EFFECT OF SUNFLOWER IN PIG DIET ON FATTY ACID CONTENT IN MUSCLE AND FAT TISSUE OF FATTENING PIGS

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Abstract

The aim of the study was to determine the effect of sunflower meal in feed mixture for fattening pigs on fatty acid composition of *M. longissimus dorsi* and backfat samples. Twenty crossbred gilts were divided into two groups and fed *ad libitum* with control diet (C) or diet containing sunflower meal (S). The content of saturated fatty acids (SFA) was higher in muscle tissue of pigs fed control diet ($P<0.001$) but there was not found significant difference between control and experimental group ($P>0.05$) in backfat samples. The monounsaturated fatty acids (MUFA) concentration was higher in both muscle and fat tissue ($P<0.01$-0.001) of control pigs. On the other hand, total polyunsaturated fatty acids (PUFA) content was higher in muscle and fat samples of pigs fed sunflower diet ($P<0.001$). The n-6/n-3 PUFA ratio was lower in control group compared to experimental group ($P<0.001$).

Keywords: Pig, sunflower, fatty acid

Lipids are important component of food. They have several functions in organism. Fat is added to the feed mixture as a source of energy. It is also source of fatty acids and can contribute to fatty acid composition in final product of animal production (Gläser et al., 1999). Feed mixture based on cereals provides n-6 fatty acids and only small amount of n-3 polyunsaturated fatty acids. The components with higher proportion of n-3 fatty acids must be added to feed in order to meat fatty acid profile alternation. The composition of feed mixture is one of the major factors, it is able to effect the most important parameters of meat quality. In pig diet, an emphasis is laid on the omega-3 fatty acids in fish oil and vegetable oils (soy, olive, linseed, sunflower, rapeseed). An interest in the composition of fatty acids of meat stems mainly from the need to find ways of producing healthier meat, i.e. with a higher ratio of polyunsaturated fatty acids (PUFA) to saturated fatty acids (SFA) and a more favourable balance between n-6 and n-3 PUFA (Wood et al., 2004). In recent years the interest in conjugated linoleic acid (CLA) which is important for human health was increased. CLA is a collective term for group of positional and geometric isomers of linoleic acid with conjugated double bond system (Hur et al., 2007).

Material and Methods

Crossbred gilts were divided into two groups (10 animals in each group) and fed with feed mixtures-control (C), sunflower diet (S) with 5 % of sunflower meal. Both mixtures control and experimental had very similar content of crude protein and energy. Nutrient and chemical composition of feed mixtures is given in Table 1, fatty acid content in feed mixtures is documented in Table 2. The average live weight of gilts was 86.36 ± 11.66 kg at the start of the experiment, final live weight was 140.55 ± 11.43 kg. The samples for laboratory analysis were collected 24 hours after slaughter. Gas chromatograph Agilent Technologies HP 6890 was used for analysis of fatty acid composition in *M.longissimus dorsi* and backfat samples. The lipid fraction was isolated by the method according to Folch et al. (1957), the preparation of the fatty acid methyl esters was done in accordance with CSN ISO 5509, fatty acid methyl esters were analysed according to CSN ISO 5508. The gas chromatograph was equipped with DB-23 cyanopropyl-methylpolysiloxane column (60m x 0.25 mm x 0.25 μm). Nitrogen was used as carrier gas (flow rate 0.8 ml/min). The temperature regime was following: 120°C for 6 min, the temperature was raised to 170°C (15°C/min) and then to 210°C (3°C/min). This temperature was held for 13.5 min. Subsequently, the temperature was increased to 230° C (40°C/min) and kept constant for 7 min. FID detector temperature was 260°C. Fatty acids were determined by comparison with standards (37 Component FAME Mix, PUFA No. 1, PUFA No. 2, PUFA No. 3; Sigma-Aldrich).The statistical evaluation was performed using the computer program QCExpert (TriloByte Statistical Software Ltd.)

Results and Discussion

The fatty acid content was measured in *M. longissimus dorsi et thoracis* samples and backfat samples of pigs fed control (C) and experimental (S) group (5 % of sunflower meal in feed mixture). The results of fatty acid analysis of M. longissimus dorsi samples are given in Table 3. There was found a higher ($P<0.001$) content of total saturated fatty acids (SFA) in muscle tissue samples in control group (40.96 ± 1.26 g/100 g of total FA) compared to S group (38.08 ± 0.87 g/100 g). The total monounsaturated

fatty acid (MUFA) content was also higher in *M. longissimus dorsi* of C group (48.04 ± 0.98 g/100 g) than in S group (46.39 ± 0.89 g/100 g). The total polyunsaturated fatty acid (PUFA) concentration was significantly higher (P<0.001) in S group (15.53 ± 1.61 g/100 g) than in C group (10.99 ± 1.55 g/100 g). In the experimental (S) group, the concentrations of linoleic, arachidonic and EPA acid were significantly (P<0.001) higher (10.77 ± 1.11 g/100 g; 2.02 ± 0.36 g/100 g; 0.06 ± 0.01 g/100 g) compared to control group (7.32 ± 0.92 g/100 g; 1.41 ± 0.47 g/100 g; 0.03 ± 0,01 g/100 g). On the other hand, the concentration of α-linolenic acid was lower in S group (0.53 ± 0.03 g/100 g). According Pieszka (2007) the inclusion of palm, linseed, rapeseed or sunflower oil into feed mixture had a significant effect on fatty acid content in *M. longissimus dorsi*. Rey et al. (2001) studied the effect of sunflower oil in pig diet on fatty acid profile in *M. longissimus dorsi*. The diet containing 20 g/kg of sunflower oil had high content of linoleic acid and low concentration of α-linolenic acid. Significantly lower content of total MUFA was found in muscle samples from pigs fed with sunflower diet.

The total SFA content was not influenced by the diet. In the experimental group was significantly higher proportion of PUFA and n-6 PUFA.

The n-6/n-3 PUFA ratio was enhanced by the sunflower diet from 9.35 ± 0.65 to 12.69 ± 0.79. This ratio is not recommended by the nutritionists. Nutritionists criticise human diet for unfavourable ratio between n-6 and n-3 which typically exceeds 10:1 and very often it is as high as 25:1, when 5:1 is regarded as ideal for good health (Weill et al., 2002).

Fatty acid content was also measured in backfat samples (Table 4). The total SFA content was not influenced by the diet (P>0.05), total MUFA content was lower (P<0.001) in S group (41.92 ± 1.27 g/100 g of total FA) in comparison to C group (46.14 ± 0.88 g/100 g) and total PUFA was in S group higher (14.37 ± 0.52 g/100 g) than in C group (10.68 ± 0.57 g/100 g). The concentrations of α-linolenic, arachidonic acid, EPA and DHA were not affected by the sunflower diet (P>0.05). The n-6/n-3 ratio was increased (P<0.001) in S group (9.53 ± 0.56) compared to C group (5.80 ± 0.46).

Table 1. Chemical composition of feed mixtures

Analysed chemical composition (g/kg)	Control (C)	Sunflower (S)
Dry matter	887.47	885.71
Crude protein	146.13	155.69
Fat	48.59	43.60
Fibre	37.33	45.24
Starch	438.90	421.50
Saccharose	21.77	20.22
Energy (MJ/kg)	13.36	13.04

Table 2. Fatty acid content (g/100 g of total fatty acids) in control and experimental feed mixtures

Fatty acid	Control (C)	Sunflower (S)
Myristic C14:0	0.26	0.14
Palmitic C16:0	11.54	12.26
Stearic C18:0	2.14	2.91
Oleic C18:1 n9	39.96	17.87
Linoleic C18:2 n6	32.89	54.74
Alpha linolenic C18:3 n3	7.61	8.55
Arachidonic C20:4 n6	0.02	0.02
EPA C20:5 n3	0.13	0.04
DHA C22:6 n3	0.01	0.01
SFA	15.16	16.42
MUFA	43.80	19.48
PUFA	41.04	64.09
n6 PUFA	33.05	54.93
n3 PUFA	7.96	8.99
n6/n3 PUFA	4.15	6.11

SFA – saturated fatty acid, MUFA – monounsaturated fatty acid, PUFA – polyunsaturated fatty acid

Table 3. The content of selected fatty acids (g/100 g of total fatty acids) in M. longissimus dorsi et thoracis samples in control and experimental groups

Fatty acid	Group	
	Control (C)	Sunflower (S)
Myristic C14:0	2.13 ± 0.26	1.93 ± 0.09
Palmitic C16:0	25.27 ± 0.99 ^{A}	23.87 ± 0.42 ^{A}
Stearic C18:0	12.40 ± 0.88 ^{b}	11.24 ± 0.54 ^{b}
Oleic C18:1 n9	40.24 ± 1.12	39.22 ± 0.84
Linoleic C18:2 n6	7.32 ± 0.92 ^{A}	10.77 ± 1.11 ^{A}
Alpha linolenic C18:3 n3	0.79 ± 0.11 ^{A}	0.53 ± 0.03 ^{A}
Arachidonic C20:4 n6	1.41 ± 0.47 ^{A}	2.02 ± 0.36 ^{A}
EPA C20:5 n3	0.03 ± 0,01 ^{A}	0.06 ± 0.01 ^{A}
DHA C22:6 n3	0.08 ± 0.01	0.06 ± 0.01
SFA	40.96 ± 1.26 ^{A}	38.08 ± 0.87 ^{A}
MUFA	48.04 ± 0.98 ^{b}	46.39 ± 0.89 ^{b}
PUFA	10.99 ± 1.55 ^{A}	15.53 ± 1.61 ^{A}
n6 PUFA	14.73 ± 1.09	13.70 ± 1.52
n3 PUFA	1.58 ± 0.09 ^{A}	1.08 ± 0.11 ^{A}
n6/n3 PUFA	9.35 ± 0.65 ^{A}	12.69 ± 0.79 ^{A}

SFA – saturated fatty acids, MUFA – monounsaturated fatty acids, PUFA – polyunsaturated fatty acids
Within a row, means with the same superscript letters are different:
a P<0.05; b P<0.01; A P<0.001

Table 4. The content of selected fatty acids (g/100 g of total fatty acids) in backfat samples in control and experimental groups

Fatty acid	Group	
	Control (C)	Sunflower (S)
Myristic C14:0	1.27 ± 0.07 ^{a}	1.50 ± 0.02 ^{a}
Palmitic C16:0	24.72 ± 0.58	24.67 ± 0.51
Stearic C18:0	16.40 ± 0.75	16.71 ± 0.92
Oleic C18:1 n9	40.80 ± 0.76 ^{A}	36.62 ± 0.87 ^{A}
Linoleic C18:2 n6	8.23 ± 0.54 ^{A}	11.66 ± 0.43 ^{A}
Alpha linolenic C18:3 n3	1.22 ± 0.09	1.03 ± 0.06
Arachidonic C20:4 n6	0.20 ± 0.05	0.22 ± 0.03
EPA C20:5 n3	0.02 ± 0.01	0.02 ± 0.01
DHA C22:6 n3	0.01 ± 0.01	0.01 ± 0.01
SFA	43.19 ± 1.12	43.71 ± 1.20
MUFA	46.14 ± 0.88 ^{A}	41.92 ± 1.27 ^{A}
PUFA	10.68 ± 0.57 ^{A}	14.37 ± 0.52 ^{A}
n6 PUFA	9.00 ± 0.55 ^{A}	12.65 ± 0.44 ^{A}
n3 PUFA	1.56 ± 0.09	1.33 ± 0.09
n6/n3 PUFA	5.80 ± 0.46 ^{A}	9.53 ± 0.56 ^{A}

SFA – saturated fatty acids, MUFA – monounsaturated fatty acids, PUFA – polyunsaturated fatty acids
Within a row, means with the same superscript letters are different:
a P<0.05; b P<0.01; A P<0.001

Conclusion

The inclusion of sunflower to pig diet had a significant effect on fatty acid profile in muscle and fat tissue. The content of total SFA, MUFA and PUFA was significantly affected in M. longissimus dorsi et thoracis and total MUFA and PUFA content in backfat samples from pigs fed sunflower diet. The n-6/n-3 PUFA ratio was influenced in both muscle and fat tissue but it was higher compared with control group and did not correspond with recommendation of nutritionists.

References

Folch J., Lees M., Sloane Stanley G.H. (1957). A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem.,* 226, 497.

Gläser K.R., Scheeder M.R.L., Wenk C.(1999). Fat score, an index value for fat quality in pigs-its ability to predict properties of backfat differing in fatty acid composition. 50th Meeting of the EAAP,Zurich. Session PGN 4.33: Quality of meat and fat as affected by genetics and nutrition.

Hur S.J., Park G.B., Joo S.T. (2007). A comparison of the effects of dietary conjugated linoleic acid contents, cholesterol, lipid oxidation and drip loss in pork loin and chicken breast. J. Muscle Foods, 18 (3): 264-275.

Pieszka M., 2007: Effect of vegetable oils supplementation in pig diets on lipid oxidation and formation of oxidized forms of cholesterol in meat. *Polish Journal of Food and Nutrition Sciences*, 57: 509-516.

Rey A.I., Kerry J.P., Lynch P.B., Lopez-Bote C.J., Buckley D.J., Morrissey P.A. (2001). Effect of dietary oils and alpha-tocopheryl acetate supplementation on lipid (TBARS) and cholesterol oxidation in cooked pork. Journal of Animal Science, 79, 1201-1208.

Wood J. D., Richardson R. I., Nute G. R.; Fisher A.V., Campo M. M., Kasapidou E., Sheard P.R., Enser M. (2004). Effects of fatty acids on meat quality: a review. Meat Sci., 66, 21-32.

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