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Fatty acid content in meat from goat kids fed linseed-supplemented mixture

Zawartość kwasów tłuszczowych w mięsie koźląt tuczonych mieszanką z udziałem nasion lnu

Summary: The objective of our study was to determine the changes in chemical composition that took place in the muscle tissue of goat kids undergoing fattening when their diet was supplemented with crushed linseed. Twenty-four White Improved male goat kids were fattened until 95 days of age. After slaughter, we collected samples from the longissimus dorsi muscles to determine its chemical composition and the fatty acid and cholesterol content. We found that the addition of 10% crushed linseed to nutritionally rich feed increased the unsaturated fatty acid content and slightly increased the cholesterol level in the muscle tissue lipid fraction; this increase is potentially beneficial with regard to human nutrition.

Key words: goat meat, fattening, meat quality, linseed supplementation, fatty acids

INTRODUCTION

The nutritional value of muscle tissue may be improved by supplementing the diets of animals undergoing fattening with plants high in oils. The essential fatty acids linoleic acid (18 : 2) and linolenic acid (18 : 3) occur naturally in ruminant diets, but at low concentrations. Linseed oil is rich in essential fatty acids, particularly linolenic acid (18 : 3). According to Wachira *et al.* [2002], including linseed oil in mixtures given to fattened lambs results in increasing levels of conjugated linoleic acid (CLA) and the polyunsaturated fatty acids (PUFA n-3). However, the structure of the ruminant gastrointestinal system does not allow for large amounts of dietary plant oils (>5% of dry matter), which can negatively affect fermentation in the rumen.

The aim of the present study was to evaluate the impact of a goat kid diet enriched with 10% crushed linseed on the chemical composition of goat kid muscle tissue, particularly with regard to the quantity and quality of intramuscular fat.

MATERIAL AND METHODS

The experiment was first performed in 2004 and then replicated in 2005; the same experimental procedures were performed and the same feed mixture composition was used. The study group comprised 24 male goat kids of the White Improved breed that stayed with their dams until 60 d of age. At 60 d, the goat kids received an additional dietary supplement of crushed oats and hay. After weaning, the kids were randomly assigned to two treatment groups of 12 animals each: the control group (K) and the experimental group (D). The animals from the experimental group were fed full rations of feed mixture including a 10% crushed linseed additive, and the control group was fed the same full rations of feed mixture without the linseed supplement (Tab. 1). Both groups were supplied with hay ad libitum.

The animals were fattened for 35 d. After slaughter at 95 d old, we collected samples from the longissimus dorsi muscles for chemical analyses. Determining the content of dry matter, crude protein, crude fat, and cholesterol was carried out in accordance with accepted methods Association of Official Analytical Chemists [AOAC 1999]. The fatty acid content of 100 g of raw meat was determined using the gas chromatography technique of Rotenberg and Anderson [1980] after fat saponification and esterification with 13%–15% BF₃/methanol. Heptadecanoic acid was used as a reference. The gas chromatography equipment that we used was a Varian CP-3800 equipped with a Varian CP WAX 52CB capillary column of 60 m length and 0.25 mm inside diameter, an FID detector, helium carrier gas, 1.4 ml min⁻¹ flow rate, 210°C column temperature, 260°C injector and detector temperature, and 1 ul of column packing. We analyzed our results using two-factor analysis of variance (ANOVA) (group and experimental year) [SAS 2003].

RESULTS AND DISCUSSION

Supplementing the feed mixture with 10% crushed linseed resulted in a 3-fold increase in the amount of linolenic acid (18 : 3) compared with the control mixture (Tab. 1). However, these changes did not lead to significant changes in the feed intake, body weight gain, or health status of the animals in the experimental group compared to the control group. Our results concerning body weight gain, the course of fattening, and goat kid slaughter performance were presented in Szymanowska *et al.* [2006].

Feeding goat kids the crushed linseed-supplemented mixture did not change the basic chemical composition of muscle tissue significantly (Tab. 2). However, there were marked differences in fatty acid content and the relative levels of types of fatty acid in meat from supplemented goat kids (Tables 3 and 4). The linolenic acid (18:3) concentration in supplemented goat kid meat was 4-fold higher compared with the control group ($P \leq 0.01$). Furthermore, except for eicosenoic acid (20 : 1), the concentrations of the other fatty acids that we studied, both saturated and unsaturated, showed a clear upward

trend. This finding was in agreement with that of Marciński *et al.* [2003] and Radzik-Rant [2005], who found that supplementing the diet with fats of a differentiated fatty acid profile leads to qualitative changes in ruminant fat content. It is not clear why there was an approximately 12% decrease in the concentration of eicosenoic acid (20 : 1) in the linseed-supplemented group. We were unable to find any research papers to assist us in interpreting this result.

Table 1. Percentage composition and nutritional value of feed mixtures
Tabela 1. Skład procentowy i wartość pokarmowa mieszanek

Specification Wyszczególnienie	Control (K) Grupa kontrolna (K)	Treatment group (D) Grupa doświadczalna (D)
Percentage composition – Skład mieszanek		
Barley (%) Jęczmień	36	36
Oats (%) Owies	17	16
Wheat bran (%) Otręby pszenne	20	20
Dry beet pulp (%) Wysłodki buraczane suszone	11	7
Post-extraction soybean meal (%) Poekstrakcyjna śruta sojowa	15	10
Flaxseed (%) Nasiona lnu	—	10
Fodder chalk (%) Kreda pastewna	0.5	0.5
Mineral mixture (%) Mieszanka mineralna	0.5	0.5
Mixture nutritive value – Wartość pokarmowa mieszanek		
MJ NEL	6.50	6.80
Total protein (g kg ⁻¹) Białko ogólne	157.5	156.0
PDI (g kg ⁻¹)	117.5	115.0
Crude fat (%) Tłuszcz surowy	1.50	5.20
Linolenic acid (% total fatty acids) Kwas linolenowy (% ogólnej zawartości kwasów)	5.43	24.55

Although compared with the control group, the experimental group had a higher total fatty acid content, the differences were not statistically significant. The only statistically significant increase was recorded for the polyunsaturated fatty acids (PUFA); there were about 30% more PUFA in the experimental group than in the control group ($P \leq 0.05$).

Table 2. Chemical composition of goat kid meat (% fresh matter)

Tabela 2. Skład chemiczny mięsa kozłąt (% świeżej masy)

Chemical composition Skład chemiczny	Control (K) Grupa kontrolna (K)		Treatment group (D) Grupa doświadczalna (D)	
	mean średnia	SD	mean średnia	SD
Dry matter Sucha masa	23.53	0.74	23.79	0.88
Total protein Białko ogólne	21.08	0.54	21.16	0.65
Crude fat Tłuszcz surowy	1.41	0.31	1.48	0.42
Crude ash Popiół surowy	1.05	0.06	1.07	0.05

Table 3. Meat fatty acid profile (*longissimus dorsi*) (mg 100⁻¹ g)Tabela 3. Zawartość kwasów tłuszczowych w mięsie (*M. longissimus dorsi*) (mg · 100⁻¹ g)

Fatty acids Kwasy tłuszczowe		Control (K) Grupa kontrolna (K)		Treatment group (D) Grupa doświadczalna (D)	
		mean średnia	SD	mean średnia	SD
14 : 0	myristic acid kwas mirystynowy	17.27	7.43	18.67	6.34
16 : 0	palmitic acid kwas palmitynowy	164.08	45.00	167.00	3.84
16 : 1	palmitoleic acid kwas palmitooleinowy	16.36	4.27	17.58	5.00
18 : 0	stearic acid kwas stearynowy	122.27	29.31	135.08	41.52
18 : 1	oleic acid kwas oleinowy	372.36	67.42	386.67	108.17
18 : 2	linoleic acid kwas linolowy	44.09	13.92	51.17	18.24
18 : 3	linolenic acid kwas linolenowy	3.09 ^{xx}	0.94	13.08 ^{xx}	6.82
20 : 1	eicosenoic acid kwas ikozenowy	2.45	1.44	2.17	1.40
20 : 4	arachidonic acid kwas arachidonowy	16.55	7.51	19.33	14.17

^{xx} P ≤ 0.01

Table 4. Amount of cholesterol and different types of fatty acids in meat (*longissimus dorsi*) (mg 100⁻¹ g)
 Tabela 4. Zawartość grup kwasów tłuszczowych i cholesterolu w mięsie (*M. longissimus dorsi*) (mg · 100⁻¹ g)

Trait Cecha	Control (K) Grupa kontrolna (K)		Treatment group (D) Grupa doświadczalna (D)	
	mean średnia	SD	mean średnia	SD
FA	727.56	81.03	809.96	130.22
SFA	307.73	67.91	318.92	82.80
UFA	454.91	80.73	490.00	127.60
MUFA	391.18	69.24	406.42	112.16
PUFA	63.73 ^x	21.17	83.58 ^x	36.41
Cholesterol	68	21	72	23
Ratio – Współczynnik				
UFA : SFA	1.51	0.26	1.54	0.18
PUFA : SFA	0.21	0.07	0.26	0.10
PUFA : MUFA	0.16 ^x	0.05	0.21 ^x	0.07

^xP ≤ 0.05

Evaluating fat quality includes determining the relative amounts of different types of fatty acids. According to Gruszecki *et al.* [1999], an unsaturated/saturated fatty acid (UFA/SFA) ratio of approximately 2 : 1 is most often recommended for optimal human nutrition. The UFA/SFA ratio for the experimental group was 1.54 : 1, which was slightly higher than the UFA/SFA ratio for the control group (1.51 : 1). However, this difference was not statistically significant. We observed a similar trend for the PUFA/SFA ratio, which was significantly higher (28%; P ≤ 0.05) in the experimental group than in the control group. Crushed linseed supplementation also significantly increased the PUFA/monounsaturated fatty acid (MUFA) ratio (P ≤ 0.05), mostly because of the increased levels of oleic acid (18 : 1), linoleic acid (18 : 2), and linolenic acid (18 : 3). Strzetelski *et al.* [2003] and Czauderna *et al.* [2004] reported increased amounts of PUFA in meat following supplementation with 5% flaxseed oil during the fattening period for lambs and beef cattle, respectively.

The cholesterol levels of the goat kid meat from both groups were within the 68–72 mg/100 g range. Cholesterol levels were approximately 5% higher overall in the linseed-supplemented experimental group, but this difference was not statistically significant. However, this result is similar to that obtained in a study by Szymanowska [2006], who emphasized the impact of goat breed and sex on cholesterol levels in meat. Salomon *et al.* [1991] obtained similar results regarding cholesterol levels in the muscle tissue of lambs fed with a diet enriched with crushed rapeseed. In contrast, in a study in which crushed rapeseed and linseed were added to the diet mixture fed to fattened lambs, the cholesterol content in muscle tissue was about 16% lower than it was in the present study [Borys *et al.* 2005].

CONCLUSION

A diet enriched with 10% crushed linseed increase the quality of meat from fattened goat kids by increasing the UFA and PUFA content by 7% and 30%, respectively, compared with the control group. The crushed linseed-supplemented diet also caused a slight, not statistically significant, increase in the cholesterol level of muscle tissue.

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Streszczenie. Celem badań było określenie zmian składu chemicznego tkanki mięśniowej tuczonych koźląt, których dawka pokarmowa wzbogacona była gniecionym nasieniem lnu. Badaniami objęto 24 koźlęta rasy białej uszlachetnionej, które tuczono wzbogaconą mieszanką przez 35 dni. Po uboju w pobranych próbach z mięśnia najdłuższego grzbietu oznaczono: skład chemiczny,

zawartość kwasów tłuszczowych i cholesterolu. Wyniki doświadczenia wskazują na możliwość oddziaływania drogą żywieniową na jakość mięsa tuczonych kozłat. Wprowadzenie do paszy treściwej 10% dodatku gniecionych nasion lnu powoduje korzystne zmiany we frakcji lipidowej tkanki mięśniowej, zwiększając ilość kwasów nienasyconych. Wzbogacona dawka pokarmowa w nieznacznym stopniu wpłynęła na zwiększenie zawartości cholesterolu.

Słowa kluczowe: użytkowanie mięsne, tucz, jakość mięsa, kwasy tłuszczowe