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Tissue protein and energy deposition in White-headed Mutton sheep x Polish Merino crossbred rams fed diets with different energy values

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ABSTRACT

Thirty-six White-headed Mutton sheep x Polish Merino crossbred lambs weighing about 23 kg were divided into two groups and fed two isonitrogenous complete pelleted diets with low (group L) or high (group H) metabolizable energy (ME) levels. The animals were fattened to a final liveweight of about 37 kg. Average daily gains in groups L and H were 220 and 242 g; intake per kg gain was: 55.7 and 53.8 MJ ME, 702 and 624 g of crude protein, respectively. Mean daily clean wool fibre production was similar in both groups (3.78 vs 3.95 g). The ME concentration in the diets did not have a significant influence on carcass dressing percentage or morphological composition. The protein content in 1 kg of empty body weight with fleece (EBW) ranged from 19.58 to 19.89%, fat from 17.10 to 17.32 %, and energy value from 11.34 to 11.48 MJ in groups L and H, respectively. The utilization of ME available for growth (k_f) by lambs from groups L and H was similar (0.40 vs. 0.43). Animals from group H deposited significantly ($P<0.05$) more protein in EBW gain (40.2 g/d) than lambs from group L (37.2 g/d).

KEY WORDS: lambs, energy level, protein deposition, energy deposition

INTRODUCTION

Important changes have occurred in sheep production in Poland in recent years. Wool production has decreased in importance and there is now greater emphasis

on meat production. However, rapid progress in meat production has been hindered, primarily by a lack of rams of meat-type breeds and also by lack of experience with this kind of production. In addition, the few imported meat breeds have not been well suited to the Polish climate. This seems to be particularly so for breeds such as Texel, Berrichonne du Cher, Suffolk and, to a lesser degree, Ile de France (Gut, 1994).

In the 1980s, intensive breeding programs were initiated in Poland with the aim of developing new synthetic male lines characterized by rapid growth rates, good feed utilization as well as desirable carcass attributes. Similar investigations were also carried out in other European countries (Cameron and Drury, 1985; Leymaster, 1991).

One of the most valuable synthetic meat lines bred in Poland is the White-headed Mutton sheep in which the genetic proportion of individual breeds is (%): Texel, 50; Ile de France, 18; East Friesian, 11; Berrichonne du Cher, 9; Wielkopolska sheep, 6 and Polish Merino, 6 (Gut, 1994). At present, breeding material of this line is being multiplied throughout Poland and used for crossing mainly with Polish Merino ewes.

There is now a need to quantify the influence of nutrition on production traits, body composition, protein and energy deposition in crossbred lambs of this synthetic line so as to determine their nutritional requirements.

The objective of this investigation was to determine the growth rate and protein and energy deposition in White-headed Mutton sheep x Polish Merino crossbred lambs fed complete pelleted diets with two different levels of metabolizable energy.

MATERIAL AND METHODS

Thirty-six White-headed Mutton sheep x Polish Merino crossbred male lambs weighing an average of 23 kg were randomly allocated to two groups (18 animals in each) and fed two isonitrogenous (approximately 15% crude protein/kg dry matter) complete pelleted diets containing 11.97 (group L) or 12.86 (group H) MJ ME/kg dry matter. Table 1 presents the composition of the diets, Table 2 shows their chemical composition and energy value. The dietary ME content was calculated on the basis of our own results of chemical analysis using the equation given by MAFF (1975):

$$\text{MJ ME/kg DM} = 0.012x_1 + 0.031x_2 + 0.005x_3 + 0.014x_4$$

in which x_1, x_2, x_3 and x_4 designate dietary content (g/kg dry matter) of crude protein, ether extract, crude fibre and N-free extractives, respectively.

Prior to the experiment, four additional lambs (initial slaughter group) weighing 23 kg were selected, sheared and slaughtered to determine the amount of

TABLE 1

Composition of complete pelleted diets, %

Components	Group	
	L	H
Dehydrated lucerne	12.29	9.87
Soyabean meal	5.70	7.80
Barley	48.53	15.17
Wheat	11.47	47.50
Wheat brans	19.90	5.00
Potatoe starch	–	12.75
Limestone	1.61	1.41
Mineral – vitamin premix *	0.50	0.50

* contains in 1 kg: vit. A 1600000 IU, vit. D_3 130 000 IU, vit. E 2000 mg, vit. B_1 500 mg, Fe 2000 mg, Cu 1600 mg, Mn 8000 mg, Zn 9000 mg, I 80 mg, Co 20 mg, Sc 30 mg, Mg 40 mg

TABLE 2

Chemical composition (g/kg dry matter) and energetic value of complete pelleted diets

Item	Group	
	L	H
Dry matter[a] (DM)	868	871
Crude protein	151	150
Ether extract	26	20
Crude fibre	138	53
N – free extractives	618	727
Crude ash	67	50
Acid detergent fibre	114	108
Neutral detergent fibre	220	211
Metabolizable energy, ME MJ/kg DM	11.97	12.86

[a] air-basis dry matter

fleece and chemical body composition. The 36 animals were kept in individual pens and fed one of two rations in the amount of 1150 g/head/d (at a liveweight of 23.0 -29.0 kg) and later, 1380 g/head/d (at a liveweight of 29.1-37.0 kg). The animals were fed at 7.00 and 14.00 h; the diets were split into equal parts. Liveweight gains and feed intake were recorded during the experiment. When the lambs reached approximately 37 kg liveweight they were sheared, starved for 20 h and slaughtered. Fleece yield was determined by shearing; samples of fleece from the shoulder, flank and thigh were collected to determine the yield of clean wool fibre according to the method described by Urbaniak (1986). Animals from the initial slaughter group were treated similarly. The EBW of lambs was expressed as the

sum of all slaughter products (including blood) minus the content of the digestive tract, gallbladder and bladder. The samples from each animal were autoclaved, freeze-dried and then their chemical composition and energy content were determined. Energy in wool was calculated from its chemical composition by multiplying the protein and fat contents by the energy value coefficients given by Urbaniak and Potkański (1987), which equal 23.50 kJ/g and 40.81 kJ/g, respectively. Energy and protein retention in lamb bodies (including wool) were calculated from the difference between the content of these components in the animal body at the end and beginning of the experiment. The basic chemical composition of feeds, wool and lyophilizates of slaughter products were determined using standard methods. Acid detergent fibre (ADF) and neutral detergent fibre (NDF) were measured according to the method of Van Soest et al. (1991) in a Fibretec apparatus (Tecator 1020, Högönas, Sweden). The energy content in lyophilizates was determined using a calorimetric bomb.

The results were analyzed statistically by analysis of variance (Steel and Torrie, 1960).

RESULTS

Table 3 presents lamb performance. The highest mean daily body weight gains were recorded in rams from group H (242 g/d) fed diets containing 12.86 MJ ME/ kg dry matter. Lower and statistically significant ($P<0.05$) body weight gains were

TABLE 3

Liveweight gains, feed utilization and wool production in growing lambs

Item	Group		SE[a]
	L	H	
Initial weight, kg	22.7	22.3	0.8
Final weight, kg	36.8	36.6	1.2
Duration, days	64	59	2.1
Liveweight gain, g/day	220[c]	242[d]	11.2
Feed utilization			
crude protein, g/kg gain	702[c]	624[d]	29
ME, MJ/ kg gain	55.7	53.8	2.7
Wool production[b], g/day	3.78	3.95	0.15

[a] standard error of the mean

[b] clean wool fibre

[c,d] means in the same row bearing different superscripts differ $P<0.05$

observed in lambs from group L (220 g/d). Lambs from group H used statistically less ($P<0.05$) crude protein per unit body weight gain. Mean daily production of clean wool fibre ranged from 3.78 g in group L to 3.95 g in group H and did not differ significantly ($P>0.05$) between groups.

The energy concentration of the diets did not influence significantly ($P>0.05$) on dressing percentage and carcass morphological composition (Table 4) or on the chemical composition of 1 kg EBW (with fleece) and its energetic value (Table 5). Protein content ranged from 19.58 to 19.89%, fat from 17.10 to 17.32%, and energy from 11.34 to 11.48 MJ.

TABLE 4

Dressing percentage and carcass composition, %

Item	Group		SE[a]
	L	H	
Dressing percentage	50.9	51.6	2.1
Carcass composition			
lean	61.2	62.0	4.1
fat	15.2	14.5	0.8
bone	19.8	19.6	1.1
connective tissue	3.8	3.9	0.2

[a] standard error of the mean

TABLE 5

Chemical composition and energetic value of 1 kg EBW (wool included) of lambs

Item	Group		SE[a]
	L	H	
Dry matter, %	40.89	41.77	2.02
Crude protein, %	19.58	19.89	1.05
Ether extract, %	17.10	17.32	1.11
Crude ash, %	4.21	4.18	0.15
Gross energy, MJ	11.34	11.48	0.56

[a] standard error of the mean

Table 6 shows ME utilization by lambs during fattening. The amount of energy (wool included) deposited in EBW was similar and ranged, respectively, from 237 to 247 MJ in groups L and H. The coefficient of utilization of ME available for growth (k_f) was slightly lower in rams from group H (0.43) than in animals from group L (0.40) but differences between groups were not statistically significant ($P>0.05$).

TABLE 6

Metabolizable energy utilization by lambs

	Group		SE[a]
	L	H	
Total ME intake, MJ/ lambs	786	762	32
Maintenance reguirement[b], MJ	195	181	8
ME available for growth, MJ	591	581	28
Energy deposition[c], MJ	237	247	13
ME utilization, k_f	0.40	0.43	0.02

[a] standard error of the mean

[b] estimated: 418 kJ ME/kg $W^{0,75}$ x mean metabolic weight x duration

[c] wool included, estimated from the difference between energy content in EBW of lambs weighing 37 and 22 kg

Protein deposition in EBW gain of rams (wool included) was significantly higher ($P<0.05$) in animals from group H (40.2 g/d) in comparison with those from group L (37.2 g/d). Animals from groups H and L retained 26.6 and 24.1% dietary protein, respectively (Table 7).

TABLE 7

Deposition of body protein

	Group		SE[a]
	L	H	
Protein intake, g/day	154	151	8
Protein deposition:			
in EBW gain, g day	34.2	37.0	1.8
in wool gain, g/ day	3.0	3.2	0.2
total, g/day	37.2[b]	40.2[c]	1.9
as % of protein intake	24.1[b]	26.6[c]	0.7

[a] standard error of the mean

[b,c] means in the same row bearing different superscripts differ $P<0.05$

DISCUSSION

This investigation was designed to determine production parameters and protein and energy retention in the bodies of White-headed Mutton sheep x Polish Merino crossbred rams grown from 23 to 37 kg body weight.

The lambs from both groups were characterized by relatively high growth rates but those fed diets containing 12.86 MJ ME/kg dry matter had mean daily body weight gains that were 10% higher and required approximately 11% less protein

per unit gain. Mean daily body weight gains in this study were similar to those reported by Urbaniak et al. (2000) in a comparable experiment carried out on Black-headed Mutton sheep x Polish Merino crossbred rams, but higher than those obtained for Polish Merino rams by Urbaniak (1986, 1995), Pająk et al. (1992), as well as for other growing of Merino-type sheep (Veress et al., 1984; Fix et al., 1988; Ball et al., 1996; Manso et al., 1998) grown to a similar final body weight.

Higher mean daily body weight gains ranging from 267 to 386 g were observed in experiments carried out on typical meat type lambs by Theriez et al. (1982a), Wylie et al. (1997), Bovalenta et al. (1998) and Tatum et al. (1998).

The results obtained in this study indicate that lambs produced by crossing White-headed Mutton sheep rams with Polish Merino ewes are characterized by a relatively high genetic potential for growth rate and feed conversion traits that, in this respect, exceed those for the Polish Merino breed. It should also be noted that the growth-associated genetic potentials of these hybrids are significantly better expressed when diets with higher energy concentrations are fed.

Fleece utilization is of little importance in sheep of meat type breeds that, as sire lines, provide rams for target commercial crossing since all lambs from these rams are slaughtered and not sheared for wool production. Still, because in the case of White-headed Mutton rams they are also utilized in rotational crossing, assessment of their wool production is desirable. The mean daily clean wool fibre production recorded in this study was not significantly dependent on dietary ME concentration. The obtained values of this parameter (3.78-3.95 g/d) were different from results in lambs of Merino type in which daily clean wool fibre production in many experiments ranged from 4.22 to 5.10 g/d (Reiss, 1969; Urbaniak, 1984, 1985). However, the obtained results were slightly higher than in the case of Black-headed Mutton sheep x Polish Merino crossbred lambs (3.66-3.75 g/d) in experiments referred to earlier (Urbaniak et al., 2000).

The comparison of dressing percentage of the examined crossbred rams with Polish Merino lambs and with the line containing Black-headed Mutton sheep reveals their good carcass attributes. The level of traits characterizing their growth performance is intermediate between the two hybrid types mentioned above. On the other hand, their after-slaughter traits, i.e. high dressing percentage (50.9- 51.6%), high content of lean meat (61.2-62.0%) and relatively low fat content (14.5-15.2%) make the hybrid lambs superior with regard to the discussed parameters, than Polish Merino lambs. The presented results of after-slaughter evaluation also reveal a positive effect of a high proportion of Texel breed (50%) in the genotype of the examined line, a trait also confirmed by other researchers (Cameron and Drury, 1985; Kempster et al., 1987; Wylie et al., 1997).

The ME level in the diets did not have a significant influence on the chemical composition of EBW. High protein (19.58-19.89 %) and low fat (17.10-17.32 %) content were recorded and the presented EBW chemical composition was more

advantageous in comparison with Merino-type lambs observed in experiments conducted by Urbaniak (1986), Fix et al. (1988) and Pająk et al. (1992).

Assessment of utilization of dietary ME for lamb growth using the comparative slaughter technique requires the determination of the quantity of energy consumed, the amount deposited in the body, and the amount needed for maintenance. The maintenance requirement was assumed, after Theriez et al. (1982b) and Urbaniak (1995), to be 418 kJ kg/ $W^{0.75}$.

Lambs from group H were characterized by a higher growth rate and thus shorter growing period than those from group L. The total ME intake during the entire period of the experiment was a little lower in relation to the amount of ME consumed by animals from group L. Total maintenance requirements of animals from group H were, therefore, lower than those from group L. The amount of ME available for growth in lambs from both groups was similar, thus lambs from group H had a slightly higher value (0.43), albeit statistically non-significant for the k_f coefficient, in comparison with rams from group L (0.40). In general, the obtained values of the k_f coefficient were higher than in the case of investigations carried out on Polish Merino lambs by Urbaniak (1986, 1995) and Pająk et al. (1992) and similar to research results reported by Theriez et al. (1982b) and ARC (1984), which were carried out on meat-type lambs.

The present investigation revealed the significant impact of dietary energy concentration on protein deposition in EBW gain (wool included) of lambs. The amount of protein deposited was higher than in Polish Merino lambs (Urbaniak, 1995) as well as in hybrid lambs crossed with Black-headed Mutton sheep rams (Urbaniak et al., 2000). The values obtained are also in line with data given by Robelin and Thierez (1981) who showed that lambs grown from 20-40 kg liveweight retain, on average, 30 to 40 g of protein per day.

CONCLUSIONS

Summing up the results of the present experiment, it can be concluded from comparison with other published data that growth and feed conversion efficiency for White-headed Mutton sheep x Polish Merino crossbred ram lambs exceed those of the Polish Merino breed, although they are inferior with regard to clean wool fibre production. It should also be emphasized that higher values for these parameters are achieved when diets contain higher energy concentrations. A higher meat content and lower fat concentration in the carcass is more desirable to the consumer. The chemical composition of EBW leads us to conclude that the crossbred lambs in the present study fulfill the requirements of meat-type sheep. Thus, they can be recommended for further development of their meat-producing qualities in Polish sheep production systems.

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STRESZCZENIE

Odkładanie białka i energii u jagniąt mieszańców białogłowej owcy mięsnej i merynosa polskiego żywionych dawkami o różnej wartości energetycznej

Trzydzieści sześć tryczków mieszańców białogłowej owcy mięsnej i merynosa polskiego o średniej początkowej masie ciała około 23 kg, podzielono na dwie grupy i żywiono dwiema izobiałkowymi, pełnoporcjowymi, granulowanymi mieszankami o niskiej (grupa L) lub wysokiej (grupa H) koncentracji energii. Zwierzęta tuczono do końcowej masy ciała około 37 kg.

Średnie dzienne przyrosty masy ciała jagniąt z grup L i H wynosiły odpowiednio 220 i 242 g; zużycie na 1 kg przyrostu wynosiło odpowiednio: EM 55,7-53,8 MJ, białka ogólnego 702 i 624 g. Średnia dzienna produkcja czystego włókna wełny była podobna w obydwóch grupach (3,66 i 3,75 g/d). Koncentracja EM w dawkach nie miała istotnego wpływu na wydajność rzeźną i skład morfologiczny tusz. Zawartość białka w 1 kg masy ciała netto (MCN) jagniąt wahała się od 19,58 do 19,89 %, tłuszczu od 17,10 do 17,32 %, a wartość energetyczna od 11,34 do 11,48 MJ, odpowiednio w grupach L i H. Wykorzystanie EM dostępnej dla wzrostu (k_f) przez jagnięta z grup L i H było podobne (0,40 i 0, 43). Zwierzęta z grupy H odłożyły nieco więcej białka w przyroście MCN (40,2 g/d) niż jagnięta z grupy L (37,2 g/d).