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Effects of different particle size of rapeseed and linseed in fattening lamb diets. I. Growth and slaughter performance

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SUMMARY – The effects of intensively feeding fattened lambs to 30-35 kg body weight with rapeseed and linseed (10% of the diet, 2:1 ratio) and of the form of these (whole, or 50 or 100% ground) on fattening performance and slaughter value were investigated. Lamb growth, feed intake and feed conversion were not affected by the proportion or form of oilseeds. The use of ground oilseeds had a beneficial effect on the EUROP carcass score, with increased external fatness, a tendency towards greater slaughter yield and loin eye area, and no differences in the leg tissue composition. Crossing prolific sheep with Texel rams did not result in differences in the lamb growth rate and had a beneficial effect on live and post-mortem evaluation of meatiness, with lower carcass fatness and no differences in the leg tissue composition. The overall effect of using rapeseed and linseed in all-mash for lambs fattened to high weight standards is initially considered as beneficial in terms of fattening results and the slaughter value of the lambs. The best effects can be expected when using partly ground oilseeds.

Keywords: Lamb, fattening, rapeseed, linseed, form of oilseeds, growth, slaughter performance.

RESUME – *"L'effet des différentes tailles de particules des graines de colza et de lin dans la ration alimentaire journalière des agneaux d'engraissement. I. Croissance et poids de la carcasse". Il a été étudié l'influence de l'alimentation des agneaux, engraissés intensivement jusqu'à 30-35 kg de poids vif avec du mélange de graines de colza et de lin (10% de mélange, en proportion colza/lin 2:1), ainsi que la forme des graines (graines entières, écrasées à raison de 50 ou 100% de la totalité des graines de la ration) et l'on a regardé les résultats d'engraissement et le poids de la carcasse ainsi que le pourcentage de viande dans la carcasse. La part des oléagineux dans la ration alimentaire, ainsi que la forme des graines oléagineuses, n'apportaient pas de différences quant à la vitesse de croissance, la quantité du mélange consommée, ni l'index de conversion du fourrage. L'écrasement des graines oléagineuses a eu un effet positif sur la teneur en viande de la carcasse selon l'échelle EUROP avec accroissement de la quantité de graisse externe, ainsi qu'une tendance d'accroissement de la quantité de viande obtenue par carcasse et l'accroissement de superficie de la coupe transversale du muscle dorsal et l'absence de différences de composition des différents tissus du gigot. Le croisement des femelles d'une population prolifique avec des béliers de race Texel n'apportait pas de différences chez les individus quant à la vitesse de croissance des agneaux et avait un effet positif sur la teneur en viande de la carcasse, contrôlée ante mortem (pendant la vie de l'animal) et post mortem (après l'abattage), avec, en même temps, une moindre teneur en graisse par carcasse et l'absence de différences de composition des tissus du gigot. En somme, l'effet de l'utilisation de graines de colza et de lin dans les mélanges alimentaires pour agneaux engraissés jusqu'à des poids élevés à l'abattage, peut être considéré, au départ, comme effet positif du point de vue des résultats d'engraissement et d'estimation du poids de viande de la carcasse des agneaux. Les meilleurs effets peuvent être espérés en utilisant des graines de colza ou de lin sous forme de graines partiellement écrasées.*

Mots-clés : *Agneau, engraissement, graine de colza, graine de lin, forme des oléagineux, croissance, teneur en viande à l'abattage.*

Introduction

Vegetable oils are important in animal nutrition as a source of nutrients, mainly energy nutrients, and as a factor affecting the meat quality. In terms of both of these aspects, the effects of using oilseeds can depend on the quantity and composition of diet components, and on the form in which they are fed. In ruminants, the form of oilseeds included in the diet determines the degree of their "protection" against digestion processes in forestomachs, and thus their nutritive value and effects on modifying meat quality (Bas and Morand-Fehr, 2000).

This study was conducted to determine the effect of using oilseeds (double-low rapeseed and linseed) and of their form in all-mash on the fattening performance and slaughter value of lambs.

Material and methods

A total of 24 ram lambs of two genotypes from the prolific populations of Polish Merino with 40-50% prolific Finn or Romanov genotype (PP) and Texel meat ram x PP (T x PP) were investigated. Lambs were fattened from weaning at 8 weeks of age to 30-35 kg body weight. Four groups, each with 6 lambs (3 PP + 3 T x PP) were fed complete diets, which composition and nutritive value are given in Table 1. Standard diet was used in group C (control). Experimental diets contained 10% double-low rapeseed and linseed at a 2:1 ratio, as whole seeds in group E1, as 50% whole and 50% ground seeds in group E2, and as 100% ground seeds in group E3. Lambs were fed a complete diet *ad libitum* with a supplement of hay (100 g hay per 1 kg all-mash) to supply structural fibre.

Table 1. Characteristics of the diets

	Diet/Group			
	C	E1	E2	E3
Components (%):				
Dried forage	10.0		10.0	
Barley grain	25.0		20.0	
Ground wheat	25.5		13.0	
Rapeseed meal	20.0		25.5	
Dried sugar beet pulp	18.0		20.0	
Double-low rapeseed	-	6.7	6.7	6.7
Linseed	-	3.3	3.3	3.3
MM	0.5		0.5	
"Polfamix O-K"	1.0		1.0	
Nutritive value per 1 kg[†]:				
UFV	0.88		0.87	
PDIE (g)	100		97	
Chemical components (g/100 g):				
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
Fibre	6.5	8.7	9.7	11.3
Fatty acid (g/100 g of fat):				
C 16:0	11.6	7.0	6.8	6.1
C 18:0	1.8	2.3	2.2	2.3
C 18:1	37.1	47.3	45.6	47.0
C 18:2	31.7	21.2	20.9	19.7
C 18:3	13.8	19.3	21.0	21.4
SFA (saturated fatty acids)	15.1	10.5	10.3	9.7
UFA (unsaturated fatty acids)	84.3	89.3	89.3	89.7
MUFA (mono-unsaturated fatty acids)	38.8	48.9	47.4	48.6
PUFA (poly-unsaturated fatty acids)	45.5	40.4	41.9	41.1
UFA:SFA	5.583	8.469	8.670	9.247
PUFA:SFA	3.013	3.829	4.068	4.237

[†]UFV: forage units (INRA, France); PDIE: protein truly digested in the small intestine (INRA, France).

Lamb slaughter and partial dissection of right half-carcasses were completed according to the procedures used at the National Research Institute of Animal Production (Nawara *et al.,* 1963). The conformation and fatness of the carcasses were evaluated according to the EU standards EUROP (Anonymous, 1992)

The results were analysed using the ANOVA procedure of the Statistica 6.0 Pl packet.

Results and discussion

The proportion of rapeseed and linseed in the experimental diets resulted in clear differences in their chemical composition and fatty acid profile compared to the control diet (Table 1). Control and experimental diets showed similar nutritive value (UFV and PDI). However, the 10% proportion of rapeseed and linseed in E diets caused these, compared to C diets, to contain more crude protein (by 27.2% on average), almost 2.5 times more fat and 52.3% more fibre. The main changes in the fatty acid profile of fat in E diets were the increased percentage of oleic acid C18:1 (dominant in rapeseed oil; by 26% on average), linolenic acid C18:3 (dominant in linseed oil; by 49%), and stearic acid C18:0 (by 26%), with concurrent decreases in palmitic acid C16:0 and linoleic acid C18:2 by 43 and 35%, respectively, as compared to control diet C. Overall, the fats of E diets compared to C diets contained more unsaturated fatty acids (UFA) and less saturated fatty acids (SFA) and consequently had a 57% higher UFA:SFA ratio on average. Among UFA, the proportion of monounsaturated fatty acids (MUFA) increased by 24%, and that of polyunsaturated fatty acids decreased by 10%, but the PUFA:SFA ratio was 34% higher in E diets than in C diets.

No great differences were found between feeding groups and genotypes in daily weight gains, feed intake and feed conversion ratio (daily intake and per kg weight gain, as feed basic) (Table 2). Both the rate of growth (257 g/day on average) and feed conversion ratio (3.65 kg) showed a regular growth trend in all the groups. No negative effects of using raw oilseeds in diets for fattened lambs (10-22% of the diet) were observed, as reported by Borys *et al.* (2004), Piechnik *et al.* (1999) and Pakulski and Osikowski (1993).

Table 2. Fattening results

	Feeding				Genotype		SEM
	C	E1	E2	E3	PP	T x PP	
n	6	6	6	6	11	13	
Final body weight (kg)	33.4	34.9	35.2	34.7	34.9	34.3	0.28
Daily gains (g)	256	256	258	257	257	257	5.35
Feed intake (kg/head/day)	0.99	1.04	0.98	0.96			
Feed conversion ratio (kg feed intake/kg live weight gain)	3.55	3.89	3.50	3.67			
Conformation and musculature (total 100 points) where:	87.8	88.8	88.0	88.5	86.0^{A}	90.2^{A}	0.58
Front (max. 30 points)	26.2	26.3	26.2	26.2	25.4^{A}	26.8^{A}	0.23
Loin (30 points)	26.3	26.5	26.0	26.5	25.7^{A}	26.8^{A}	0.21
Leg (40 points)	35.3	36.0	35.8	35.8	34.8^{A}	36.5^{A}	0.27

Data in the same row with identical superscript differ significantly (A: p≤0.01; a: p≤0.05).

The presence and form of oilseeds in the diets did not affect live lamb conformation or muscling, while the T x PP crossbreeding significantly improved the latter parameters (in total by 4.9%, P≤0.01) (Table 2). Grinding oilseeds and crossbreeding with Texel had a favourable effect on EUROP carcass meatiness score (Table 3). In highest classes U and R, there were 33 and 17 percentage units more carcasses in groups E2 and E3 than in groups C and E1, and among the crossbreds, 29 percentage units more in T x PP than PP. However, this was not evident in the linear measurements of carcasses (Table 3).

Table 3. Evaluation and measurements of carcasses

	Feeding				Genotype		SEM
	C	E1	E2	E3	PP	T x PP	
Cold carcass weight (kg)	13.6^{A}	15.1	16.6^{A}	15.0	15.5	14.7	0.34
EUROP classification (%):							
Conformation/musculature							
U	16.7	16.7	50.0	-	-	38.5	
R	50.0	50.0	50.0	83.3	63.6	53.8	
O	33.3	33.3	-	16.7	36.4	7.7	
Fatness							
2	16.7	-	-	16.7	-	15.4	
3L	33.3	33.3	66.7	33.3	54.5	30.8	
3H	50.0	66.7	33.3	50.0	45.5	53.8	
Carcass evaluation (max. 9 pkt):							
Conformation/musculature:							
Front	6.8	6.7	7.2	6.8	6.6^{a}	7.1^{a}	0.11
Loin	7.0	7.0	7.2	7.3	6.8^{a}	7.4^{a}	0.12
Leg	6.8	7.0	7.5	7.0	6.6^{A}	7.5^{A}	0.13
Measurements (cm):							
Length	56.0	52.6	57.8	57.2	57.6	54.4	1.21
Depth of chest	24.1	24.1	24.4	24.7	24.3	24.3	0.22
Width of chest	13.9	14.2	14.9	15.4	14.7	14.5	0.23
Depth of leg	16.1	16.4	17.4	16.3	16.5	16.6	0.18
Index of leg length	24.3	23.7	23.2	24.1	23.6	24.0	0.19
Leg circle	59.5^{A}	62.2	64.3^{Aa}	61.0^{a}	62.3	61.3	0.58
Width of loin	13.5	13.8	14.1	12.3	14.3	12.7	0.47

Data in the same row with identical superscript differ significantly (A: p≤0.01; a: p≤0.05).

Feeding and grinding of oilseeds did not have a significant effect on the proportion of basic carcass parts or on the tissue composition of leg (Table 4). There was a tendency towards an increased proportion of front and/or middle parts in the lambs of E groups, at the expense of the proportion of rump (2.06 percentage units higher than in group C on average). This was associated with the markedly higher measurements of external fatness of carcasses from E groups (Table 4). In group E2, the layer of fat over the ribs was twice as thick as in C (P≤0.01). The greater fatness of lambs given oilseeds was reflected in the higher slaughter yield, in group E2 also significantly greater than in C (by 6.4 percentage units, P≤0.05). In all E groups, increases were found in loin eye area, and the differences in relation to group C for E1 and E2 lambs (18.2 and 21.1%, respectively) proved statistically significant (Table 4).

The available results of experiments are inconclusive as to the effect of using vegetable oils in lamb fattening on carcass fatness and overfatness of muscle tissue. Yamamoto *et al*. (2003) reported a significant increase in the fatness of lambs fattened with rapeseed and linseed diets, while Borys *et al.* (2004) and Piechnik *et al*. (1999) did not find a clear effect. The effect of many naturally related genetic and environmental factors on fatness parameters and the high animal-specific variation of these factors make it difficult to compare the effect of individual factors on this group of traits.

Crossing prolific sheep with Texel rams did not significantly affect this group of slaughter value parameters. However, there was a tendency towards much lower external fatness of carcasses from T x PP than PP animals (by 14.4%), an associated decrease in slaughter yield (by 1.9 percentage units) and a surprising decrease in loin eye area (by 6.8%). These results only partly confirm the effect of Texel rams on the slaughter value of fattened lambs, especially on their tissue composition.

Table 4. Parameters of slaughter value

	Feeding				Genotype		SEM
	C	E1	E2	E3	PP	T x PP	
Slaughter yield (%)	43.5^{a}	45.9	49.9^{a}	46.2	47.4	45.5	0.82
Carcass parts (%)							
Front	40.4	41.6	41.0	40.7	40.8	41.1	0.26
Middle	25.7	25.6	27.0	27.0	26.4	26.3	0.28
Leg	34.4	32.7	32.0	32.2	32.8	32.9	0.33
Valuable cuts (%)	43.5	43.4	43.9	43.8	43.8	43.5	0.29
Leg tissues (g/100 g)							
Muscles (M)	72.1	74.0	73.3	75.4	73.6	73.8	0.49
Fat (F)	13.0	11.9	13.2	11.2	12.3	12.4	0.43
Bones	14.9	14.1	13.4	13.4	14.1	13.8	0.32
M:F ratio	5.87	6.40	5.57	6.74	6.26	6.05	0.22
Loin eye area (cm^2)	12.3^{Aa}	14.6^{a}	14.9^{A}	13.8	14.4	13.4	0.35
Fat layer over the ribs (mm)	3.5^{A}	4.6	6.9^{A}	5.2	5.5	4.7	0.43

Data in the same row with identical superscript differ significantly (A: p≤0.01; a: p≤0.05).

In none of the analysed parameters there was a significant feeding group x genotype interaction, which is evidence that lambs of both genotypes showed an identical response to the experimental feeding applied.

Conclusions

The proportion and form of rapeseed and linseed in the fattening diets of lambs did not result in differences in their daily feed intake or in their feed conversion ratio, while the average growth rate showed a regular growth trend.

The use of ground oilseeds had a beneficial effect on carcass conformation and muscling score according to the EUROP criteria, with a greater external fatness of carcasses and a tendency for increased slaughter yield and loin eye area, and no differences in the tissue composition of leg.

Crossing prolific sheep with Texel rams did not result in differences in the growth rate of fattened lambs, and had a beneficial effect on *postmortem* carcass conformation and muscling scores, with tendency to lower external fatness of carcasses and no differences in the tissue composition of leg.

Overall, from the viewpoint of fattening and slaughter value, the use of 10% rapeseed and linseed in the diet of lambs fattened intensively to high weight standards is considered beneficial, and the best effects can be expected when using partly ground oilseeds.

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