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Productivity and body composition of Black-headed Mutton sheep x Polish Merino crossbred rams fed complete pelleted mixtures with different energy concentrations

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ABSTRACT

Thirty-two Black-headed Mutton sheep x Polish Merino crossbred lambs weighing about 22 kg were divided into two groups and fed two isonitrogenous complete pelleted diets containing low (group L) or high (group H) metabolisable energy (ME) levels. The animals were fattened to a final liveweight of about 36 kg. Average daily gains in groups L and H were 228 and 250 g; intake per kg gain was: ME, 56.6 and 54.8 MJ; crude protein, 718 and 649 g, respectively. Mean daily clean wool fibre production was similar in both groups (3.66 vs 3.75 g). The concentration of ME in diets did not significantly influence dressing percentage or morphological composition of the carcass. The protein content in 1 kg of empty body weight (EBW) ranged from 18.6 to 18.8%, fat from 17.6 to 18.1%, while energy value from 11.25 to 11.55 MJ in groups L and H, respectively. The utilisation of ME available for growth (k_f) by lambs from groups L and H was similar (0.38 vs 0.40). Animals from group H deposited a little more protein in EBW gain (39.1 g/d) than lambs from group L (36.8 g/d).

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

INTRODUCTION

So far Polish sheep breeders have failed to develop local domestic meat type sheep breeds and, on the other hand, natural conditions prevailing in our country place specific constraints on rearing and utilisation of imported valuable meat type

sheep breeds (Suffolk, Berrichonne du Cher, Texel) which come, primarily, from sea climates.

For the above reasons, investigations were undertaken at A. Cieszkowski Poznań Agricultural University with the aim to develop domestic meat sheep breeds. So far, researchers succeeded in breeding four new synthetic lines of meat sheep for which separate flock books have been established. One of the registered synthetic lines is a Black-headed Mutton sheep which was obtained as the result of crossing Suffolk, Wielkopolska, Polish Merino and East-Friesian sheep (Gut and Slósarz, 1995). Currently, breeding material of this line is being distributed all over the country for commercial crossing, mainly with ewes of the Polish Merino breed.

In view of the above arguments, it was justifiable, for both cognitive and practical reasons, to undertake nutritional studies concerning estimation of chemical body composition and deposition of protein and energy by crossbreed sheep derived from the above synthetic line.

The aim of this research was to determine the productivity, chemical composition of empty body weight (EBW) and protein and energy deposition in Black-headed Mutton sheep x Polish Merino crossbred lambs, fed complete pelleted diets of two different levels of metabolisable energy (ME).

MATERIAL AND METHODS

Thirty-two Black-headed Mutton sheep x Polish Merino crossbred rams weighing an average of 22 kg were randomly allocated to two groups (16 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. The components of the diets are listed in Table 1, while their chemical composition and energetic value are given in Table 2. The dietary ME contents were calculated on the basis of our own results of chemical analysis using equation N° 75 given by ARC (1984):

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

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.

Before the beginning of the experiment, 4 additional lambs (zero group) weighing 22 kg were selected, sheared and slaughtered to determine the amount of fleece and chemical composition of their body. The experimental animals were penned individually and fed one of two rations in the amount of 1150 g/head/d (liveweight of animals 20.0-28.0 kg) and later 1380 g/head/d (liveweight of animals 28.1-36.0 kg). The rations were split into equal parts that were fed at 7.00 and 14.00 h. During fattening liveweight and feed intake were recorded.

TABLE 1

Composition of complete pelleted mixtures, %

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

TABLE 2

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

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

a air-basis dry matter

The trial was terminated when the lambs reached a weight of about 36 kg. Then they were sheared, starved for 20 h and slaughtered. Fleece yield was determined by shearing and samples of fleece from the shoulder, flank and thigh were collected. These samples were used to determine the yield of clean wool fibre according to the method described by Urbaniak (1986). Animals from the zero group were treated similarly. The EBW of lambs was expressed as the sum of all slaughter products (including blood) less 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 quantity of protein and fat contents by the energy value coefficients given by Urbaniak and Potkański (1987) which equal 5.609 kcal/g and 9.741 kcal/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 beginning and end of the experiment.

The basic chemical composition of feeds, wool and lyophilizates of slaughter products was determined using standard methods. ADF and NDF were determined by the method of Goering and Van Soest (1970). An automatic calorimeter was used to determine the energy content in lyophilizates.

To compare treatment means the analysis of variance (Steel and Torrie, 1960) and the Duncan's multiple range test were used.

RESULTS

Liveweight gains, wool production and feed utilisation in lamb fattening are presented in Table 3. The highest average liveweight gains were recorded in lambs fed diets containing 12.86 MJ ME (group H), 250/d, while the rams from group L grew significantly more slowly ($P \leq 0.05$), 228 g/d. Animals from group H used significantly ($P < 0.05$) less crude protein per unit of liveweight gain.

TABLE 3

Liveweight gains, feed utilisation and wool production in fattening lambs

	Group		SE[a]
	L	H	
Initial weight, kg	21.5	22.0	1.6
Final weight, kg	35.4	36.0	2.6
Duration , days	61	56	3.7
Liveweight gain, g/day	228[c]	250[d]	12
Feed utilisation:			
crude protein, g/kg gain	718[c]	649[d]	46
ME, MJ/kg gain	56.6	54.8	3.8
Wool production[b], g/day	3.66	3.75	0.18

[a] standard error of the mean

[b] clean wool fibre

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

Clean wool fibre production did not differ significantly between groups, but the little higher value of this parameter (3.75 vs 3.66 g/d) was found in lambs from group H. The level of dietary energy did not have a significant influence on dressing percentage and morphological composition of the carcass (Table 4).

TABLE 4

Dressing percentage and carcass composition

	Group		SE[a]
	L	H	
Dressing percentage, %	48.7	49.1	2.8
Carcass composition, %			
lean	59.2	59.4	3.0
fat	16.3	16.1	1.0
bone	20.3	20.6	1.6
connective tissue	4.2	3,9	0.2

[a] standard error of the mean

The energy concentration in diets did not have a significant influence on chemical composition and energetic value of EBW (Table 5). Protein content in 1 kg EBW ranged from 18.59 to 18.82% , fat from 17.60 to 18.10%, while energetic value from 11.25 to 11.55 MJ.

The amount of energy deposited in the lambs' bodies (Tables 6) was similar in both groups. However, the coefficient of utilisation of ME available for growth (k_p) was found to be a little higher in lambs from group H, but differences between groups were not significant (P>0.05).

The energy concentration in the diets did not significantly influence (P≥0.05) protein deposition in lambs' bodies (Table 7). The largest quantities of protein were retained by lambs from group H, 36.1 g/d in EBW gain, 3.0 g/d in wool gain

TABLE 5

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

	Group		SE[a]
	L	H	
Dry matter , %	40.30	40.92	2.82
Crude protein, %	18.59	18.82	1.11
Ether extract, %	17.60	18.10	1.23
Crude ash, %	4.11	4.00	0.20
Gross energy, MJ	11.25	11.55	0.86

[a] standard error of the mean

TABLE 6

Metabolisable energy utilisation by lambs

	Group		SE[a]
	L	H	
Total ME intake, MJ/ lambs	788	760	54
Maintenance requirement [b], MJ	183	168	9
ME available for growth, MJ	605	600	40
Energy deposition [c], MJ	229	240	12
ME utilisation, k_1	0.38	0.40	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

TABLE 7

Protein deposition in lamb body

	Group		SE[a]
	L	H	
Protein intake, g/day	164	162	10
Protein deposition			
in EBW gain, g/day	33.9	36.1	2.1
in wool gain, g/day	2.9	3.0	0.2
total, g/day	36.8	39.1	2.4
in % of protein intake	22.4	24.0	1.1

[a] standard error of the mean

and 39.1 g/d of total gain, while the animals from group L retained 33.9, 2.9 and 36.8 g/d, respectively. Rams from group H retained 24.0% of dietary protein intake, while animals from group L, 22.4%.

DISCUSSION

In the performed experiments, the influence of different levels of ME in complete pelleted diets on performance as well as protein and energy deposition in the body of Black-headed Mutton sheep x Polish Merino crossbred rams was ascertained.

Lambs from both groups reached relatively high body weight gains, although rams fed diets containing 12.86 MJ ME/kg dry matter (group H) were characterized by 9.6% higher growth rate and by 11% lower protein consumption per unit of

body weight gain. Daily weight gains obtained in these experiments were higher than those in experiments carried out on Polish Merino rams reported by Urbaniak (1986, 1995), Urbaniak and Potkański (1987) and Żebrowska et al. (1992), which were fattened to a similar final body weight, and on other Merino-type sheep (Veress et al., 1984; Fix et al., 1988; Ball et al., 1996; Manso et al., 1998). However, the growth rate of rams from this experiment was lower than that of typical meat-type lambs whose mean daily body weight gains, depending on experimental conditions, range from 267 to 414 g (Theriez et al., 1982a; Bovolenta et al., 1998; Tatum et al., 1998). The obtained results indicate that crossbred lambs derived from the crossing of Black-headed Mutton sheep with Polish Merino ewes are characterized by high genetic predispositions with regard to growth rate and feed utilisation which exceed, in this regard, the Polish Merino breed. It is worth emphasizing that the genetic potential associated with the growth of these crossbreeds is utilized better when the animals are fed diets with higher energy concentrations.

In the case of meat-type lambs, the wool yield is less important. Mean daily crude wool fibre production obtained in these investigations was not significantly correlated with the energy concentration in the diet. The obtained values of this parameter (3.66-3.75 g/d) differed from results obtained in experiments conducted on Merino-type lambs in which daily crude wool fibre production ranged from 3.80 to 5.10 g (Reis, 1969; Urbaniak, 1984, 1995). The use of diets of different energy concentration in this experiment did not significantly affect slaughter percentage or carcass morphological composition. However, the concentration of protein was higher and fat was lower than in rams of the Polish Merino breed that were slaughtered at similar body weights in experiments carried out by Urbaniak (1986) and Pająk et al. (1992). The obtained values of these parameters correspond with results reported by ARC (1984) for meat-type lambs.

The chemical composition of EBW did not depend on the energy level in the feed. A high protein concentration in EBW of rams was recorded (18.59-18.82%) and the chemical composition of EBW was more advantageous in comparison with Merino-type lambs in experiments conducted by Urbaniak (1986), Fix et al. (1988) and Pająk et al. (1992).

The assessment of utilisation of dietary ME on lamb growth using the comparative slaughter technique requires the determination of energy intake, energy content in animals' bodies at the beginning and end of an experiment, as well as maintenance requirements. The maintenance requirement was assumed, after Ørskov and McDonald (1970), Theriez et al. (1982b), and Urbaniak and Potkański (1987), at the level of 418 kJ kg $W^{0.75}$.

Because rams from group H were characterized by a higher growth rate and shorter fattening period, the total ME intake during the entire period of the experiment was similar to the amount of energy intake by animals from group L, so the average maintenance requirements of animals from group H, in relation to

mean metabolic weight, were, therefore, lower. The above interdependencies are why the quantity of ME available for growth in lambs from both groups was similar and animals from group H achieved a slightly higher (0.40), albeit statistically non-significant, value of the k_f coefficient in comparison with animals from group L (0.38). 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.

In the performed experiments a distinct, but statistically non-significant, increase in protein deposition in EBW of lambs fed diets with higher energy concentrations (group H) was observed, as confirmed by the correlations in the growth rate, production of clean wool fibre and feed conversion ratio. The amount of protein deposited in EBW gain was higher than in studies conduced by Urbaniak on Polish Merino sheep (1986, 1995).

Summing up the results of investigations discussed in this paper, it can be concluded that crossbred lambs of Black-headed Mutton sheep x Polish Merino are characterized by a higher growth rate and better feed conversion ratio and, simultaneously, by lower production of clean wool fibre than lambs of Polish Merino breed. A higher meat content and lower fat content in carcass accompanied by a better, from the consumer's point of view, chemical composition of EBW support the conclusion that the examined crossbred lambs fulfil the requirements of meat-type sheep and, consequently, can be recommended for further development of this direction of sheep production in Poland.

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STRESZCZENIE

Produkcyjność oraz skład ciała jagniąt mieszańców czarnogłowej owcy mięsnej i merynosa polskiego żywionych mieszankami pełnoporcjowymi o różnej koncentracji energii

Trzydzieści dwa tryczki mieszańce czarnogłowej owcy mięsnej i merynosa polskiego o średniej początkowej masie ciała około 22 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 36 kg.

Średnie dzienne przyrosty masy ciała jagniąt z grup L i H wynosiły odpowiednio 228 i 250 g ($P \leq 0.05$), a produkcja czystego włókna wełny 3,66 i 3,75 g/d. Zużycie energii metabolicznej (EM) na 1 kg przyrostu wynosiło 56,6 i 54,8 MJ, a białka ogólnego 718 i 649 g, odpowiednio w grupach L i H. Koncentracja EM w dawkach nie miała istotnego wpływu na wydajność rzeźną i skład morfologiczny tusz. Zawartość białka w 1 kg masy ciała netto (MCN) wahała się od 18,6 do 18,8%, tłuszczu od 17,6 do 18,1%, a wartość energetyczna od 11,25 do 11,55 MJ, odpowiednio w grupach L i H. Wykorzystanie EM dostępnej dla wzrostu (k_r) przez jagnięta z grup L i H było podobne (0,38 i 0, 40). Zwierzęta z grupy H odłożyły nieco więcej białka w przyroście MCN (39,1 g/d) niż jagnięta z grupy L (36,8 g/d).