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EFFECT OF THE FORM OF RAPESEED AND LINSEED IN LAMB DIETS ON SOME HEALTH QUALITY PARAMETERS OF MEAT

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Vegetable oils are important in the nutrition of slaughter animals as a source of nutrients, mainly energy components, and as a factor modifying the health quality of raw meat. The effects of using oilseeds in these two cases depend on both the amount and composition of the ration's components and on the form in which they are fed. In ruminants, the form of dietary oilseeds determines the degree to which they are "protected" against digestion in the forestomachs and thus their nutritive utilization and the effect they have on modifying meat quality (Bas and Morand-Fehr 2000; Oprządek and Oprządek 2003).

The objective of this study was to determine the effect of the form of oilseeds (double-low rapeseed and linseed) on fattening performance, slaughter value and meat quality in slaughter lambs.

Material and methods

Intensively fattened ram-lambs from a population of prolific sheep (Polish Merino, Finn and Romanov) and their F_1 crosses with the meat breed Texel [50% each] were investigated. Lambs were fed on an *ad libitum* basis with a complete diet with a structural supplement of hay. Animals were fattened from weaning at 7-8 weeks of age to 30–35 kg of body weight. Four groups of lambs were fed isoproteic and isoenergetic diets. Their components, nutritive value and chemical composition are given in Table 1. Treatments were diet composition and the form of oilseeds. The control group (C) received a standard diet, and the experimental diets used in groups E1, E2 and E3, in addition to the standard diet, contained full-fat double-

low rapeseed and linseed at a 2:1 ratio, at 10% of the diet's weight. They were in the form of whole seeds (group E1), 50% whole and 50% ground (group E2), and 100% ground (group E3). A group design of the experiment was used, with 10 lambs per feeding group. Carcass analysis and determinations of meat composition and quality were made in 6 lambs from each feeding group, which means a total of 40 lambs were fattened and 24 were analysed for their carcasses.

Table 1. Characteristic of feed mixtures

	Group			
	C	E1	E2	E3
Components (%):				
- dried grass	10,0		10,0	
- barley grain	25,0		20,0	
- crushed wheat	25,5		13,0	
- rape extracted meal	20,0		25,5	
- dried sugar beet pulp	18,0		20,0	
- rapeseed „00"	-	6,7[1]	6,7[2]	6,7[3]
- linseed	-	3,3[1]	3,3[2]	3,3[3]
- MM	0,5		0,5	
- Polfamix „O-K"	1,0		1,0	
Feeding value of 1 kg:				
UFV	0,88		0,87	
PDIE; g	100		97	
Chemical composition (%):				
- dry matter	88,6	89,8	89,6	89,3
- protein	13,6	17,9	17,0	17,0
- fat	1,8	5,5	4,9	5,2
Fatty acid profile				
SFA; %	15,1	10,5	10,3	9,7
UFA; %	84,3	89,3	89,3	89,7
MUFA; %	38,8	48,9	47,4	48,6
PUFA; %	45,5	40,4	41,9	41,1
PUFA Ω3 (C18:3)	13,8	19,3	21,0	21,4
PUFA Ω6:Ω3	2,297	1,099	0,995	0,921
UFA:SFA	5,583	8,469	8,670	9,247
PUFA:SFA	3,013	3,829	4,068	4,237

[1] - whole seed, [2] - 50% whole and 50% ground seed, [3] - 100% ground seed

Lambs were slaughtered, their carcasses cut up, and right halfcarcass partly dissected following the procedures applied at the National Research Institute of Animal Production (Nawara et al. 1963)

The *longissimus dorsi* muscle was analysed for:

- water content, by drying the samples at 105°C to a solid mass,
- protein content according to Kjeldahl (PN-75/A-04018) on Tecator instrument,

- fat content using the Soxhlet method, according to the Polish Standard PN-73/A-82111,
- tenderness with Warner-Bratzler (WB) shear apparatus,
- colour lightness with Specol 11 spectrophotometer (Rd-O attachment, 730 μm),
- flavour, aroma, tenderness and juiciness of cooked muscles were evaluated organoleptically by a panel of 5 judges on a 5-point scale.

Cholesterol content was determined in *m. semitendinosus* using gas chromatography (Hewlett Packard 5890 sII with a flame-ionization detector, column HP-1.25 m × 0.20 mm × 0.11 μm). Fatty acid profile of the diets and intramuscular fat and the content of conjugated linoleic acid c9, t11 (CLA) in intramuscular fat (*m. semitendinosus*) were determined according to the procedures given by Kramer et al. (1997) as modified by the Meat and Fat Research Institute in Warsaw (Borys et al., 1999), using gas chromatography (Hewlett Packard model 6890 with a flame-ionization detector and column Rtx – 2330: 105 m × 0.25 mm × 20 μm).

The results were analysed statistically with Statistica 6.0 PL packet (STATISTICA, 2002), using ANOVA procedure and Duncan's multiple range test.

Results and Discussion

In keeping with the methodological assumptions, the control and experimental diets were of a similar nutritive value expressed in the feed unit for meat production (UFV) and protein digested in the small intestine (PDIE) - Table 1. The 10% supplement of full-fat rapeseed and linseed in the experimental diets (E) led to clear differences in their chemical composition and in their fatty acid profile in relation to the control diet (C). Changes in the chemical composition of E diets in relation to C diet (the increased content of fat and changes in the fatty acid profile) were proportionate to differences in the chemical composition and fatty acid profile of the components of the standard and experimental diets (Bas and Morand-Fehr 2000; Michalec-Dobija 2000).

There were no large differences in the rate of growth, consumption of diets and conversion of diets and nutrients per unit of weight gain, both between the experimental and the control groups and between the experimental groups. The good rate of growth shown by lambs in all the groups (average daily gains of 272±5 g) and similar consumption and conversion of the diets (differences of ±5%) point to their good palatability and nutritive value, regardless of the proportion and form of oilseeds.

Table 2. Results of fattening

	Group				SEM
	C	E1	E2	E3	
Body weight (kg): - initial	19,1	18,9	19,3	19,0	0,53
- finishing	34,1	34,1	35,6	34,2	0,42
Fattening period; days	56	57	58	58	1,41
Daily weight gain; g	273	266	281	267	5,88
Daily consumption of feed mixture; kg/head	0,99	1,04	0,98	0,96	
Consumption per 1 kg weight gain:					
- feed mixture	3,55	3,89	3,50	3,67	
- UFV	3,39	3,69	3,32	3,47	
- PDIE; g	390	416	374	391	

Table 3. Slaughter value and meat quality

Trait	Group				SEM
	C	E1	E2	E3	
Dressing percentage; %	43,5A	45,9	49,9A	46,2	0,82
Valuable cuts; %	43,5	43,4	43,9	43,8	0,29
Leg tissue composition (%):					
- muscle	72,1	74,0	73,3	75,4	0,49
- fat	13,0	11,9	13,2	11,2	0,43
- bone	14,9	14,0	13,4	13,4	0,32
Area of loin "eye"; cm^2	12,3ab	14,6b	14,9a	13,8	0,35
Fat layer over the ribs; mm	3,5A	4,6a	6,9Aa	5,2	0,43
Content in 100 g muscular tissue:					
- water; g	76,63	76,88	76,75	76,67	0,12
- protein; g	21,02	20,85	20,83	20,94	0,04
- fat; g	1,35	1,26	1,42	1,39	0,10
- cholesterol; mg	68,0	62,6	62,7	63,6	0,87
WB tenderness; kG	5,37	5,42	5,12	5,73	0,19
SP brightness of muscle colour; %	46,3	43,1	43,9	47,2	0,92
Organoleptic evaluation (max 5 pnt.)					
- palatability	4,27	4,22b	4,45ab	4,18a	0,04
- flavour	4,20	4,20	4,35	4,20	0,05
- tenderness	4,18	4,25	4,37	4,17	0,04
- juiciness	4,43	4,43	4,53	4,38	0,05

AA - P≤0,01, aa, bb - P≤0,05

An influence of feeding oilseeds on selected parameters of slaughter value was observed. In several cases, it varied according to their physical form in the diet (Tab. 3). Lambs from all E groups surpassed those from group C in terms of dressing percentage (by an average of 3.8 percentage units, NS), muscle tissue percentage in leg (by 2.1 p.u., NS) and loin eye area (by 2.1 cm^2 or 17.1%, for groups E1 and E2 significant at $P \leq 0.05$), with greater external fatness over ribs (on average by 60.0%, for group E2 significant at $P \leq 0.01$). It is worth noting the clearly highest dressing percentage of group E2 lambs that were fattened with a diet supplemented with 50% whole and 50% ground oilseeds, which was related to the highest external fatness in this group.

The feeding factors had a certain effect on the quality of lamb meat, but it was not significant (Tab. 3). Muscles of lambs fattened with ground oilseeds (groups E2 and E3) contained slightly more intramuscular fat (IF) than those of the control group (by 4.4% on average, NS), and those of E1 lambs fattened with whole oilseeds contained 6.6% less IF (NS). The lower IF content of lamb muscles in group E1 may indicate a certain deterioration in digestibility of dietary fat when exclusively whole oilseeds were used. Under intensive fattening to high weight standards (30-35 kg), IF content of the lamb muscles was generally low (below 1.5% which is considered a minimal limit for organoleptic value of meat). This could be related to their 50% Texel genotype. In this situation, the increased fatness of muscles obtained as a result of using oilseeds in experimental groups E is considered beneficial.

The use of oilseeds, whatever their physical form, had a beneficial effect on lowering the cholesterol content of lamb muscles. In groups E, it was 7.4% lower on average than in group C (NS). This was associated with an almost twice higher DFA:OFA (hypo- to hypercholesterolemic acids) ratio in E diets than in C diet (Tab. 1).

There were no statistically significant differences in tenderness and colour lightness of muscles after cooking. The use of oilseeds had no clear effect on the organoleptic scores of cooked muscles, with a difficult-to-interpret tendency for higher scores of all parameters in group E2, in which oilseeds were 50% ground.

The application in experimental diets of the 10% rapeseeds and linseeds at a 2:1 ratio had no significant effect on percentage of the majority of fatty acids in intramuscular fat (Tab. 4). Greater differences, partly statistically significant, occurred for long-chain acids (C20:4, C20:5 and C22:5), which were clearly less abundant in the fat of lambs from experimental

groups, by an average of 28.9, 19.9 and 26.5%, respectively. By far the lowest proportion of these acids was characteristic of IF in lambs from group E2, and the differences in relation to group C in the proportion of C20:4 and C22:5 acids were 45.2 and 39.8% (P≤0.01).

Table 4. Fatty acid profile of muscular tissue

Fatty acids	Group				SEM
	C	E1	E2	E3	
C 14:0	2,28	2,48	2,88	2,41	0,14
C 15:0	0,85	0,78	0,72	0,75	0,02
C 16:0	21,02	21,00	22,02	21,23	0,22
C 16:1	2,10	2,22	2,45	2,15	0,06
C 17:0	1,70	1,80	1,72	1,68	0,03
C 17:1	0,78	0,87	0,77	0,68	0,03
C 18:0	12,98	13,30	13,25	14,05	0,24
C 18:1	40,38	41,90	42,65	40,35	0,47
C 18:2	8,27	7,30	6,50	8,05	0,33
C 18:3	1,17	1,13	1,12	1,12	0,04
C 20:4	3,85A	2,97	2,11A	3,13	0,20
C 20:5	0,57	0,52	0,38	0,47	0,03
C 22:5	1,08A	0,85	0,65A	0,88	0,06
SKL: - % in FA pool	0,29	0,33	0,36	0,46	0,04
- mg/100g tissue	3,88	4,10	4,92	6,68	0,54
SFA	39,47	40,08	41,22	40,75	0,39
UFA	59,83	59,18	57,33	58,38	0,41
MUFA	43,67	45,32	46,30	43,58	0,50
PUFA	16,17	13,87	11,63	14,80	0,63
UFA : SFA	1,52	1,48	1,42	1,43	0,02
PUFA : MUFA	0,37	0,31	0,25	0,34	0,02
PUFA : SFA	0,42	0,35	0,29	0,36	0,02
PUFA Ω3	3,08	2,73	2,37	2,72	0,12
PUFA Ω6	13,08a	11,21	9,42ab	12,28b	0,51
PUFA Ω6:Ω3	4,23	4,17	4,00	4,63	0,13
DFA	72,82	72,48	71,18	72,43	0,36
OFA	26,48	26,78	27,97	26,70	0,34
DFA : OFA	2,77	2,72	2,56	2,72	0,05

AA - P≤0,01, aa, bb - P≤0,05

Overall, the analysed indicators of lamb meat health quality based on fatty acid profile of IF were less favourable in the groups of lambs fed with oilseed diets than in the control group. They were the least beneficial in lambs from group E2, which could result from the greatest carcass fatness and overfatness of muscle tissue, which is normally accompanied by an

increased degree of tissue fat saturation. The observed tendency for less favourable health parameters of the fatty acid profile of IF in lambs fed with rapeseed and linseed does not agree with our own findings (Borys et al. 2004) and the studies of other authors (Macedo et al. 2003; Potkański et al. 2001), in which the results were generally beneficial, but less beneficial than when only linseed or a greater proportion of linseed in fattening diets was used.

In all the experimental groups CLA was found to increase, both its percentage in total fatty acids and its absolute content in the muscles (Tab. 4). This difference was not significant, although it should be noted that grinding the oilseeds had a clear effect on increasing the content of this healthy component. Muscles of lambs from group E1, which received whole rapeseed and linseed, contained 5.7% more CLA than in group C, whereas the differences for groups E2 and E3 (50 and 100% ground seeds) were 26.8 and 72.2% respectively.

The clearly beneficial effect of oilseeds on CLA in IF and muscles was related to the higher content in the experimental diets of C18:0, C18:1 and C18:3 and the concurrent lower content of C18:2 acid (Borys et al. 2004). This is in disagreement with many authors (Mir et al. 2000; Reklewska and Bernatowicz 2002) who hold the view that linoleic acid C18:2 is the main precursor of CLA in the meat and milk of ruminants.

Conclusions

1. The use in complete diets for lambs of full-fat double-low rapeseed and linseed (at a rate of 10% and 2:1 ratio), regardless of their form (whole and 50 or 100% ground) did not result in differences in the growth rate of the lambs and in the consumption and conversion of feeds and nutrients per unit of weight gain.

2. Under intensive fattening of 50% Texel lambs to 30-35 kg of body weight, the use of oilseeds had a beneficial effect on selected parameters of slaughter value and meat quality, on the increased dressing percentage and on the proportion and development of muscles, with greater fatness of carcasses and muscles that was within the optimal range.

3. The use of oilseeds had a favourable effect on the lower cholesterol content of the lambs' muscle tissue (regardless of the degree to which they were ground) and on the higher CLA content, especially when using ground oilseeds.

4. No significant effect of using rapeseed and linseed on fatty acid profile of intramuscular fat was found, with a tendency towards poorer health quality, resulting primarily from the

lower proportion of long-chain polyunsaturated fatty acids (C20:4, C20:5 and C22:5), especially when using 50% ground seeds.

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