounts in the fodder.

The impact of CLA addition into the fodder on the change of fatty acids profile was not proved by Stangl et al. (1999), which were observed in others experiments.

The studies of other authors Bee (2001), Eggert et al. (2001) and Pieszka et al. (2004) proved that the pigs from the group given addition of conjugated linoleic acid had higher content of saturated fatty acids and lower content of monounsaturated fatty acids in tissues.

The impact of given flax seeds on the increase of the unsaturated fatty acids amount were the subject of research of Grześkowiak et al. (2002). The backfat of animals fed with the fodder with flax seeds addition contained 5.39% more polyunsaturated fatty acids as compared to the control group. The n6 to n3 ratio, belonging to polyunsaturated fatty acids in the fatteners backfat from the tested group decreased to 2.78 and in the control group was 7.05.

Migdał et al. 2001 in their research proved that the internal part of backfat has more saturated fatty acids than the external part. Therefore, the fatty acid profile samples from the dorsal and lumbar part of backfat and also from their external and internal part may be diverse.

Conclusions

Summarizing obtained results it should be stated that the pigs from the experimental groups given addition of sunflower oil or conjugated linoleic acid had higher content of saturated fatty acids (SFA) and hypercholesterolemic acids (OFA) and also lower content of unsaturated fatty acids (UFA, MUFA) and hypocholesterolemic acids (DFA) as compared to the animals from the control group, which was confirmed by statistical differences. This fatty acid profile is not preferred in the rational human nutrition. However, in sausages production technology where pork fat, including backfat is used, not a greasy backfat is preferred thus of higher content of saturated fatty acids.

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