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INFLUENCE OF LINSEED ENRICHED DIET ON OMEGA-3 FATTY ACIDS CONTENT IN PORK

UTJECAJ HRANE OBOGAĆENE SJEMENOM LANA NA SADRŽAJ OMEGA-3 MASNIH KISELINA U MESU SVINJA

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SUMMARY

The aim of this study was to evaluate the influence of diet supplemented with linseed rich additive under commercial name Vitalan (Vitalac, France) on omega-fatty acids content in pig meat. The main ingredient in Vitalan is extruded linseed, which made the test diet rich in omega-3 acids.

Fourteen pigs were divided in to the control and the experimental group and grown to cca 110 kg of average live weight. The experimental group was fed a standard diet enriched with 2.5% of Vitalan. After the end of the feeding period, the meat samples from both groups were analyzed for omega-3 and omega-6 fatty acids content in raw and oven- roasted meat. The ratio between omega-6 and omega-3 acids was established. Additionally, other parameters, such as weight gain, feed consumption and feed conversion ratio of pigs were monitored during the study.

The experimental group fed linseed enriched diet showed higher omega-3 acids content in meat (>7 mg/100g), had reduced ratio of omega-6 and omega-3 acids in meat (< 3), thus making it better for human consumption from the health perspective. Also, the treatment with enriched diet caused faster weight gain vs control diet (0.623 vs 0.592 kg/day), lower feed consumption (272 vs 274 kg/kg) and better feed conversion (3,36 vs 3,56 kg/kg).

The conclusion was that the diet enriched with extruded linseed had a beneficial effect on the majority of parameters monitored in the study.

Key words: pigs, extruded linseed, omega fatty acids

INTRODUCTION

It is now generally recognized that dietary fats play an important role in human health. Among dietary fats the major role belongs to polyunsaturated fatty acids (PUFA) with n-3 PUFA being most beneficial for human health. There is a great deal of evidence that n-3 PUFAs have anti-inflammatory, antithrombogenic and hypotriglyceridemic properties, they inhibit the formation of atherosclerotic plaques, prevent arrhythmias and act

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against some cancers such as breast, colon and prostate (Rose and Conolly, 1999; Connor, 2000).

At the same time increased levels of n-6 fatty acids are associated with an increase in chronic diseases (Givens et al., 2006). Because of n-3 PUFA beneficial effects and the fact that Western diet is very rich in n-6 fatty acids (Enser et al., 2000) the nutritional authorities recommend the diet rich in n-3 polyunsaturated fatty acids and that n-6/n-3 ratio should be lowered to between 1 and 4 instead of the current 15-20:1 (Simopoulos, 2002).

One way to improve this ratio is by modifying the fatty acids composition in meat, which is an important part of human diet and a natural supplier of fatty acids. Animal diet determines the fatty acid composition in meat and by changes in the diet, fatty acids ratio in meat and its nutritional value can be modified (Lizardo at al., 2002; Guillevic at al., 2009).

This is usually done by feeding animals on the feed enriched with fish oil or fish meal as sources of n-3 (omega-3) PUFAs or by feeding meals containing seeds or oils rich in n-3 fatty acids (Raes et al., 2004; Kouba, 2003).

The aim of this study was to investigate the influence of supplemented linseed diet rich in n-3 (omega-3) polyunsaturated fatty acids on fatty acid composition and in particular omega-3 content and n-6/n-3 ratio in raw and roasted pork.

MATERIAL AND METHODS

Animals and diet

The study was conducted on 14 pigs, three-race hybrids: Pietrain x (Swedish Landrace x Large Yorkshire), at the pig farm „Sabo Janos", Jermenovci, Serbia. The pigs were divided into two groups and fed two types of diet, a standard diet and a diet enriched with Vitalan (Vitalac, France) until reaching approximate live weight of 32.5 kg. One group was fed the control diet and the experimental group was fed the standard diet enriched with 2.5% of Vitalan. Vitalan contained 85% of extruded linseed and the rest were wheat bran and antioxidants. The diets composition is shown in Table 1.

The pigs were fed until the age of 210 days, when they were slaughtered. Total feed consumption, daily weight gain and feed conversion ratio were monitored. The animals were fed *ad libitum*.

Slaughter and sampling

The animals were slaughtered and samples of meat (*M. Longissimus dorsi, bacon and back fat*), 6 pieces (200g each) from both groups were collected and kept in the refrigerator at 4 °C.

A half of the samples were roasted in the oven at the temperature of 80-85 °C until the temperature in the centre of the meat reached 69 °C (about 1 hour), cooled and kept in the refrigerator at 4 °C.

Table 1. Composition of experimental diets
Tablica 1. Sastav hrane za tov svinja

Components - Sastojci	C - K %	E - O %
Maize - Kukuruz	51,0	50,0
Barley - Ječam	28,0	26,8
Soybean meal - Sojina sačma	18,0	17,7
Premix	2,5	2,5
Acidifier - Zakiseljivač	0,5	0,5
Vitalan		2,5
Total - Ukupno	100,0	100,0

* C – Control group E – Experimental group
* K – Kontrolna skupina O – Pokusna skupina

After 24 hours, fresh and roasted, samples were sent to the laboratories of Food Technology Institute in Novi Sad, where fatty acid analysis and sensory evaluation were performed.

Fatty acid analysis

The preselected meat samples were homogenized with food processor and fat was extracted, using petrol ether, from 1 g of each sample. From the extracted lipids fatty acid methyl esters were prepared with boron trifluoride/methanol solution. Obtained samples were analyzed by a gas chromatograph Agilent 7890A system with FID, auto-injection module for liquid and headspace sampling, equipped with fused silica capillary column (DB-WAX 30 m, 0.25mm, 0.50 um). The fatty acids were identified by comparison with standards from Supelco 37 component FAME mix and data from PUFA NO.2, Animal source BCR-163 beef/pork fat blend. Results were expressed as mg of fatty acids per 100 g of tissue (mg/100g) and as a ratio between omega-6 and omega-3 fatty acids.

RESULTS AND DISCUSSION

During the study animals were regularly fed and there were no illnesses or losses. All pigs were similar in size, vivacious and healthy, with shiny and clean hair. Results of monitoring the average weight, average weight gain, feed consumption and feed conversion ratio are shown in Table 2.

From the results shown in Table 2, it is evident that pigs from the experimental group fed on diet enriched with extruded linseed (Vitalan) consumed 272.2 kg of feed while the piglets from the control group fed on the diet not enriched consumed 274.0 kg of feed. Even though they consumed less feed, the pigs from the experimental group, enriched with Vitalan, achieved higher weight (115 kg) than the pigs from the control group (109 kg).

The average daily weight gain of pigs fed Vitalan enriched diet was higher (0.623 kg daily) than of the pigs from the control group (0.592 kg).

Pigs from the experimental group that were fed the extruded linseed diet, had better feed utilization compared to the control group, as shown by feed conversion. The feed conversion ratio in the experimental group was 3.36 kg of feed per 1 kg of weight gain, while in the control group it was 3.56 kg/kg.

The results of this study show that pigs fed diet enriched with extruded linseed (Vitalan) performed better than the control group.

The use of different diets also affected the meat quality. Sensory evaluation gave unanimous opinion that roasted meat of pigs fed enriched diet had better colour, it was juicy, soft and of superb taste.

Results of the fatty acids analysis confirmed that this meat was of very good quality from the health perspective (Table 3.).

Table 2. Average weight and weight gain of pigs, feed consumption and feed conversion ratio
Tablica 2. Promjena težine i prirast svinja, potrošnja i konverzija hrane

	Average weight - Prosječna težina kg		Average weight gain Prosječan prirast kg/day	Feed consumption Potrošnja hrane	Feed conversion ratio Konverzija hrane
	80. day	210. day	80. - 210. day	kg	kg/kg
C - K	32,00	109,00	0,592	274,00	3,56
E - O	34,00	115,00	0,623	272,20	3,36

* C – Control group E – Experimental group
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Table 3. Omega fatty acids and free fat content in pork (mg/100g of fat tissue)
Tablica 3. Sadržaj slobodne masti i omega masnih kiselina u mesu svinja, (mg/100g masnog tkiva)

		Free fat, % Slobodna mast, %		Ω 3		Ω6		Ω6/Ω3	
		$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd
Fresh meat Svježe meso	C, K	5,11	0,86	0,35	0,11	11,84	1,22	33,83	2,14
	E, O	5,57	0,53	7,85	0,85	18,98	1,01	2,43	0,18
Roasted meat Pečeno meso	C, K	6,02	1,11	0,34	0,08	10,45	2,95	30,74	3,53
	E, O	5,34	0,75	7,61	0,28	19,01	1,96	2,49	0,17
Bacon	C, K	28,10	4,12	0,81	0,17	13,11	0,96	16,19	0,70
Slanina	E, O	26,10	3,78	8,44	0,52	18,61	0,04	2,21	0,13
Back fat	C, K	86,50	4,23	0,45	0,14	12,34	1,47	27,42	2,75
Leđna masnoća	E, O	82,90	3,98	7,28	1,37	17,34	2,23	2,38	3,46

* C – Control group E – Experimental group
* K – Kontrolna skupina O – Pokusna skupina

From the results shown in Table 3. of fresh meat, it is evident that the use of linseed enriched diet resulted in increased levels of omega-3 fatty acids in the experimental group (7.85 mg/100g of tissue) compared to the control group (0.35 mg/100 g of tissue). This significantly contributed to the more favourable ratio of omega-6/omega-3 in the treatment group (2.43) compared to the control group (33.83).

Similar results were obtained with roasted meat. Omega-3 fatty acid content was higher in the roasted meat of pigs fed enriched diet (7.61 mg/100 g of tissue) than in the meat from the control group (0.34 mg/100 g of tissue). Also, the omega-6 to omega-3 ratio was much more favourable in the experimental group (2.49) than in the control group (30.74).

Results on the free fat content in bacon showed that the proportion of free fat in the control and experimental groups was similar (28,10 or 26,10% respectively). It is evident that the use of linseed enriched diet resulted in increased levels of omega-3 fatty acids in the experimental group (8.44 mg/100g of tissue) compared to the control group (0.81 mg/100 g of tissue). Therefore, the ratio of omega-6 and omega-3 fatty acids was significantly more favorable in the experimental group (2.21) compared to the control group (16.19).

Chemical analysis of the back fat, gave similar results. The free fat contents in both examined groups were comparable (C = 86.50% i E = 82.90%). Omega-3 fatty acid content was higher in the back fat of the pigs fed enriched diet (7.28 mg/100 g of tissue) than in the meat from the control group (0.45 mg/100 g of tissue). The omega-6 to omega-3 ratio was also much more favourable in the experimental group (2.38) than in the control group (27.42).

These results are comparable with the results obtained in similar studies in France (Guillevic at al., 2009) comparing the influence of sunflower diet and diet with linseed on performance of pigs and nutritional quality of their tissue. In their experiments, omega-6 to omega-3 ratio was between 2,5 and 4 in tissue of pigs fed feed enriched with extruded linseed.

CONCLUSIONS

Based on the results of this study, the following conclusions can be made

- Pigs fed diet enriched with extruded linseed (experimental group) compared to the control group gained slightly higher total weight, with lower feed consumption and better daily weight gain, and did not increase the lipid content in the tissue.

- Levels of omega-3 fatty acids in the fresh and roasted meat, bacon and back fat of experi-mental group were much higher than in the control group with the ratio of omega-6 to omega-3 fatty acids much more favourable in the experi-mental group compared to the control group.

- From nutritional point of wiev, our study shows superiority of the extruded linseed enriched diet which significantly elevated the levels of omega-3 fatty acids and improved the ratio of omega-6 and omega-3 fatty acids to the desired level of around 4.

- Our study could contribute to development of n-3 PUFA pig production.

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SAŽETAK

Cilj studije je bio odredjivanje utjecaja hrane obogaćene sjemenom lana komercijalnog naziva Vitalan (Vitalac, France) na sadržaj omega-3 kiselina u mesu svinja. Glavni sastojak Vitalana je ekstrudirano sjeme lana koje čini ovu hranu bogatom omega-3 kiselinama.

Četrnaest svinja je podijeljeno u kontrolnu i pokusnu skupinu i uzgajano do prosječne težine od 110 kg žive vage. Pokusna skupina je hranjena standardnom smjesom obogaćenom sa 2,5% Vitalana. Na kraju pokusa uzorci mesa iz obje skupine su analizirani na sadržaj omega-3 i omega-6 masnih kiselina u sirovom i pečenom mesu. Određen je odnos između omega-6 i omega-3 kiselina. Tijekom pokusa praćeni su i drugi parametri:

promjene težine i prirast svinja, potrošnja i konverzija hrane. Tretman hranom koja sadrži laneno sjeme rezultirao je većim koncentracijama omega-3 kiselina (> 7 mg/100g) što je smanjilo omjer omega-6 i omega-3 kiselina u mesu (< 3) čineći ga, iz zdravstvene perspektive, boljim za ljudsku ishranu. Isto tako tretman je doprinio bržem prirastu težine (O-0,623, K-0,592 kg/dan), manjoj potrošnji hrane (O-272; K-274 kg/kg) i boljoj konverziji hrane (O-3,36; K-3,56 kg/kg).

U zaključku, ishrana obogaćena ekstrudiranim sjemenom lana imala je koristan učinak na većinu promatranih parametara u ovoj studiji.

Ključne riječi: svinje, ekstrudirani lan, omega masne kiseline