Growth Performance of Weaner Lambs Maintained on Varying Levels of Dietary Protein and Energy in the Pre-weaning Phase

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ABSTRACT : Influence of pre-weaning nutrition on post-weaning gain was assesses under intensive feeding in Malpura lambs. Thirty six Malpura (15 days old) lambs divided in to 3 equal groups were maintained on high (G1), medium (G2) and low (G3) energy and protein containing creep mixture with free suckling and *ad libitum* roughage (pala leaves: *Ziziphus nummularia*) up to 90 days of age. The lambs during post-weaning phase were fed on a 40:60 roughage and concentrate based composite diet to assess their post-weaning growth response. Total dry matter intake in pre-weaning phase was higher ($p<0.01$) in G3 than G2 and G1 while feed conversion efficiency was better in G1 than G2 and G3. The birth weight, 15 days body weight and weaning weight were however similar in the three groups. The finishing body weight, total body weight gain and average daily gain during post-weaning phase were higher ($p<0.01$) in G3 than in G1 and G2. The lambs in G3 consumed more ($p<0.01$) dry matter during post-weaning phase along with better feed conversion efficiency than other two groups. However, the DCP intake/kg body weight gain was higher in G1 than G2 and G3. Digestibility of DM, OM, CP, NDF, ADF and energy were similar among the three groups during post-weaning phase. Percent nitrogen retention as nitrogen intake was higher ($p<0.01$) in G3 (71.1%) than G1 (67.7%) and G2 (69.7%) during the post-weaning phase of study. The G1, G2 and G3 lambs in post-weaning phase consumed 8.1, 7.7 and 8.1 g DCP and 246.8, 227.2 and 246.1 kcal DE/kg $W^{0.75}$/d and had 84.4, 80.0 and 111.1 g average daily gain, respectively. It is concluded that the lambs fed on low energy and protein containing creep mixture in pre-weaning phase showed improvement in growth during post-weaning phase under optimum feeding regime. *(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 10 : 1394-1399)*

Key Words : Growth, Feed Conversion Efficiency, Nutrient Digestibility, Plane of Nutrition

INTRODUCTION

Under existing grazing practices in India, lambs on a farmers field attain 16 kg body weight at 6 months of age (Kaushish et al., 1990) and are generally slaughtered around 9 to 12 months of age weighing about 20 to 22 kg (Karim et al., 1998). The observed lower growth rate of native sheep is ascribed to their poor genetic potential or low plane of nutrition for most of the year, unorganized husbandry practices and inadequate prophylactic and curative health coverage. Lambs after birth depend solely on dam's milk till seven days of age and thereafter start nibbling which gradually increases to a significant proportion of the diet by fourth week (Jenssens and Ternouth, 1987). Creep mixture is generally provided to lambs one week after birth to stimulate early rumen development and supplement their nutrient up-take for faster growth (Hamada et al., 1976). Although considerable work has been conducted in India on post-weaning growth and nutrient requirements of lambs (Karim, 1999) there is little information on pre-weaning plane of nutrition and its effect on post weaning growth of the lambs (Santra and Karim, 1999a). The pre-weaning nutrition of lambs significantly affect their post-weaning growth performances. Additionally, the dietary level of protein and energy in pre-weaner phase is known to have sizeable influence on post-weaning body weight gain of the lambs (Andrighetto et al., 1993). The reported experiment was, therefore, conducted by maintaining pre-weaner Malpura lambs on varying levels of dietary protein and energy in creep mixture to study their nutrient utilization pattern and growth responses in the post-weaning phase under intensive feeding.

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MATERIALS AND METHODS

The experiment was conducted at Central Sheep and Wool Research Institute, Avikanagar, India located at 75° 28'E latitude and 26° 17'N longitude and 320 m above mean sea level. The climate of the location is typical hot semiarid. The experiment was initiated in the month of March and continued till August, 1997. During the experiment average minimum and maximum ambient temperature and RH of the location ranged from 22 to 32 and 30 to 44°C and 20 to 96%, respectively.

Experimental animals and feeding management

Thirty six Malpura lambs at 15 days after birth were randomly divided into 3 equal groups (G1, G2 and G3) of 12 lambs each. In addition to free suckling, these lambs had round the clock free access *ad libitum* creep mixtures having high (G1), medium (G2) and low (G3) digestible protein and energy values (table 1). The lambs after 15 days of birth were maintained in individual chain link enclosures within an animal shed with free suckling from their

Table 1. Physical composition of experimental rations

Attributes	Creep mixture			Post-weaning ration
	G1	G2	G3	
Cenchrus ciliaris				20
Pala (*Ziziphus nummularia*) leaves	-	-	50	20
Barley grain	68	25	37	43
Groundnut cake	30	15	-	14
Wheat bran	-	58	-	-
Mineral mixture[a]	1	1	1	2
Common salt	1	1	1	1

[a] Mineral mixture contained calcium 28.0%, phosphorus 6.2%, common salt 35.8%, iron 0.4%, iodine 250 ppm, manganese 740 ppm, copper 280 ppm and sulfur 0.15%.

[b] Vitamin supplement (Rovimix)® was added 20 g per 100 kg of concentrate mixture. Rovimix® contained 40000 IU vitamin A, 20 mg vitamin B_2 and 5000 IU vitamin D_3 per g. (% on air dry basis)

respective dams and received *ad libitum* creep mixture of identified composition and air dried pala (*Zizyphus nummularia*) leaf in separate containers. The pre-weaning growth study was continued up to 90 days of lamb age. After weaning the lambs from G1, G2 and G3 were individually fed on a composite feed with 60:40 concentrate and roughage (pala leaves - *Ziziphus nummularia*) for another 90 days. Feed was offered once at 09:00 h and daily records of feed offered and residue left were maintained through out the study. The lambs were weighed in weekly intervals for assessing their growth profile. The physical and chemical composition of the creep mixtures fed to the lambs during pre-weaning phase and composite feed fed to the lambs during post-weaning phase are presented in table 1 and table 2, respectively. Milk yield of the ewes was estimated by lamb suckling method while the milk composition was estimated by the method of AOAC (1990). The plane of nutrition of these lambs in pre weaning phase is already reported by Karim et al. (2001).

Metabolism trial

At five months of lamb age, a metabolism trial was conducted on 8 representative animals from each group in cages with facility for quantitative collection of faeces and urine to assess their plane of nutrition following a protocol of five days adjustment and seven days collection period. Representative samples of feed offered, residue left, faeces and urine voided in 24 hours during 7 days collection period were pooled, processed and preserved for later chemical analysis.

Chemical analysis

Samples of feed offered, residue and faeces from the metabolism trial were analyzed for DM, OM, CP (AOAC, 1990) and cell and cell wall contents (Van Soest et al., 1991). Urine samples collected during the trial period were analyzed for nitrogen (AOAC, 1990). The gross energy value of the samples was determined using Ballistic Bomb Calorimeter (Gallenkemp CBB- 330-010 L, UK).

Table 2. Chemical composition of experimental ration (on % DM)

Attributes	Creep mixture			Composite ration	*Cenchrus ciliaris*	Pala leaves
	G1	G2	G3			
OM	89.2	91.2	86.1	89.3	89.7	80.7
CP	21.4	16.9	14.3	14.8	3.7	11.7
ADF	14.1	17.8	29.3	27.4	60.2	50.1
NDF	40.4	49.6	61.4	46.6	81.9	62.4
Cellulose	11.1	12.3	16.7	16.4	21.3	21.9
Hemicellulose	26.3	31.8	32.2	19.2	21.7	12.4
ADL	3.0	3.8	7.6	6.6	10.7	13.0
GE (kcal/g DM)	4.7	4.5	4.1	4.7	4.5	4.3

OM, organic matter; CP, crude protein; NDF, neutral detergent fibre; ADF, acid detergent fibre; ADL, acid detergent lignin; GE, gross energy; DM, dry matter

Statistical analysis

The data generated in the experiment were subjected to analysis of variance as per Snedecor and Cochran (1967) and significant group differences were compared by Duncan's Multiple Range Test (Duncan, 1955). Body weight changes of individual lamb during the post-weaning phase was charted by fitting third degree polynomial equations and the generated constants were subjected to least squares analysis of variance to assess the group differences. The pooled constants for the groups are presented graphically (fig. 1).

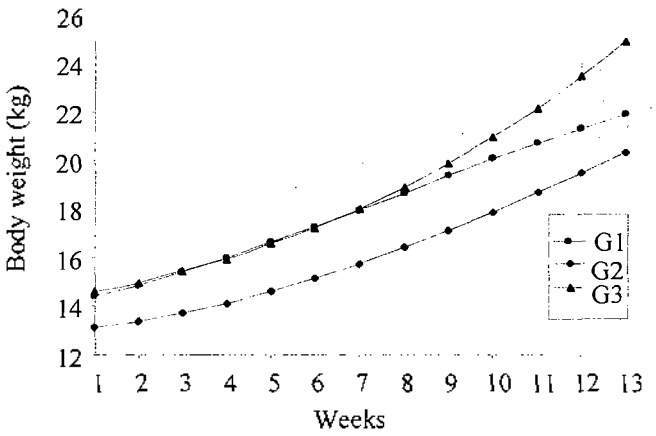

Figure 1. Growth curve of post-weaner lambs

$G1=Y1=14.06+0.32X1+0.048X1^2-0.002X1^3$

$G2=Y2=12.99+0.11X2+0.048X2^2-0.001X2^3$

$G3=Y3=14.26+0.30X3+0.027X3^2-0.001X3^3$

Table 3. Growth performance of experimental lambs

Parameters	Treatment groups			SEM
	G1	G2	G3	
Number of experimental animals	12	12	12	-
Birth weight (kg)	2.8	2.6	3.0	0.25
15 days body weight (kg)	4.9	4.8	5.4	0.34
Weaning weight (kg)	14.3	13.0	14.8	0.81
Pre-weaning average daily gain (g)	123.8	107.9	123.6	8.57
Total dry matter intake during pre-weaning phase (kg)/lamb				
Creep mixture	13.8^{A}	14.8^{A}	17.3^{B}	1.07
Pala leaves	1.2	1.3	1.1	0.16
Milk	5.8^{A}	5.9^{B}	6.1^{C}	0.01
Total	20.8^{A}	22.0^{A}	24.5^{B}	0.92
Per cent feed efficiency during pre-weaning phase	45.9^{B}	37.9^{A}	38.8^{A}	2.41
Post-weaning phase				
Finishing body weight (kg)	21.9^{A}	20.2^{A}	24.8^{B}	1.19
Post-weaning body weight gain (kg)	7.6^{A}	7.2^{A}	10.0^{B}	0.37
Post-weaning average daily gain (g)	84.4^{A}	80.0^{A}	111.1^{B} 1	8.39
Total DCP intake (kg)	4.94^{A}	4.50^{A}	6.3^{B}	0.31
Total DE intake (M cal)	147.8^{A}	134.5^{A}	189.9^{B}	14.41
Feed conversion ratio				
Dry matter intake (kg DM/kg live weight gain)	7.2^{A}	7.6^{A}	6.4^{B}	0.39
DCP intake (g/kg gain)	650.0^{B}	627.0^{A}	636.0^{A}	6.73
DE intake (M cal/kg gain)	19.4	18.6	18.9	0.97

Unlike superscript in a row differ significantly ($p<0.01$)

RESULTS AND DISCUSSION

Milk yield and milk composition of ewes

The milk yield of the ewes was 500 g/day on the day of lambing while peak yield was recorded on 2nd and 3rd week (575 g). The average milk yield of the ewes over the lactation length was 496 g/day amounting to total lactation yield of 41.7 kg in 84 days. The observed average daily milk yield of the Institute bred Malpura ewes was similar to earlier reports (Mollel, 1984) while the yield was higher than the native sheep under farmers management (Riyazuddin et al., 1998) and lower compared to cross bred Bharat Merino (Singh, 1997) and Mutton Synthetic (Singh and Singh, 1987) ewes. On an average, the milk of the ewes contained 6.08% fat, 3.39% lactose, 5.12% protein, 9.50% solid not fat, 15.80% total solid and 1.30% ash.

Growth performance and feed conversion efficiency

The lambs were maintained exclusively on dam's milk till 15 days after birth. Under the cafeteria system of feeding management and free suckling followed in the study, the creep mixture consumption of G1 and G2 lambs during pre-weaning phase amounted to 66.3 and 67.2% of total DMI, respectively while in G3 group it was 70.6% indicating that lambs of G3 group sizably increased their creep mixture consumption to match the lower DCP and DE value of the creep mixture offered to them. Similarly the pala leave consumption was near about 6% of total DMI in G1 and G2 while it was 4.5% in G3. The lower pala leave consumption in G3 fed low energy and protein containing creep mixture was due to their proportionately higher creep mixture intake. Likewise the milk consumption was 27.9% of total DMI in G1 which decreased ($p<0.01$) to 26.8% in G2 and 24.9% in G3. Lower milk consumption by G2 and G3 lambs was possibly a reflection of their higher creep mixture intake restricting milk consumption due to gut fill limitation. The total DMI from all the three sources in pre-weaning phase was however similar in G1 and G2 and higher ($p<0.05$) in G3 (table 3). The DMI from all the three above sources amounted to 2.2, 2.5 and 2.4% of body weight, respectively in G1, G2 and G3. It is established that nutrient density of ration and DMI, within limit, are inversely related (Slabbert et al., 1992) hence the observed differences were expected. The birth weight, 15th day weight and weaning (90 days) body weight, total gain and average daily gain were however similar in the three groups during the pre-weaning phase (table 3). The growth rate observed in the present study in pre-weaning phase was similar to earlier reports on pre-weaner lambs (Singh and Singh, 1987; Santra and Karim, 1999b).

Although the weaning weights were similar in the three groups still the finishing body weight of the lambs in G3 group was significantly ($p<0.01$) higher than the lambs in G1 and G2. The post weaning average daily gain was also

Table 4. Dry matter intake and nutrients digestibility of lambs in post weaning phase

Parameters	Treatment groups			SEM
	G1	G2	G3	
Body weight during metabolism trial period (kg)	21.8	20.3	23.1	1.75
Dry matter intake				
g/d	878.9	763.5	853.8	91.46
g/kg body weight/d	40.1	37.7	36.8	2.12
g/kg $W^{0.75}$/d	86.7	79.6	81.5	3.46
Water intake				
liter/d	2.4	2.0	2.1	0.17
ml/kg body weight/d	109.1	98.5	95.2	8.14
liter/kg dry matter intake/d	2.7	2.6	2.5	0.29
Digestibility coefficients				
Dry matter				
Intake (g/d)	878.9	763.5	853.8	64.37
Digestibility (%)	62.8	62.0	62.4	1.09
Organic matter				
Intake (g/d)	795.6	693.6	776.4	58.62
Digestibility (%)	64.4	64.0	64.7	0.93
Crude protein				
Intake (g/d)	133.6	116.9	130.9	12.42
Digestibility (%)	63.6	63.3	64.6	0.57
NDF				
Intake (g/d)	387.6	331.7	369.5	26.51
Digestibility (%)	37.5	36.2	35.8	1.78
ADF				
Intake (g/d)	222.6	189.3	210.6	16.38
Digestibility (%)	26.0	25.6	24.8	1.07
Cellulose				
Intake (g/d)	131.1	110.8	123.0	13.44
Digestibility (%)	35.2	33.2	34.6	1.43
Hemicellulose				
Intake (g/d)	165.0	142.4	158.9	9.51
Digestibility (%)	53.0	56.3	55.6	1.02
GE				
Intake (Mcal/d)	4.2	3.6	4.1	0.29
Digestibility (%)	59.9	60.1	62.3	1.24

highest in the G3 (111.1 g) followed by G1 (84.4 g) and G2 (80.0 g) indicating their better growth response. Among G1 and G3, the growth response was better in G3 than G1 during last four weeks of the study (fig. 1). The results indicated that the G3 lambs exhibited improvement in body weight gain during post-weaning phase of growth. Total dry matter, DCP and DE intake during 90 days post-weaning growth study was similar in G1 and G2 and higher ($p<0.01$) in G3. The feed conversion ratio (kg dry matter and DCP intake/kg gain) was higher ($p<0.01$) in G3 than G1 and G2. The feed conversion ratio of the three groups was within the range of earlier reports on the same genetic group under intensive feeding (Karim and Arora, 1997; Karim and Rawat, 1997).

Nutrients digestibility

The daily dry matter intake of the lambs during the metabolic trial period in post-weaning phase was similar in the three groups ranging from 3.7 to 4.0 per cent of the body weight or 79.6 to 86.7 g / kg $W^{0.75}$. The daily dry matter intake of weaned lambs in active phase of growth under Indian conditions range from 3.5 to 4.0 per cent of their body weight (Shinde et al., 1995; Karim and Arora, 1997; Santra and Karim, 1999a). Ranjhan (1980) suggested that the dry matter intake of 73 g/kg$W^{0.75}$/d was adequate for growing lambs for their optimum growth while it was 81 g/kg $W^{0.75}$/d in the study of Falman and Eyal (1978). These observations compare favorably with our finding indicating that dry matter intake of the lambs in the present study was adequate for their growth requirement. The daily water intake in terms of unit body weight as well as daily dry matter intake was similar in the lambs of three groups. The lambs in the G1, G2 and G3 groups consumed water amounting to 10.9, 9.8 and 9.5 per cent of their body weight respectively which was higher than 5 to 6 per cent reported for sheep under comfortable condition (More and Sahani, 1978). The post weaning phase of the growth study was conducted during the month of June to August which is considered as hot humid condition exerting greater heat stress on the animals compared to hot dry environmental condition (Guerrini, 1981). As a result the animals consumed more water to meet their thermo regulatory need (Karim, 1990). Digestibility of dry matter, organic matter, crude protein, fibre fraction (NDF, ADF and cellulose) and gross energy were similar in the three groups. The expected improvement in nutrients digestibility in G3 lambs previously maintained on low energy and low protein diet during pre-weaning phase was not evident in the present study. This was possibly due to similar dry matter intake in the three groups during metabolism trial period. The digestibility of the nutrients observed in the present study were comparable to the range of nutrient digestibility values in published reports on lambs in active phase of growth (Santra and Karim, 1999a).

Plane of nutrition and nitrogen balance

Lambs in all the three groups were in positive nitrogen (N) balance (table 5). The daily nitrogen intake and its excretion in urine and faeces were similar in the lambs of three groups. However nitrogen retention as per cent of daily nitrogen intake was higher ($p<0.01$) in G3 while it was similar in G2 and G1. During post weaning phase of experiment, the lambs of G3 group grew at a faster rate which is also supported by higher nitrogen retention in them.

Table 5. Plane of nutrition and nitrogen balance in post-weaner lambs

Parameters	Treatment groups			SEM
	G1	G2	G3	
Nutritive value of ration				
DCP (g kg^{-1} DM)	9.4	9.7	9.9	0.25
DE (M cal kg^{-1} DM)	2.8	2.9	3.0	0.28
Plane of nutrition				
DCP intake				
g/d	82.8	73.6	84.6	6.51
g/kg body weight/d	3.7	3.6	3.4	0.21
g/kg $W^{0.75}$/d	8.1	7.7	8.1	0.29
DE intake				
Mcal/d	2.5	2.2	2.6	0.39
kcal/kg body weight/d	114.2	107.7	112.5	4.10
kcal/kg $W^{0.75}$/d	264.8	227.2	246.1	16.41
Nitrogen balance				
Intake (g/d)	28.4	26.4	30.0	2.14
Voided in faeces (g/d)	8.2	6.2	7.4	1.05
Voided in urine (g/d)	1.0	1.1	1.2	0.13
Nitrogen retained (g/d)	19.2	18.3	21.4	1.53
Per cent nitrogen retention	67.7^{A}	69.7^{AB}	71.1^{B}	1.07

Unlike superscript in a row differ significantly ($p<0.01$).

The daily nitrogen retention was 67.7, 69.7 and 71.1 per cent in G1, G2 and G3 groups respectively which is considered to be adequate for the growing lambs (Santra and Karim, 1999a). Relatively higher N retention and the observed lower rate of gain in these lambs was possibly due to poor quality N available to them. It is established that poor quality feed N is incorporated to lesser extent in body synthesis. Further, it is also realised that protein requirement of the lambs in hot condition, as in the present experiment, will be higher due to heat mediated impairment of protein metabolism (El-Fouley et al., 1978) and increased protein losses in sweating (Mc Dowell et al., 1969). Under such situation the protein synthesis in the body does not match with protein utilization in lambs resulting in reduction of growth (Ames and Brink, 1977).

Daily DCP intake was similar in the three groups (8.1, 7.7 and 8.1 g/kg $W^{0.75}$/d in G1, G2 and G3 group, respectively) and adequate as per recommendation of ICAR (1985). Similarly, the lambs of G1, G2 and G3 groups on an average consumed 246.8, 227.2 and 246.1 kcal DE/kg $W^{0.75}$/d respectively. In post-weaning phase the lambs on an average consumed 33 g DCP / Mcal DE for an average daily gain of 92 g. The observed values were near to Kearl (1982) recommendations of energy and protein allowance for growing lambs under tropical environment which was possibly due to low quality of tropical protein (Weston, 1981).

CONCLUSION

The pre-weaner lambs maintained on free suckling and low quality creep mixture showed improvement in total dry matter and digestible energy intake during post-weaning phase which was reflected in their better growth response.

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