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YIELD AND QUALITY OF CULINARY MEAT FROM FATTENED LAMBS AS RELATED TO FORM OF DIETARY RAPESEED AND LINSEED

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Production of good quality lamb meat is dependent on many factors, e.g. the genotype and technology of production, weight category of live animals and the method of feeding the lambs [4, 6, 9, 12, 15]. From the viewpoint of the meat industry, evaluation of the technological usefulness of slaughter lambs must account for the yield of cuts and saleable meat from carcasses and for basic parameters of meat composition and quality that determine its processing and culinary value [3].

The aim of this research was to determine the effect of fattening lambs with diets containing whole or ground double-low rapeseed and linseed on the yield of cuts and culinary meat and on basic parameters of meat quality.

Material and Methods

Left halfcarcasses of 24 ram lambs from a population of prolific sheep (Merino-Finn and Merino-Romanov) and their commercial crosses sired by Texel rams were investigated. Lambs after weaning at 7-8 weeks of age were randomly assigned to 4 groups and intensively fattened with complete isoenergetic and isoproteic all-mash (for composition and nutritive value see the table below) on an *ad libitum* basis, to which was added a structural supplement of hay at 100 g per 1 kg all-mash. In group I (control) a standard mixture without oilseeds, and in the other groups experimental diets of the same composition supplemented with 10% full-fat rapeseed and linseed at a 2:1 ratio were used. Whole oilseeds were used in group II, 50% whole and 50% ground oilseeds in group III, and 100% ground seeds in group IV.

Lambs were slaughtered at 30-35 kg of body weight according to the procedures applied at the National Research Institute of Animal Production [10]. Sides were cut up into basic and saleable elements following the methods of the Meat and Fat Research Institute [2].

Measurements of pH (Radiometer PHM 80 Portable with a combination electrode) and electrical conductivity (PQM-L KOMBI) were made on selected muscles 24 h postmortem [12]. Both measurements were done on the *m. longissimus dorsi* (LD) at the first and second lumbar vertebra and at the sixth and seventh thoracic vertebra, the *m. psoas major*, the *m. semimembranosus*, the *m. biceps femoris*, the *m. quadriceps femoris*, and the *m. supraspinatus*.

The *longissimus dorsi* (LD) muscle was analysed 24 h postmortem for:

- fat content using the Soxhlet method according to the Polish Standard PN-73/A-82111,
- water content by drying the sample at 105°C to a solid mass,
- protein content according to the Kjeldahl method (PN-75/A-04018), using Tecator equipment,
- colour lightness with Minolta Chroma Meter CR-300,
- drip loss from the muscle sample inserted into a plastic bag and weighed after 48 h of storage in a refrigerator at 4°C (drip loss expressed in % from the difference between weights of sample prior to and after storage),
- weight loss during cooking of muscle samples in water until reaching internal temperature of 70°C,
- water holding capacity (WHC) according to Grau and Hamm [5] as modified by Pohja and Niniwaara [13].

Sensory evaluation of cooked meat was carried out by a panel of 5 judges with proven sensory skills. A 5-point scale was used to assess aroma, juiciness, tenderness and palatability [1]. Meat tenderness was measured on a Warner-Bratzler (WB) shear apparatus.

The results were analysed statistically with Statistica 6.0 PL packet using one-way variance analysis and Tukey's test to verify significant differences between the groups [16].

Components composition as well as feeding value of all-mash

	Group / All-mash			
	Control	Experimental		
	I	II	III	IV
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]
- mineral mixture 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	

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

Results and Discussion

The results in Table 1 indicate that compared to the control group, the presence of oilseeds in the experimental diets had a beneficial effect on increasing the weight of sides and carcass cuts analysed. The present findings are evidence that lambs fed with the all-mash supplemented with 50% ground linseed and rapeseed (group III) were characterized by the greatest weight of side and all cuts, the differences in relation to the control group being statistically significant in the majority of cases. The highest weight of sides in group III resulted mainly from the highest dressing percentage in this group of lambs accompanied by the highest rate of growth, as shown by the production part of the experiment [2]. Piechnik et al. [11] showed that the use of rapeseed in pasture feeding of lambs had no effect on weight gains, dressing percentage and weight of basic cuts.

Similar significant relationships were found for the amount of culinary meat obtained from the cuts (Tab. 2). In group III compared to I, a significantly greater amount of culinary meat was obtained from shoulder, fore quarter and leg – by 16.3, 24.8 and 18.9% respectively ($P \leq 0.05$). Total weight of culinary meat obtained from sides of carcasses was the highest in group III, being 20.8, 6.5 and 7.3% greater than in groups I, II and IV, respectively (NS). There were no significant differences in percentage of cuts and culinary meat in sides depending on the proportion and form of oilseeds in the diets.

Mean values of pH and electrical conductivity (EC) for different muscles (Tab. 3) confirm that lambs of all the groups under comparison were characterized by a similar and good meat quality, with average pH of 5.76-6.02 and EC of 2.06-4.15 mS. In our previous studies, the meat of lambs representing different genotypes also showed low values of electrical conductivity [7, 8]. In other species of animals, higher values of electrical conductivity have been observed [14].

Basic chemical composition and physico-chemical traits of meat of the investigated lambs are shown in Table 4. No significant differences were found in the analysed parameters between the feeding groups.

The results of sensory evaluation of meat from all the feeding groups are considered highly beneficial (Tab. 5). Average scores for all parameters exceeded 4.2 points, with the higher scores being obtained for all parameters by lambs from group III compared to the other groups (4.42 and 4.25 points, respectively). The highest organoleptic scores for muscle tenderness in group III are reflected in the lowest shear apparatus measurements of tenderness in this group.

It is concluded that under intensive fattening of lambs to 30-35 kg of body weight, the use of full-fat rapeseed and linseed in complete diets increased the weight of sides, cuts and culinary elements of carcass. The most favourable results in this respect were obtained when using 50% ground oilseeds. No significant effect of the proportion and form of oilseeds in diets on percentage of cuts and culinary meat in sides was found. The analysed qualitative parameters of meat confirmed its high quality. The nutritional factor did not lead to significant differences in chemical composition and physico-chemical parameters of the muscles and the sensory evaluation after cooking.

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Table 1. Weight of cuts and their percentage share in the halfcarcass

Cuts	Statist. param.	Group							
		I		II		III		IV	
		Weight; g	% of halfcarcass	Weight; g	% of halfcarcass	Weight; g	% of halfcarcass	Weight; g	% of halfcarcass
Halfcarcass	$\bar{x}$	6563A	100,00	7437	100,00	8112B	100,00	7392	100,00
	Sd	876		751		655		683	
Shoulder with shank	$\bar{x}$	1112a	16,94	1238	16,65	1303b	16,06	1246	16,86
	Sd	122	0,98	114	0,70	96	0,92	121	0,75
Fore quarter without shoulder	$\bar{x}$	1298A	19,78	1526	20,52	1648B	20,32	1487	20,12
	Sd	229	0,93	176	0,89	120	0,72	124	0,50
Loin	$\bar{x}$	850	12,95	969	13,03	1058	13,04	922	12,47
	Sd	129	1,21	156	1,30	105	0,67	128	1,22
Breast with ribs	$\bar{x}$	703A	10,71	837	11,25	943B	11,62	834	11,28
	Sd	122	0,64	98	0,57	117	0,79	114	0,74
Leg with shank	$\bar{x}$	2393a	36,46	2618	35,20	2878b	35,48	2649	35,84
	Sd	257	1,24	228	1,15	268	0,67	259	1,07
Less valuable parts	$\bar{x}$	207	3,16	249	3,35	282	3,48	254	3,43
	Sd	42	2,11	53	2,96	65	2,19	48	2,78

A,B - P≤0,01; a, b - P≤0,05

Table 2. Yield of culinary meat from the half carcass

Culinary meat	Statist. param.	Group							
		I		II		III		IV	
		Weight; g	% of halfcarcass	Weight; g	% of halfcarcass	Weight; g	% of halfcarcass	Weight; g	% of halfcarcass
From shoulder without bones	$\bar{x}$	735a	11,20	827	11,12	878b	10,82	830	11,23
	Sd	82	0,66	81	0,73	72	0,41	94	0,45
From fore quarter	$\bar{x}$	728a	11,09	863	11,60	968b	11,93	843	11,40
	Sd	172	1,07	149	0,94	97	0,57	89	0,54
From loin	$\bar{x}$	850	12,95	969	13,03	1058	13,04	922	12,47
	Sd	129	1,21	155	1,30	105	0,67	128	1,22
From breast	$\bar{x}$	497	7,57	600	8,07	691	8,52	601	8,13
	Sd	96	0,66	75	0,48	81	0,45	80	0,55
From leg without shank	$\bar{x}$	1487a	22,73	1615	21,71	1834b	22,57	1638	22,14
	Sd	156	0,97	179	0,92	215	0,10	190	0,10
Total culinary meat	$\bar{x}$	4297	65,54	4874	65,53	5429	66,88	4834	65,37
	Sd	131	0,96	129	0,86	106	0,51	115	0,51
Shank	$\bar{x}$	434	6,61	463	6,23	469	5,78	472	6,38
	Sd	30	0,31	18	0,33	27	0,31	29	0,45

a, b - $P \leq 0,05$

Table 3. Measurements of pH_{24} and electrical conductivity EC (mS) in different muscles

Location of measurement	pH_{24}								EC							
	I		II		III		IV		I		II		III		IV	
	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd
M. longissimus dorsi:																
- 6/7 pectoral vertebra	5,87	0,09	5,78	0,13	5,84	0,09	5,82	0,07	3,18	1,06	2,98	1,20	2,83	0,76	3,38	1,72
-1/2 lumbar vertebra	5,80	0,09	5,76	0,12	5,79	0,13	5,80	0,08	3,60	1,01	3,40	1,21	3,65	0,48	3,20	0,67
M. psoas major	5,84	0,07	5,85	0,18	5,87	0,05	5,85	0,13	2,63	0,52	2,30	0,75	2,53	0,42	2,06	0,62
Leg:																
-m. semimembranosus	5,84	0,10	5,82	0,08	5,82	0,12	5,87	0,06	2,85	0,58	3,06	0,68	3,40	0,65	3,42	0,90
-m. biceps femoris	5,83	0,11	5,88	0,04	5,69	0,34	5,86	0,05	3,70	0,50	4,15	1,15	4,05	0,89	4,08	1,19
-m. quadriceps femoris	5,95	0,14	5,94	0,11	5,90	0,08	5,91	0,04	2,98	0,52	2,93	0,39	2,60	0,60	2,70	0,55
Shoulder:																
- m. supraspinatus	6,02	0,09	6,01	0,10	5,87	0,38	5,99	0,11	2,38	0,23	2,70	0,56	2,55	0,45	2,55	0,63
- m. triceps femoris	5,95	0,08	5,91	0,12	5,88	0,12	5,94	0,05	3,40	1,18	2,71	0,55	3,05	0,38	2,98	0,84

Table 4. Basic chemical composition and physico-chemical traits of *m. longissimus dorsi* (%)

Trait	Group							
	I		II		III		IV	
	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd
Water content	76,63	0,60	76,88	0,57	76,75	0,69	76,67	0,69
Intramuscular fat content	1,34	0,22	1,26	0,20	1,42	0,19	1,39	0,21
Total protein content	21,02	0,48	20,85	0,40	20,83	0,60	20,94	0,61
Brightness of colour	46,35	2,58	43,12	4,75	43,94	3,06	47,23	6,49
Drop loss	2,62	0,83	2,10	0,73	2,27	0,70	2,35	0,71
Water holding capacity	33,72	2,20	33,34	2,48	33,44	2,31	33,90	1,67
Cooking loss	31,71	3,79	32,86	3,58	32,23	2,41	30,58	5,63

Table 5. Sensory evaluation and measurement of cooked meat tenderness

Traits		Group							
		I		II		III		IV	
		$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd
Sensory evaluation:	- flavour	4,20	0,18	4,20	0,31	4,35	0,27	4,20	0,15
	- juiciness	4,43	0,26	4,32	0,25	4,53	0,16	4,38	0,23
	- tenderness	4,18	0,12	4,25	0,28	4,37	0,22	4,17	0,19
	- palatability	4,26	0,08	4,21	0,18	4,45	0,16	4,18	0,19
WB tenderness; N		52,64	8,33	53,13	9,90	50,19	10,49	56,18	8,30