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Influence of feed selection on fatty acid composition of fattening pig meat

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Introduction

Fatty acids in adipose tissue of pigs can be synthesized from non-lipid substrates or direct by absorption of fatty acids from feedstuffs. Thus, for example, glucose obtained by digestion of corn and barley increases the proportion of saturated fatty acids (SFA) in relation to the polyunsaturated fatty acids (PUFA), which is not the case when the so-called oil fractions from concentrated feed are used in pig nutrition. However, as already mentioned, the fats are commonly used in pig nutrition, because they increase the energy value of feedstuffs and the amount of grain (especially corn) used in the pigs' diet is decreased (Lampe et al., 2006). Soybean, sunflower and other oilseeds that contain fatty acids of n-3 series and fatty acids of n-6 series are commonly used in pig nutrition. Flaxseed contains about 35 to 45% of oil compared to the dry material mass (Karleskind, 1996), and more than 70% of the oil consists of PUFA, which primarily is alpha-linolenic acid (ALA), an essential n-3 fatty acid and linoleic acid (LA), n-6 essential fatty acid.

The relationship between the two groups of PUFAs plays a significant role in the development of cardiovascular and other chronic diseases in humans: n-6 acids, whose main representative is linoleic acid (C18: 2 n-6) and n-3 fatty acids, whose main representative alpha linolenic acid (C18: 3 n-3). Numerous studies confirm that increased intake of n-3 fatty acids may decrease the risk of heart disease and vascular disorders, but also may relieve symptoms and improve the clinical manifestation in some autoimmune and inflammatory disorders (Enser et al., 2000).

The aim of this study was to investigate the possibility of using different feed for pigs to increase content of n-3 fatty acids in adipose tissue, as well as to improve the ratio of n-6/n-3 fatty acid, which is known to be disbalanced in the modern way of people diet.

Materials and Methods

In the experiment crossbreed pigs Yorkshire x Landrace were used, with initial body weight of 60 kg. The pigs were divided into three experimental groups of 10 pigs in each and were fed with standard diet (NRC, 1998) provided for the final fattening pigs of 60-100 kg (finisher).The groups differed only in that experimental group A had a full-fat soybean meal, experimental group B had a preparation of flaxseed at the recommended rate of 2.5% in the mixture (Vitalan-Vitalac, France), and experimental group C had feed which contained sunflower seed.

The Vitalan preparation of flaxseed contains 85% of extruded flaxseed, and the rest are wheat bran and antioxidants. The mixtures were balanced and fully met the needs of the animals at this stage of fattening. Pigs were kept up to average weight of 105 kg. At the end of the experiment, after slaughtering, processing and cooling carcasses, samples of adipose tissue (back) were taken from each pig in all three groups. The samples of complete feed mixtures and adipose tissue were examined for fatty acid composition. Total lipids for the determination of fatty acids were extracted from muscle tissue of pigs with hexane/isopropanol mixture by accelerated extraction (ASE 200, Dionex, Germany). After solvent evaporation the total lipids were converted into fatty acid methyl esters (FAME), which were determined by Shimadzu 2010 gas chromatograph (Trbović et al., 2011).

Results and Discussion

Chemical analysis of the fatty acid composition of complete mixtures showed that the feed which contained flaxseed (B) had significantly lower ($p < 0.01$) content of SFA, and a significantly higher content ($p < 0.01$) of PUFA compared to mixtures with full-fat soybean meal (A) and mixtures with sunflower (C). The trials showed that more than 70% of flaxseed oil consists of PUFA (mainly ALA and LA) (Nikolovski et al., 2008). Also the ratio of n-6/n-3 fatty acids in the mixture for group B was statistically significantly lower (5.57) compared to the mixtures used in groups A and C (11.00 and 52.65, respectively; $p < 0.01$). Fatty acid profile of the carcass directly reflects the fatty acid profile

in animal diet (Eastwood, 2002). Since flaxseed has desirable fatty acid composition, many producers are interested in including it in the finisher pig diets, to improve fatty acid composition of meat.

Analysis of fatty acids composition of carcass fat determined statistically significant differences between experimental groups.

Table. Content of fatty acids in feed and in adipose tissue of pigs that used different meals

Fatty acids, %, relationship	Feed			Adipose tissue		
	A	B	C	A	B	C
	$\overline{X}$± Sd	$\overline{X}$± Sd	$\overline{X}$± Sd	$\overline{X}$± Sd	$\overline{X}$± Sd	$\overline{X}$± Sd
SFA*	20.17±0.32^{A}	18.38±0.60^{A}	20.60±0.46^{B}	31.30±0.52^{A}	33.16±0.51^{A,B}	30.61±0.34^{B}
MUFA*	25.51±0.32^{A}	25.46±0.26^{B}	35.29±0.56^{A,B}	41.91±0.48^{A}	44.42±0.26^{A,B}	42.64±0.33^{B}
PUFA*	54.33±0.48^{B}	55.99±0.70^{A}	43.54±0.76^{A,B}	26.32±0.40^{A}	22.05±0.46^{A,B}	26.69±0.18^{B}
n-6*	49.79±0.41^{A}	47.46±0.60^{A}	42.73±0.76^{A}	24.91±0.43^{A}	20.09±0.47^{A,B}	25.75±0.67^{B}
n-3*	4.54±0.22^{A}	8.53±0.22^{A}	0.81±0.1^{A}	1.42±0.13^{A}	1.97±0.09^{A}	0.94±0.02^{A}
n-6/n-3**	11.00±0.54^{A}	5.57±0.14^{A}	52.65±1.10^{A}	17.74±1.89^{A}	10.23±0.57^{A}	27.30±0.67^{A}

^{A,B} Same letters indicate statistical significance p <0.01; * (%) ** (ratio). Group A - a diet with full-fat soybean meal; group B – flaxseed diet preparation, group C - diet with sunflower

Adipose tissue of pigs in the groups that received flaxseed contained significantly higher (p <0.01) content of n-3 fatty acids, or 1.97% compared to 1.42% in the group that received the full-fat soybean meal in diet and 0.94% for group that received sunflower, a significantly (p <0.01) lower content of n-6 fatty acids, or 20.09% compared to 24.91% and 25.76%. The ratio n-6/n-3 of fatty acids in adipose tissue in group B pigs was significantly lower (p <0.01) or 10.23 compared to groups A and C (17.74 and 27.30). In this study, the total content of SFA and monounsaturated fatty acids (MUFA) was significantly higher (p <0.01) in adipose tissue of pigs that were fed with flaxseed, compared to other groups of pigs, but the amount of PUFA in the adipose tissue of these pigs was significantly lower (p <0.01) (Table).

One of the first studies on the effects of feeding with flaxseed on the lipid profile of pig carcasses was performed by Cunnane et al. (1990). The pigs were fed diets containing 5% of flaxseed during the period of 2 weeks aged to 10 weeks of age. Pigs had significantly higher level of ALA in their liver, kidney, heart, skin, subcutaneous adipose tissue and muscle, and significantly higher levels of DHA and EPA in the liver, kidneys and heart. This study provided evidence that including flaxseed improves the profile of n-3 fatty acids in pig carcasses.

After that, more research was conducted to determine the optimal level of flaxseed inclusion and appropriate duration of feeding with flaxseed to ensure the enrichment of n-3 fatty acids, with no negative impact on carcass quality (Matthews et al., 2000; Markovic et al., 2011a, b; Enser et al., 2000; Thacker et al., 2004).

Okanović et al. (2010) have determined the effects of food enriched with flaxseed on the content of n-3 fatty acids in swine with average weight of 110 kg. Treatment with food containing flaxseed resulted in higher concentrations of n-3 fatty acids (> 7 mg per 100 g) which reduced the ratio of n-6 and n-3 fatty acids in meat (<3) making it, from a health perspective, the better for human nutrition. Similar results were obtained in research by other authors (Baltic et al., 2011; Stanislawa Raj et al., 2010; Vaclavkova and Beck, 2007).

Because of the many potential benefits of n-3 fatty acids in the diet, consumer demands for n-3 enriched products are increasing. Recommendations for daily intake of n-3 fatty acid from all dietary sources for adult men is 1.6 g, and for adult women 1.1 g. In contemporary human diets, the ratio of n-6/n-3 polyunsaturated fatty acids is relatively wide (10-15:1), so that efforts are currently being made to enrich food with n-3 fatty acids, so making this ratio approximately optimal (4:1).

Conclusions

The study concluded that the addition of flax preparation to pig diet:

- increased the content of n-3 fatty acids and improved relation of n-6/n-3 fatty acids in the feed;
- decreased the content of n-6, but increased the content of n-3, and therefore made more favorable the ratio of n-6/n-3 fatty acids in the adipose tissue of pigs.

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