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Rearing suckling Polish Lowland lambs on creep feed with different protein levels

J.J. Pająk, T. Żebrowska, M. Słowak and Z. Długolęcka

The Kielanowski Institute of Animal Physiology and Nutrition, Polish Academy of Sciences
05-110 Jabłonna, Poland

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ABSTRACT

Four groups of 44 suckling lambs (30 male and 14 female) were given supplementary feeds: meadow hay and a concentrate with barley containing: 162, 135 or 103 g crude protein in dry matter (groups H, M and L, respectively) or a mixture with oats, containing 138 g crude protein, group C. Restricting crude protein in the mixture to about 14% in DM did not have a detrimental effect on the growth of lambs, but when the mixture containing about 10% protein was given, the body weight gain of male lambs significantly declined. From day 28 of life to weaning at 89-93 days, the body weight gains of ewes did not differ among groups and equaled 120 - 132 g per day, while male lambs gained 142^{a}, 147^{a}, 126^{ab} and 115^{b} g ($P<0.05$) daily in groups C, H, M and L, respectively. The intake of dry matter from creep feed by suckling lambs was markedly lower than given in the IZ standards.

KEY WORDS: Polish Lowland lambs, creep feed, protein level, suckling lambs

INTRODUCTION

Suckling lambs obtain sufficient nutrients and energy from milk to cover maintenance and growth for the first four weeks of life. As the amount of milk produced by the mother decreases, it becomes necessary to add concentrates to the lamb's diet (Snowder and Glimp, 1991); the relatively early introduction of dry feed promotes the development of digestive functions in young lambs (Ørskov, 1983).

There is little data in the literature on the effects of creep feeding suckling lambs of Polish breeds on their rearing and later performance. According to Potkański et al. (1991a,b) partial replacement of soyabean oilmeal with rapeseed oilmeal or rape seed in the mixture given suckling Polish Merino lambs did not affect their growth rate. The body weight gains of Polish Lowland lambs were,

however, lower when they were given a mixture containing ground yellow lupin seeds instead of soyabean oilmeal (Pająk et al., 1999). Feed intake and body weight gain were lower when the lambs were fed mixtures with a lower crude protein content than when a high-protein feed was given (12 vs 17% in DM), but the suckling lambs creep fed with high protein contents grew more slowly during fattening and showed poorer feed utilisation (Pająk et al., 1994). However differences in final body weight and average daily gain between the groups Gaddi x Merino lambs fed from 7 to 90 day of life isoenergetic creep diets containing 11-21% CP were not significant (Sawal et al., 1996). Those authors suggest that creep diets containing 11% CP can be used to feed lambs during the preweaning period.

The objective of this study was to evaluate the effect on rearing of creep feeding suckling lambs with feeds having different protein compositions and levels.

MATERIAL AND METHODS

Animals

The experiment was conducted on four groups of 44 lambs each (30 males and 14 females) from twin births (two rams or one couple). Ewes and their lambs were housed in pens with creep feeders. The ewes were not included in the study, but were fed in groups according to IZ (1993) standards with the same rations of concentrates and bulk feeds.

Experimental diets

The suckling lambs were offered creep feed from day 11 of life. The feed was composed of meadow hay and concentrates with various proportions (33-98%) of rolled barley and contained: 16.2, 13.5 or 10.3% crude protein (CP) in dry matter (DM), respectively for groups H, M and L, or a mixture with 60% rolled oats, containing 13.8% CP in DM, for the control group, C (Table 1). The lambs had free access to the feed and water as well as salt licks containing trace elements. The concentrates and hay were given twice daily. Refusals were collected and weighed in the morning before fresh feed was given.

Experimental procedure

The lambs were weighed on days 2 and 28 of life and on two consecutive days before weaning at around 90 days of age. Feed intake, utilisation, and daily weight gain were determined from day 28 of life to weaning. Feed intake was compared

TABLE 1

Composition and nutritive value of concentrate for suckling lambs

Component, %	Group			
	C	H	M	L
Rolled barley	-	33.3	63.7	98.0
Rolled oats	59.9	-	-	-
Ground triticale	6.6	11.2	6.0	-
Ground wheat	14.4	24.4	12.9	-
Wheat bran	10.1	17.2	9.1	-
Soyabean meal	7.0	11.9	6.3	-
Mineral-vitamin supplement[1]	2.0	2.0	2.0	2.0
In 1 kg DM of concentrate				
crude protein, g	138	162	135	103
degradable, g	103	119	100	78
undegradable, g	35	43	35	25
digested in small intestine, g	31	35	28	21
PDIN, g	112	129	105	77
PDIE, g	107	123	112	99
UFV	1.01	1.09	1.12	1.15
metabolisable energy, MJ	12.8	12.8	12.9	13.2

[1] in %: calcium carbonate – 45, dicalcium phosphate – 25, commercial mineral-vitamin supplement Polfamix CJ – 15, sodium chloride – 15

with the daily requirements according to IZ standards (1993). The chemical composition of the feeds was analyzed by AOAC methods (1990). Protein degradation in the rumen was determined in three cows according to Mehrez and Ørskov (1977), effective ruminal protein degradation at $k_{0.06}$ was calculated according to Ørskov and McDonald (1979). Ileal digestibility of protein undegraded in the rumen (PDI) was determined using a mobile bag methods according to Hvelplund et al. (1992). The PDIN and PDIE contents were calculated according to INRA (1993) on the basis of the determined ruminal protein degradation coefficients and ileal digestibility of rumen undegraded protein. Metabolisable energy was calculated using the MAFF formula (1975), maintenance requirement was computed using the value of 418 kJ ME/$kg^{0.75}$ (Theriez et al., 1982).

Statistical analysis

The results were subjected to one-way analysis of variance. The significance of differences between means was tested with the Tukey least significance difference test. All calculations were performed using Statgraphics® Plus, ver. 7.0 (1993) software.

RESULTS

Concentrate mixtures with rolled oats (C) and rolled barley (M) contained similar amounts of crude protein, but the PDI content of the concentrate with barley was about 10% lower than in the oat based concentrate (Table 1). PDI in concentrate H, which had the highest crude protein content, was about 13% higher than in concentrate C with the intermediate protein content. Concentrate L with the lowest protein content had about 32% less PDI than concentrate C and 40% less than concentrate H.

The proportion of concentrate in dry matter intake ranged from about 43 to 46% when concentrates H, M and L were fed, while concentrate C accounted for about 52% of the ration intake (Table 2). This resulted in the differences in PDI intake being much smaller than among concentrates, and did not exceed 18% between groups H and L, which were given the feeds with the highest and lowest crude protein contents.

TABLE 2

Composition and nutritive value of dry matter consumed by suckling lambs

Component	Group			
	C	H	M	L
Concentrate mixture, %	52.0	43.8	46.2	42.7
Meadow hay, %	48.0	56.2	53.8	57.3
Crude protein, g	130	139	128	114
degradable, g	89	93	86	76
undegradable, g	41	46	42	38
digested in small intestine, g	32	34	31	28
PDIN, g	99	105	95	82
PDIE, g	97	103	98	92
UFV	0.83	0.83	0.85	0.85
Metabolisable energy, MJ	11.8	11.7	11.8	11.8

The crude protein content in the dry matter of consumed feeds (Table 2) equaled about 130 g/kg in groups C and M, while in group H it was about 7% larger and about 12% lower in group L. PDI in consumed DM when the concentrates containing 14% CP were fed was about 6-8% lower, while in group L it was 20% lower than the PDI taken up in group H. In rations, the PDI is given as the smaller of the two values, PDIN or PDIE. Only in group L was PDIN the limiting factor, and was 10 g/kg less than PDIE (Table 2).

When concentrates C, M and L were fed, the intake of creep feed DM per kg metabolic body weight ($W^{0.75}$) was about 37 g/kg$^{0.75}$, regardless of the protein level. Only when concentrate H was fed DM intake increased to 41 g/kg$^{0.75}$ (Table 3).

TABLE 3

Daily nutrient and energy intake, maintenance requirement to weaning *(mother milk is not taken into account in this calculation)*

Indices	Group			
	C	H	M	L
n	44	44	44	44
Intake/day/$W^{0.75}$				
dry matter, g	36.7	41.0	37.6	37.3
crude protein, g	4.8	5.7	4.8	4.2
metabolisable energy, MJ	0.44	0.47	0.44	0.44
net energy, MJ	0.20	0.22	0.21	0.20
Intake/day/lamb				
dry matter, g	272	282	261	260
crude protein, g	35	39	33	30
metabolisable energy, MJ	3.21	3.28	3.06	3.07
net energy, MJ	1.46	1.52	1.45	1.41
Daily maintenance requirement				
metabolisable energy, MJ	3.1	2.9	2.9	2.9

calculated: 418 kJ x mean metabolic weight ($W^{0.75}$)

Intake of concentrate DM per kg metabolic body weight was 18.0; 17.4 and 15.9 g/kg$^{0.75}$ when concentrates H, M and L, respectively, were given. The intake of concentrate C containing oats equaled 19.1 g DM/kg$^{0.75}$ and was about 9% greater than of concentrate M, which had a similar crude protein content, but contained barley. The amount of PDI consumed daily/$W^{0.75}$ was equal in groups C and M (1.17g/kg$^{0.75}$). The lambs given concentrate H received about 19% PDI more (1.39 g/kg$^{0.75}$), those given concentrate L received about 11% less (1.04 g/kg$^{0.75}$) than the lambs in groups C and M.

The amount of creep feed consumed covered from 55 to 63% of DM requirements, from 40 to 54% CP requirements, and from 53 to 58% of net energy requirements (Table 4) according to IZ standards (1993).

The daily weight gains of female lambs from day 2 to 28 of life differed among groups ($P<0.01$); those in group H grew slowest (Table 5) with gains about 24% smaller than those in the fastest-growing group (group C). During rearing from

TABLE 4

The nutritive value of rations in comparison with recommended allowances by IZ standards[1] *(milk is not taken into account in this calculation)*

Intake as per cent of requirement	Group			
	C	H	M	L
Dry matter	58.5	63.1	55.3	56.8
Crude protein	46.4	53.6	43.2	40.4
Net energy	53.7	58.1	52.6	52.7

[1] Nutrient Requirements of Cattle and Sheep, Traditional System (1993)

day 28 of life to weaning, the daily gains of female lambs did not differ significantly and equaled 120 g when concentrates H and L were fed.

Similar differences ($P<0.05$) were found in the growth rate of male lambs between days 2 and 28 of life, and those in group H, similarly as the female lambs, grew slowest and their gains were about 17% smaller than of the young rams in the fastest growing group (C). Between day 28 of life and weaning, the male lambs in group L grew from 9 to 22% more slowly than the others (Table 6).

The lambs utilized from 1.9 to 2.1 kg CP from creep feed for 1 kg body weight gain (ewe milk is not taken into account in this calculation). Protein utilisation was similar regardless of its level in the ration and equaled about 250 g/kg gain, with the exception of group H. The lambs in this group used 280 g/kg, which is 13% more than in the remaining groups (Table 7). The worst energy utilisation was found when the lambs were fed the low-protein concentrate (group L): about 12-15% worse than in group C.

TABLE 5

Body weight and liveweight gain from birth to weaning of female suckling lambs

Indices	Group				SEM
	C	H	M	L	
n	14	14	14	14	
Body weight, kg					
at 2 day of age	4.1	3.9	3.8	4.1	0.16^{NS}
at 28 day of age	9.5^{A}	8.0^{B}	8.5^{AB}	9.2^{A}	$0.30^{P<0.01}$
at weaning	17.8	15.5	17.1	16.9	0.86^{NS}
Days of age at weaning	91^{A}	88^{Ba}	91^{A}	90^{ABb}	$0.6^{P<0.01}$
Daily liveweight gain, g					
from 2 to 28 days of age	208^{A}	158^{Ba}	178^{AB}	196^{ABb}	$10.9^{P<0.01}$
from 28 days of age to weaning	128	120	132	120	11.4^{NS}
from 2 days of age to weaning	148	129	142	139	9.0^{NS}

TABLE 6

Body weight and liveweight gain from birth to weaning of male suckling lambs

Grupa	Group				SEM
	C	H	M	L	
n	30	30	30	30	
Body weight, kg					
at 2 day of age	4.5	4.5	4.4	4.4	0.13 ^{NS}
at 28 day of age	10.3^{a}	9.3^{b}	9.4^{ab}	9.9^{ab}	0.34 $^{P<0.05}$
at weaning	19.6	18.5	17.7	17.3	0.83 ^{NS}
Days of age at weaning	91^{AB}	88^{C}	92^{A}	90^{B}	0.4 $^{P<0.01}$
Daily liveweight gain, g					
from 2 to 28 days of age	224^{a}	185^{b}	190^{b}	210^{ab}	10.8 $^{P<0.05}$
from 28 days of age to weaning	142^{a}	147^{a}	126^{ab}	115^{b}	9.2 $^{P<0.05}$
from 2 days of age to weaning	162^{a}	155^{ab}	141^{ab}	139^{b}	8.1 $^{P<0.05}$

TABLE 7

Feed utilisation per kg of gain from 28 days of age to weaning *(mother milk is not taken into account in this calculation)*

Indices	Group			
	C	H	M	L
n	44	44	44	44
Utilisation/kg gain:				
dry matter, kg	1.91	1.99	1.98	2.14
crude protein, g	248	279	254	245
metabolisable energy, MJ	22.5	23.2	23.3	25.3
net energy, MJ	10.2	10.7	11.0	11.7

DISCUSSION

INRA (1993) standards do not give requirements for suckling lambs. IZ standards (1993) give from 170 g in the early stage to 154 g CP/kg DM in the last ten days before weaning (days 91-100 of life) for suckling lambs. The crude protein content in the DM of rations for the period of creep feeding lambs from days 28 to 100 computed on this basis is 160 g/kg DM, and the energy value of the ration is 5.84 MJ EN/kg DM.

The results of this experiment confirmed earlier conclusions (Pająk et al., 1994) that male lambs are more prone to react to a decreased protein content in creep feed by reducing body weight gain than are female lambs. From day 28 of

life to weaning, female lambs grew similarly, and their gains did not depend on the protein content of the concentrate, while the male lambs given the creep feed with the lowest protein content grew more slowly ($P<0.05$) than those in the other groups, which confirms the widespread opinion about the smaller protein requirement of female lambs than of male lambs.

After 28 days of life, the growth rate of male lambs given creep feed containing barley was about 14 and 22% slower in groups M and L than in the young rams in group H (Table 6). This was probably caused by the approximately 8 and 20% lower PDI intake in the daily rations in these groups in comparison with group H (Table 2).

The reduction of feed consumption when the protein content of the ration is lowered is a known occurrence (Ensminger et al., 1990). Suckling Polish Lowland lambs fed meadow hay and concentrates containing from 123 to 167g crude protein in DM grew similarly. Feeding concentrates containing less than 15% crude protein in DM lowered feed intake, resulting in slightly lower gains. The differences in the gains were not statistically significant because of the high intragroup variability resulting from the lack of full genetic consolidation of this breed, as well as from variability within sibling pairs (Pająk et al., 1994).

By lowering the crude protein level in DM of barley concentrates by 17 and 36% in comparison with group H (groups M and L), the amount of PDI in the DM of consumed feed decreased by about 9 and 18% (Table 2), but the reaction of suckling lambs was similar, and was manifested as reduced consumption of DM/kg$^{0.75}$ by 8.3 and 9.0% in groups M and L, respectively (Table 3). Purroy et al. (1993) also report that male lambs fed rations containing 12% crude protein consumed significantly less feed per kg$^{0.75}$ than at 15 or 18% protein contents. At a similar reduction of 9 and 22%, the amount of PDI in DM of the consumed ration (Pająk et al., 1994) and intake of DM/kg$^{0.75}$ declined by 14.8 and 15.5% in comparison with the group fed the concentrate with the same (167 g) crude protein content as in the presently described experiment (162 g/kg DM). No explanation for this observation has been found. Sawal et al. (1996) reported that in Gaddi x Merino lambs, fed in suckling period isoenergetic diets containing 11 to 21% CP, DM intake of creep feed was not affected by the level of protein.

Analysis of daily consumption of metabolisable energy in solid feeds and the maintenance requirements of lambs (Table 3) shows that in groups M and L, the amount of energy available for growth was similar: 0.16 and 0.17 MJ EM/lamb daily. In an earlier experiment (Pająk et al., 1994) lambs in similar groups consumed 0.42 i 0.49 MJ EM/lamb daily. In both experiments the decline in consumption of metabolisable energy available for growth in groups fed the concentrates with the lowest protein content in comparison with those fed concentrate H containing 162 or 167 g CP/kg DM was identical and equaled 55%. When feeds containing 135 or 147 g CP/kg DM were given, intake was also similar in

the two experiments and equaled 58 or 61%, respectively. Despite such large differences in the consumption of metabolisable energy available for growth, this had no effect on the gains of female lambs, and the lowering of the growth rate of male lambs did not exceed 23% in either experiment.

Villette and Theriez (1981) reported that during suckling, the intake of feed per kg metabolic body weight was independent of the birth weight of male lambs, but their daily gain was positively correlated with it. In our experiment, in which groups were fed creep feed, we did not find a statistically proven influence of birth weight of lambs on daily gains after 28 days of life.

Both during fattening (Pająk et al., 1993) and rearing (Pająk et al., 1994), Polish Lowland lambs consume less DM feed than the IZ standards (1993) give. In the present experiment, DM intake by lambs was, in comparison with these standards, smaller by 37% (in the group fed the concentrate with the highest crude protein content) to 45% in the groups fed concentrates with reduced protein contents (Table 4). In an earlier experiment (Pająk et al., 1994) lambs in similar groups consumed from 10 and 22-24% less DM than given in the IZ standards (1993).

The reduction in crude protein intake in relation to the standards (Table 4) results from lower DM intake and the methodology used in the experiment (lowering the protein content of the offered feeds). Lower feed consumption in the present experiment together with the lower birth weight of the lambs explains their slower growth rate.

According to Ensminger et al. (1990) oat grain is a better feed for sheep than barley. On comparing the results of rearing the group C lambs-fed the concentrate containing about 60% rolled oats-with those of group M lambs that were fed a concentrate having the same protein content (CP, PDI) but containing barley, it was found that the intake of the barley-containing concentrate was about 15% lower. The daily intake of ileal digestible protein was about 7% lower in group M than in C, which may account for the approximately 11% smaller daily gains of male lambs after 28 days of life (Table 6).

These results do not corroborate those of Ørskov et al. (1974) who showed that during fattening from a body weight of about 15 to 35 kg, lambs that had been weaned early had 29% greater gains and 11% better feed utilisation when fed with barley rather than oats. This may have been caused by the poorer development of the rumen and its function, which is indicated by the 55% higher gut content (% of liveweight) and 11% worse digestibility of organic matter of rations containing oats than barley.

The magnitude of daily gains could also have been modified by the dam's milk yield (Snowder i Glimp, 1991), which was not measured in this experiment. According to the cited authors, the correlation between milk yield and the growth rate of lambs is significant: up to day 56 it does not exceed 0.75 for single and 0.6 for

twins. A decline in maternal milk yield causes an increase in creep feed consumption (Ørskov, 1983). It seems that in the final stage of lactation, maternal milk yield is no longer a significant factor, since during this time solid feed intake by lambs increases. This is supported by the results of Frey et al. (1991), who found that Finn-Targhee dams given additional concentrates during grazing produced more ($P<0.05$) milk in the final stages of lactation (724 vs 586 ml/day) than those not given supplementary feed, but this had no effect on the body weight gains of the nursing twins. Milk intake was positively ($P<0.01$) related to growth, however, feed DM intake was not related to milk intake (Sawal et al., 1996).

In our experiment we did not determine the weight of the mothers at lambing, and, according to Barghout and Abdel-Aziz (1989), this has an influence ($P<0.01$) on daily gains and the weight of lambs at weaning at 10 weeks. On the basis of the growth of lambs of both sexes from day 2 to 28 of life, it can be assumed that the mothers of the lambs in group C produced more milk than the others (Tables 5 and 6). During this period, the gains of lambs in group H were about 24 and 17% smaller than in group C, in female and male lambs, respectively. In group M, lambs regardless of sex grew 14-15% more slowly, and in group L, about 6% more slowly than those in group C. This could also have affected the growth rate of lambs in later periods, since maternal milk yield in the first month of lactation affects lamb performance in the subsequent weeks of lactation (Bocquier et al., 1987).

The gains of suckling lambs (Tables 5 and 6) were relatively small, smaller than in an earlier experiment (Pająk et al., 1994), as well as smaller than of lambs of other breeds (Kosanovič et al., 1977; Potkański et al., 1991a,b; Urbaniak and Potkański, 1991a,b). This may be related to the dependence described by Villette and Theriez (1981) between the birth weight of lambs and their gains during suckling. Lambs that weigh more at birth gain faster, moreover, they gain less fat (INRA, 1993). In our experiment, female lambs in particular were lighter 2 days after birth than in the previous experiment (3.9; 3.8 and 4.1 vs 4.0; 4.3 and 4.5 in groups H, M and L, respectively; Pająk et al., 1994). The birth weight of lambs, maternal milk yield, and related growth rate of lambs are significantly affected by the year of the experiment (Niżnikowski et al., 1991).

Feed utilisation (excluding milk) did not differ among groups (Table 7) and was slightly better than in the earlier experiment (Pająk et al., 1994).

CONCLUSIONS

During suckling period, a reduction in the protein content of the feed mixture used in creep feeding lambs from 16 to about 14% in DM does not adversely affect gains, but a feed containing about 10% CP in DM is unsuitable for this group of animals.

Suckling Polish Lowland lambs consume less DM than given in the IZ standards (1993) foresee therefore, it is necessary to adjust requirements for DM and for the possibility of implementing economical protein nutrition.

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STRESZCZENIE

Odchów jagniąt ssących polskiej owcy nizinnej dokarmianych mieszankami o różnej zawartości białka

Cztery grupy, po 44 jagniąt ssących (w tym 14 jarek i 30 tryczków), dokarmiano sianem łąkowym i mieszanką treściwą z jęczmieniem zawierającą: 162, 135 lub 103 g białka ogólnego w suchej masie – grupy H, M i L, odpowiednio, bądź mieszanką z owsem zawierającą 13.8% białka ogólnego w suchej masie – grupa C. Ograniczenie poziomu białka w mieszance do ok. 14% w suchej masie nie spowodowało pogorszenia przyrostów jagniąt, natomiast przy skarmianiu mieszanki o ok. 10% białka stwierdzono istotne pogorszenie tempa wzrostu tryczków.

Od 28 dnia życia do odsadzenia (w 89-93 dniu życia) przyrosty jarek nie różniły się istotnie między grupami i wynosiły 120-132 g dziennie, tryczki przyrastały średnio po 142^{a}, 147^{a}, 126^{ab} i 115^{b} g ($P<0.05$) w grupach C, H, M i L, odpowiednio.

Jagnięta ssące polskiej owcy nizinnej zjadają mniej s.m. niż przewidują normy IZ, zachodzi zatem potrzeba wprowadzenia w nich korekty zapotrzebowania na s.m. oraz białko.