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Effect of the biofuel products' application in semi-intensive fattening of lambs Part I. Fattening results and slaughter value

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In this study, the investigations on the effect of the application of by-products from biofuel production in semi-intensive fattening of lambs on their growth and slaughter value were carried out. After weaning from their mothers at the age of 8 weeks, the ram lambs were fattened until reaching body weight of 35 kg (±3 kg) in 5 groups, 10 animals in each group. After completion of fattening, 6 lambs from each group were slaughtered and subjected to slaughter analysis. Each group contained 50% of lambs of prolific-dairy Koluda sheep breed (OK) and 50% of F_1 Ile de France rams x OK ewes (If x OK). The animals were fed the concentrates in the quantity of ca. 3% of body weight. Additionally, hay from grass *ad libitum* was administered, or grazing on pasture for 5-6 hours per day was employed. The control group received standard concentrate mixture based on cereal components (50.5%) and rapeseed meal (20%) and the control group were fed the experimental mixtures, containing rapeseed meal or maize DDGS (50%), linen seed (5%) and E vitamin (0.2%). During fattening, consumption of feed and nutrients in group and growth rate of the lambs were examined. Assessment of slaughter value was carried out, as well. The application of 50% rapeseed meal or DDGS in the mixture, with the simultaneous addition of linen seeds and E vitamin, irrespectively of the roughage employed in the ration, did not affect feed consumption, in spite of higher level and consumption of dietary fat in the experimental groups. Any significant effect of high participation of oil components in the mixture on daily body weight gains was not found. Generally, more favourable fattening results were obtained when employing DDGS and during grazing of the lambs on the pasture. When feeding the diets with oil components and supplementation with E vitamin, dressing percentage was found to increase; in case of simultaneous grazing on the pasture, the tendency to greater loin "eye" area and higher fatness of carcass was recorded. The crossing of prolific-dairy Koluda ewes with the rams of meat Ile de France breed, had a favourable effect on the growth rate and meatiness of crossbreds, with the tendency towards greater fatness of carcasses.

KEY WORDS: lambs / oil components / fattening results / slaughter value

In connection with the dynamically developing production of biofuel components derived from seeds of oil crops and cereal grain, large quantities of products related with this production have become commercially available. They should be rationally managed, first of all as feed for farm animals [1, 2, 6]. Problems connected with the utilisation of by-products of biofuel production from oil crop seeds (cake and meal) as well as various grain by-products (primarily dried distillers' grain with solubles - DDGS) in feeding of farm animals have recently been investigated in many Polish and international studies [5, 7, 15]. In Poland such research has indicated the potential to use by-products of rapeseed oil production in feed mixtures for lamb fattening [5, 12]; however, no such studies have been conducted on the application of DDGS. Studies and recommendations found in available literature, mainly American [8, 9, 10, 11, 14, 16], refer to the use of DDGS under animal production conditions differing from those found in Poland.

In view of the above it seems advisable to conduct studies on the effect of feeding fattened lambs with compound feeds containing a high share of biofuel production by--products, using them in the currently most recommended semi-intensive fattening system including hay or fresh forage in the feed rations. The first part of this study presents results obtained in terms of the course of fattening and slaughter value of lambs, while the second part of this study will discuss results concerning cutting yield of the carcass as well as the chemical composition, physico-chemical properties and organoleptic quality attributes of meat.

Material and Methods

Experimental fattening was conducted on 50 lambs (tup lambs) starting from weaning at the age of approx. 8 weeks until they reached body weight of 35 kg (±3 kg). Lambs were fattened in 5 groups of 10 animals each. Each group was composed of 5 randomly selected lambs of the prolific-dairy Kołuda sheep line (OK) and 5 randomly selected F_1 crossbreds of rams of the mutton Ile de France breed and OK ewes (If x OK).

Lambs were fed using concentrate mixtures of varying composition, provided in the daily amount equivalent to approx. 3% body weight of lambs, additionally supplemented with grass hay fed *ad libitum* or pasture grazing for 5-6 h/day. The component composition of concentrate mixtures as well as the nutritive value of feed intake by lambs in individual groups are given in Tables 1 and 2. In the control group (K) the standard feed mixture was applied, based on cereal components and rapeseed meal. The experimental groups were fed rapeseed meal (SR) or maize dried distillers' grain with solubles (DDGS) as well as linseed + an addition of vitamin E (0.2%). Linseed in the experimental feed mixtures was used as a component additionally supplementing the feed ration with polyunsaturated fatty acids (mainly linolenic acid C18:3), while vitamin E supplementation was applied as an antioxidant in feed rations with high contents of unsaturated fatty acids.

At the end of the fattening period 6 randomly selected tup lambs from each group were slaughtered (3 OK and 3 If x OK) and their slaughter value was determined post mortem following the methodology of the Institute of Animal Production [13].

Table 1
Ingredient composition of concentrate mixtures (%)

Component	Type of concentrate		
	K	SR	DDGS
Barley grain	25.0	20.0	33.5
Ground wheat	25.5	–	–
Wheat middinng	–	13.5	–
Rapeseed meal	20.0	50.0	–
DDGS	–	–	50.0
Linen seed	–	5.0	5.0
Dried forage	10.0	–	–
Dried sugar beet pulp	18.0	10.0	10.0
Mineral mixture	0.5	0.5	0.5
Premix	1.0	0.8	0.8
Polfamix E	–	0.2	0.2

Type of concentrate mixture: K – for group K (standard); SR – rapeseed meal + linen seeds (for groups SR+S and SR+P); DDGS – DDGS + linen seeds (for groups DDGS+S and DDGS+P
DDGS – maize distillers dried grains with solubles (all fractions)

The results were analysed statistically using the STATISTICA 8.0 software package applying the two-way analysis of variance (feeding method, lamb breed) in the orthogonal system and the model with interactions. Significance of differences between the feeding groups was estimated using Duncan's test.

Results and discussion

The use of feed mixtures varying in their component composition and pasture grazing had no marked effect on feed intake either in the case of concentrate mixtures or roughage in terms of dry mass. Nevertheless, consumption of concentrate in the experimental groups was slightly lower in relation to that in the control - in the SR groups it was on average by 2.1%, while in the DDGS groups it was by 3.7% lower, respectively (tab. 2).

The component composition of feed mixtures and pasture grazing distinctly differentiated fat content in the feed ration and the daily intake of that nutrient (tab. 2). In comparison with the K group, fat content in feed rations of the experimental groups was many-fold higher - in the SR groups on average 2.6 times greater, while in the DDGS groups it was

5.4-fold greater. Comparable differences were found in the intake of that nutrient. Among the experimental groups in both grazing groups fat content in the feed rations and its daily intake were higher than in the groups fed hay in the sheep barn.

More marked differences in the consumption of concentrate mixture and nutrients per 1 kg body weight gain were observed only between the DDGS+P and K groups; in the DDGS+P group concentrate intake was by 16.5% lower, UFV by 6.9% and PDIE by 13.9% lower, respectively (tab. 2).

No statistically significant differences were found in daily weight gains or the length of the fattening period between lambs of the experimental groups and the control (tab. 3). Also differences between the experimental groups were generally slight; nevertheless, lambs of the DDGS+P group with the greatest weight gains exceeded the slowest growing SR+P lambs by 22.8% ($P \leq 0.01$).

Table 2
Daily consumption of feed and nutrient intake

Specification	Feeding group				
	K	SR+S	SR+P	DDGS+S	DDGS+P
Feeds (kg/head):					
concentrate mixture	0.84	0.82	0.86	0.82	0.80
grass hay	0.26	0.29	0.02	0.26	0.02
pasture forage	–	–	1.11	–	1.05
Fat (g):					
in 100 g DM ration	1.5	3.5	4.2	7.7	8.1
daily consumption	14.1	33.8	40.4	71.0	75.2
Nutritive value of ration:					
JPŻ – UFV	0.98	0.94	0.92	1.02	1.00
BTJE – PDIE (g)	110.6	118.0	112.6	109.2	105.1
Consumption per 1 kg body weight gain:					
concentrate mixture (kg)	3.58	3.27	3.57	3.44	2.99
JPŻ – UFV	3.78	3.58	3.99	3.95	3.52

Feeding groups: K – control; SR+S – SR mixture + grass hay; SR+P – SR mixture + pasture grazing; DDGS+S – DDGS mixture + grass hay; DDGS+P – DDGS mixture + pasture grazing
DM – dry matter, UFV – feed units for meat production, PDIE – protein digested in small intestine according to energy available in rumen

Table 3
Fattening performance

Trat	Feeding group					Breed origin		SEM
	K	SR+S	SR+P	DDGS+S	DDGS+P	OK	If x OK	
n	10	10	10	10	10	25	25	
Body weight (kg):								
beginning of fattening	22.25	19.95	20.45	21.50	21.10	21.24	20.86	0.482
end of fattening	35.40	34.50	34.35	34.65	35.25	34.54	35.12	0.196
Days in fattening	53.3	56.0	59.6	52.4	50.8	55,8	53.0	2.133
Daily weight gains (g)	258	264	232^{A}	259	285^{A}	241^{A}	278^{A}	6.555

OK – Koluda Sheep, If x OK – crossbreds F_1 Ile de France x OK, SEM – standard error of arithmetic mean, AA – P≤0.01

The high share of rapeseed meal and DDGS in concentrate mixtures for the experimental groups and the resulting several times greater fat content in feed rations (particularly those containing DDGS) to a limited extent reduced intake of concentrate mixture (by 2-4%) at the simultaneous lack of marked differences in the daily intake of UFV and PDIE. Greater differences in relation to the control observed in the intake of concentrate and UFV per 1 kg weight gain in lambs from the DDGS+P group (lower than in K) were related with the fastest growth rate in that group. Weight gains in that group were by 10.5% greater than in group K.

Comparable, high daily body weight gains in the case of lambs from the control (258 g) and from the experimental groups (on average 260 g) indicate that the use of 50% rapeseed meal or DDGS in the feed ration for lambs fed in the semi-intensive system (in the system of ration feeding including forage) makes it possible to obtain a highly satisfying growth rate, similar to that when feeding is based on the standard feed mixture composed of cereal components. Further studies would be required to clarify whether growth rates in the SR+P lambs inferior to those in the K group and better growth rates in the DDGS+P group (in both cases by approx. 10%) were caused by the effect of forage used in those groups or by other factors.

At a relatively uniform body weight before slaughter of lambs in all the feeding groups a higher dressing percentage was recorded for lambs from the experimental groups, particularly those grazing on the pasture (tab. 4). Differences in dressing percentage between the SR+P and DDGS+P groups and K, amounting to 3.54 and 3.34 percentage points, proved to be statistically significant (P≤0.05). In lambs from the grazing groups a trend was observed towards a greater loin eye area (on average by 9.7% greater than in the K group and on average by 11.0% than in the SR+S and DDGS+S groups). At the same time, fat layer over the ribs in carcasses of grazing lambs was on average by 31.8% greater than

Table 4
Slaughter value of lambs

Parameter	Feeding group					Breed origin		SEM
	K	SR+S	SR+P	DDGS+S	DDGS+P	OK	If x OK	
n	6	6	6	6	6	15	15	
Body weight before slaughter (kg)	33.80	33.23	33.87	34.44	34.57	33.74	34.22	0.283
Carcass dressing percentage	41.8^{ab}	43.0	45.4^{a}	43.8	45.2^{b}	43.9	43.8	0.410
Loin „eye" area (cm^2)	12.4	12.4	13.3	12.1	13.9	11.9^{A}	13.8^{A}	0.346
Fat layer over the rib (mm)	4.2	3.8	5.6	4.5	5.4	4.4	5.0	0.268

AA – P≤0.01; aa, bb – P≤0.05

it was in carcasses of lambs from the other groups. However, these differences turned out to be statistically non-significant due to the high variability of this parameter (coefficients of variation V ranging from 27 to 37%) and the relatively small population of animals included in this study.

Crossbreds sired by rams of the mutton Ile de France breed (If x OK) had more advantageous fattening results and slaughter value parameters than tup lambs of the prolific--dairy Kołuda sheep. At a uniform mean body weight at the beginning and completion of fattening (tab. 3), If x OK tup lambs had body weight gains by 37 g greater, i.e. by 15.4% higher (P≤0.01). The applied commercial crossbreeding scheme had no effect on dressing percentage (tab. 4). In turn, crossing of Kołuda ewes with Ile de France rams influenced an increase in loin eye area (by 16.0%; P≤0.01) and at the same time the trend towards greater external carcass fatness of crossbreds (by 13.6%; NS).

Overall in terms of post-slaughter parameters of slaughter value generally more advantageous results were found for pasture grazing than feeding lambs hay in the sheep barn irrespective of the high share of rapeseed meal or DDGS in the concentrate mixture. The higher dressing percentage of lambs from the grazing groups (P) on the one hand was accompanied by greater external carcass fatness, which could have resulted from the greater daily fat intake in those groups, but simultaneously a greater loin eye area was recorded, which in turn may be ascribed to the advantageous effect of animal mobility in animals grazing on the pasture in comparison to lambs kept indoors.

As it was mentioned above, several studies on the use of DDGS in feeding of fattened lambs have been conducted in recent years in the United States. This is connected with the dynamic development of bioethanol production in the USA and the need to utilise large quantities of DDGS in animal feeding. The aim of those studies was to determine the effect of various DDGS shares added in concentrates on the growth rate and slaughter value of fattened lambs [9, 14, 17, 18] and the use of DDGS as supplementary feed for lambs fattened on the pasture [16]. It was shown that even a 60% DDGS share in the mixture had no negative effect on fattening results and carcass quality in lambs. Results reported by

Susin et al. [16] indicate that the application of DDGS in an amount equivalent to a 1.3% body weight of lambs when grazing on poor quality pasture increased daily weight gains almost two-fold.

In the American guidelines for animal production practice [8, 10, 11] the recommended share of dried distillers' grain in feed mixtures for fattened lambs amounts to 10-20%, depending on its type (DDG or DDGS). This is justified by the concern over exceeding admissible fat content in the ration and exceeding admissible (non-toxic) levels of sulphur and phosphorus at the simultaneous calcium deficit. Fully satisfactory production results recorded in this study at a 50% share of SR and DDGS in the feed mixture for lambs fattened in the semi-intensive system and the data recorded in another study conducted by the authors [4] on the levels of these elements at a 30% DDGS share in a feed mixture for intensively fattened lambs do not confirm reasons for concern reported by American researchers.

In the semi-intensive fattening system crossing of prolific-dairy Kołuda sheep with rams of the mutton Ile de France breed had an advantageous effect on the growth rate of lambs and their meatiness (loin eye area) at a lack of differences in dressing percentage and a trend towards greater carcass fatness in crossbreds in comparison to Kołuda tup lambs. The effects observed in terms of growth rate and slaughter value of If x OK crosses may be considered as generally advantageous and comparable to those recorded in previous studies conducted by the authors when applying the same commercial crossing scheme irrespective of the fattening method and the body weight standard of fattened lambs [3].

Based on these results it may be stated that the application of a 50% share of rapeseed meal or DDGS in feed mixtures for lambs in the semi-intensive fattening regime, irrespective of the adopted feeding system (indoor vs. pasture grazing) had no marked effect on feed intake despite the fat content in the ration being several times greater and its higher daily intake. No significant effect on fattening results (daily weight gains, feed intake and UFV) was observed for feeding lambs with the tested oil components and vitamin E supplementation, at the generally more advantageous results in the group fed a mixture with DDGS and grazing on the pasture, and the less advantageous results when using rapeseed meal and grazing. The application of feed mixtures with a high share of oil components resulted in an increased dressing percentage of fattened lambs, while at the simultaneous grazing a trend was also observed towards an increase in loin eye area and greater external carcass fatness.

Crossing of prolific-dairy Kołuda ewes with rams of the mutton Ile de France breed had an advantageous effect on the growth rate of crossbred lambs and their meatiness, at the uniform dressing percentage and a trend towards greater carcass fatness.

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