Production Performance and Carcass Characteristics of Malpura and Mutton Synthetic Lambs Fed Low and High Energy Rations in a Semiarid Region of India

N. P. Singh*, S. K. Sankhyan and V. S. S. Prasad
Division of Animal Nutrition Central Sheep and Wool Research Institute.
Avikanagar-304 501 (Via-Jaipur) Rajasthan, India

ABSTRACT : Forty eight lambs (24 each of Malpura and Mutton synthetic breeds) were weaned at 90 days of age and divided into two groups. One group of 12 lambs from each of the two breeds was maintained on low energy (52% TDN) and the other group of 12 on high energy (58% TDN) feedlot ration until 6 of the lambs attained 20 kg and the other 6 attained 25 kg live weight in each of the two groups. Daily feed intake and weekly body weights were recorded. Conventional metabolism trials were conducted on the two breeds and the two rations. The growth rate was found to be higher for lambs on high energy ration ($p<0.01$). The growth rate was also higher for higher target weight groups ($p<0.01$). The breed did not significantly affect the live weight gains. Mutton synthetic lambs required less number of days to reach 20 kg live weights but took more time to reach 25 kg target weight as compared to Malpura lambs ($p<0.01$). The lambs of both the breeds reached 25 kg live weight earlier on high energy than those on low energy ration ($p<0.01$). The dry matter intake, irrespective of breed, was significantly higher (4.57% or 93.4 g per $kgW^{0.75}$) on low energy than that on high energy ration (4.20% or 87.2 g per kg $W^{0.75}$). The digestibility coefficients of all the nutrients excepting crude fibre were significantly higher on high energy diet irrespective of the breed. Lambs on low energy ration, however, digested the crude fibre more than those on the high energy ration ($p<0.05$). Although there were no significant differences in the intakes of nitrogen, calcium and phosphorus, the balance of nitrogen was higher on high energy ration. The DCP and TDN values were 9.70 and 52.76% for low energy and 9.89 and 57.68 % for high energy ration, respectively. The dressing percentages on live weight basis were 50.2 on low and 51.6 on high energy ration, 50.5 at 20kg and 51.3 at 25 kg slaughter weight and 51.0 in Malpura and 50.8 in Mutton synthetic lambs, respectively. The percent of bones in the carcass was higher on low energy ration in Mutton synthetic lambs at 20 kg slaughter weight than others. It was concluded that the performance of the lambs in respect of mutton production was significantly better on high energy ration fed upto 25 kg slaughter weight with no or little breed differences. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 5 : 655-659)***

Key Words : Performance, Carcass Characteristics, Lambs, Energy, Feedlot Ration

INTRODUCTION

The productivity of Indian sheep is low compared to those in more agriculturally developed countries. The main reasons for the low productivity are low genetic potential and poor nutritional status of our native sheep. The sheep meat available in the Indian market comes either from old and culled adults or from male lambs maintained on scrub vegetation under extensive system and slaughtered at any time between 9 months to one year of age. The meat quality and quantity are poor due to poor market weight, lower dressing percentage and narrow meat: bone ratio (Singh and Patnayak, 1987; Kaushish et al., 1990 and Karim, 2000). Under the existing conditions of our range lands and natural pastures, great limitation is on the availability of adequate protein for more than half the year (Bhatia et al., 1973, 1978). Studies have revealed that marked improvement both in quantity and quality of meat produced could be achieved by crossbreeding the indigenous breeds with exotic mutton breeds and feeding the lambs on feedlot rations intensively (Prasad et al., 1981; Singh, 1982; Sehgal and Rawat, 1983; Singh and Singh, 1987 and Karim et al., 2002). However, feeding of crossbred lambs *ad lib.* on very high energy feedlot rations to obtain faster and higher slaughter weights resulted in undesirable higher fat deposition in the carcass (Karim and Santra, 2000) The present study was, therefore, conducted to study the production performance and carcass characteristic of native (Malpura) and crossbred (Malpura X Dorset/Suffolk) weaner lambs on two energy levels using *Zizyphus nummularia* leaf meal as the roughage source at two targeted slaughter weights and recommend appropriate level of feed energy and proper slaughter weight.

* Corresponding Author: N. P. Singh. Tel: +91-1437-220143, Fax: +91-1437-20163, E-mail: npsingh@cswri.raj.nic.in
Received September 17, 2002; Accepted January 14, 2003

MATERIALS AND METHODS

Experimental protocol

Forty eight lambs (24 each of Malpura and Mutton synthetic breeds) after weaning at 3 months of age were divided into 2 groups and maintained on low energy (R1) and high energy (R2) rations from 91 days of age until they attained the target weights. These groups were further divided into 2 target weights, 20 kg and 25 kg. Low energy

Table 1. Ingredients and chemical composition of the complete feeds (%)

Ingredients	Low energy	High energy
Pala (*Zizyphus nummularia)* leaves	57	37
Barley	20	40
Ground nut cake	20	20
Mineral mixture	02	02
Common salt	01	01
Vitablend (AD_3) per Quintal, g	25	25
Chemical composition	% on dry matter basis	
Dry matter	95.26	94.59
Crude protein	18.45	18.90
Ether extract	01.32	01.19
Crude fibre	17.96	13.78
Nitrogen free extract	50.10	54.15
Total carbohydrate	68.06	67.93
Total ash	12.17	11.98
Calcium	02.13	01.86
Phosphorus	00.41	00.45

* Vitablend: contained vitamin A 50,000 I.U./g, Vitamin D_3 5.000 I.U/g

ration (R1) comprised of dry pala (*Zizyphus nummularia)* leaves, barley, ground nut cake, mineral mixture and salt (57: 20: 20: 2: 1, on DM basis) while the high energy ration contained pala leaves 37 parts and barley grain 40 parts, with rest of the ingredients being same (Table 1). The complete feed was offered for *ad libitum* intake to all the 8 experimental groups in individual pens. Daily record of offered and residue of the feed was maintained throughout the experimental period. Body weights of lambs were recorded at a week interval and daily when the lambs approached the target weight. The metabolism trial was conducted for 7 days just after completion of 30days of feeding of experimental rations on 5 lambs from each group. Samples of diet, its residue and faeces were collected daily during the metabolism trial, dried at 60-70°C for 24 h, ground to pass a 2 mm screen in Willey mill and kept as per standard procedure, while the urine samples were processed for further chemical analysis (AOAC,1990). The lambs were slaughtered for detailed carcass analysis when they achieved the target weights.

Slaughter protocol

The lambs were fasted for 18 hours with free access to water and slaughtered in an experimental abattoir by halal method (Slaughter according to Mohammedan law). The conscious animals were placed in lateral recumbency with head facing up wards. Bleeding was carried out by an incision on the jugular vein on the both sides and in some cases on the trachea, oesophagus and spinal cord. Head was removed at the atlanto-occipital joint and the carcass was partially skinned on the floor and than hanged on the racks by hind legs and the remaining skin was removed. Evisceration was carried out and carcass and non-carcass components were separated and weighed. Fore and hind feet were removed at the carpal and tarsal joints immediately after slaughter. Hot carcass weight included total edible offals (testis, spleen, pancreas, caul fat, kidney fat, kidney, liver and heart). Lungs, trachea and heart were weighed as one piece and designated as pluck. Inedible offals constituted blood, lungs, intestine, head and hooves. Loin eye area (cm^2) was recorded on the cut surface of the *Longissimus dorsi* muscle at the interface of 12th and 13th rib on both sides of the carcass. The carcass was then split along the mid line into two halves and one half carcass was cut in to leg, loin, rack and shoulder and breast and shank as per ISI (1963) specifications. Different carcass cuts were ice chilled, stored and manually dissected next day into lean, fat and bone contents.

Statistical analysis

Data of feed intake, nutrient utilization, growth rate and carcass measures were subjected to analysis of variance (Sendecor and Cochran, 1969) considering rations, breeds and target slaughter weights independently as main effects using SPSS 10 package. The statistical analysis did show interaction effects in case of some measures, the differences, however, did not reach the level of significance and were, therefore, ignored.

RESULTS AND DISCUSSION

Initial average weaning live body weight of Malpura and Mutton synthetic lambs ranged from 10.8 to 12.3 and 12.5 to 13.7 kg, respectively. Final body weight recorded irrespective of breed and target weights was similar for ration R1 and R2, and was higher ($p<0.01$) for 25 kg target weight. While comparing breeds no differences were observed.

Malpura lambs attained target weight of 20 kg in 63.8 and 69.3 days on R1 and R2 rations, and differences were significant ($p<0.01$), while Mutton synthetic lambs attained similar weights in 50.2 and 53.0 days. Total gain and average daily gains of Malpura and Mutton synthetic lambs were higher on R2 than R1, among breeds differences were non-significant, but for target weights (20 kg and 25 kg), the gain was higher ($p<0.01$) for 25 kg weight. Total number of days on feeding to achieve the target weight was longer ($p<0.01$) in Malpura (72.2 days) than Mutton synthetic (66.3 days), irrespective of the experimental rations. The differences were obviously more pronounced ($p<0.01$) for 25 kg target weight, than that of 20 kg. Although the Malpura lambs maintained on R2 had a faster rate of gain (138.5 g/d) than that on R1 (130 g/d), they took longer time to achieve the target weight, mainly due to their lower weaning weights (10.8 kg). Karim and Santra, (2000)

Table 2. Least square means of body weight gains and feed consumption

Particulars	Main effect comparison[1]						
	Ration I*	Ration II**	Target weight 20 kg	Target weight 25 kg	Malpura	Mutton synthetic	Overall means
Initial body weights (kg)	12.97±0.47	12.47±1.06	12.3±0.97	13.1±0.41	12.3±0.93	13.07±0.53	12.68±0.85
Final body weight (kg)	22.85±2.45	22.92±2.47	20.4±0.15	25.35±0.05	22.93±2.43	22.85±2.50	22.88±2.46
Total gain (kg)	9.95±2.25	10.47±1.76	8.15±1.03	12.25±0.38	10.63±1.74	9.78±2.49	10.20±2.19
Average daily gain (g)	140.7±9.08	151.95±10.42	138.23±7.92	154.45±7.74	146.27±14.09	146.40±7.45	146.33±11.27
Number of days on feeding	69.9±13.80	68.62±9.50	59.07±7.79	79.45±3.69	72.22±6.46	66.30±14.92	69.26±11.87
Total feed intake (kg)	64.25±22.00	54.88±12.91	42.90±4.13	76.22±11.06	58.70±13.19	60.42±22.78	59.56±18.64
Feed intake/head/d (g)	894.27±146.24	790.70±94.00	729.93±34.79	955.05±95.06	803.85±110.10	881.12±143.10	842.48±133.39
Feed required per kg live weight gain	6.3±0.66	5.2±0.52	5.3±0.41	6.2±0.86	5.5±0.63	6.0±0.89	5.75±0.82

[1] (p<.01), * Low energy, ** High energy

Table 3. Digestibility coefficients of nutrients (%)

Nutrients	Low energy		High energy	
	Malpura	Mutton synthetic	Malpura	Mutton synthetic
Dry matter	56.37[a]±2.528	56.28[a]±0.550	64.41[b]±1.763	61.99[b]±0.801
Crude protein	53.65[a]±2.748	51.55[a]±1.594	62.15[b]±2.588	58.00[b]±2.519
Ether extract	35.57[a]±4.654	37.59[a]±2.167	50.88[b]±5.546	45.67[b]±2.928
Crude fiber	50.39[b]±3.834	51.95[b]±1.766	35.62[a]±1.766	37.30[a]±2.171
Nitrogen free extract	65.60[a]±2.324	66.13[a]±0.358	74.94[b]±1.833	72.62[b]±0.825
Total carbohydrate	61.15[a]±1.670	62.14[a]±0.173	67.16[b]±1.283	65.56[b]±0.607

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

also made a similar observation that 6 month body weight of lambs was directly related to their weaning weights. Malpura and Mutton synthetic lambs fed on R1 gained 8.3 and 6.7 kg in 63.8 and 50.2 days, respectively. Although the total gain in Mutton synthetic lambs was lower (<0.01) than Malpura on R1, their higher weaning weights and rate of gain resulted in lesser number of days required to achieve 20 kg. Similar trend was observed in both the breed groups maintained on R2. However, the 25 kg target weight was achieved in 81.3, 74.5 and 84.3, 77.7 days by Malpura and Mutton synthetic lambs, maintained on R1 and R2 rations, respectively. Total gain and average daily gains were apparently higher in Mutton synthetic than Malpura lambs, but higher initial weaning weights of Malpura lambs resulted in lesser number of days required to achieve the target weight on R1. Inspite of having lower weaning weight Malpura lambs on R2 ration had higher ADG and took less time to reach 25 kg than Mutton synthetic lambs. Overall feed consumption in Malpura lambs was lower (803.8 g) as compared to Mutton synthetics (881.1 g), feed conversion efficiency for 25 kg target weight was higher than that for 20 kg (Table 2). In general, pooled consumption of feed on R1 (894.3 g/h/d) was higher than on the R2 (790.7 g/h/d) irrespective of breed and target weight. The consumption of feed is mainly associated with energy/nutrient density in the ration so as to meet the nutrient requirements. Similar observations were also made by Misra et al. (2000) in adults maintained on mustard straw and top feed based diets. Total feed intakes of Malpura and Mutton synthetic lambs irrespective of two rations and target weights are presented (Table 2). Malpura lambs required less (p<0.01) feed (5.5 kg) than Mutton synthetics (6.0 kg) per kg live weight gain irrespective of the energy level and target weight. Sehgal et al. (1982), however, reported higher feed conversion efficiency in crossbreds than the natives maintained on 25:75 roughage to concentrate feedlot ration.

Low energy ration (R1) containing 57% pala leaves (Table 1) reflected in high crude fibre content (18.0%) and low nitrogen free extract (51.0%), while the high energy ration (R2) with low pala content (37%) had low fibre (14.0%) and high NFE (54.2%). The digestibility coefficients of various nutrients such as DM, CP, EE, NFE and total carbohydrates were lower (p<0.01) on R1 than on

Table 4. Intake and balance of nitrogen calcium and phosphorus (g/h/d)

Items	Low energy		High energy	
	Malpura	Mutton synthetic	Malpura	Mutton synthetic
Intakes				
Nitrogen	23.9±2.39	23.9±3.21	21.2±2.42	24.2±1.98
Calcium	16.5±1.67	16.6±1.87	12.3±4.12	14.2±3.11
Phosphorus	02.9±0.66	03.0±0.49	02.8±0.89	03.2±0.67
Balance				
Nitrogen	+7.8±1.55	+7.7±1.61	+9.2±1.49	+10.0±2.50
Calcium	+7.9±1.65	+6.8±1.79	+6.3±0.99	+7.2±1.33
Phosphorus	+1.3±0.67	+1.2±0.83	+1.4±0.67	+1.6±0.79

Table 5. Nutritive value of the rations and intake of digestibility of nutrients

Items	Low energy		High energy	
	Malpura	Mutton synthetic	Malpura	Mutton synthetic
Nutritive value				
DCP (%)	09.90±0.50	09.51±0.91	09.67±0.68	10.12±1.20
TDN (%)	52.61±3.56	52.91±1.97	58.78±3.28	56.58±2.56
Nutrient intake				
DCP/h/d (g)	79.59±6.86	76.53±9.87	80.45±7.89	86.43±10.31
DCP/kg $W^{0.75}$ (g)	09.26±1.32	08.89±2.61	09.67±2.11	10.12±1.58
TDN/h/d (g)	425.7±50.2	427.5±35.64	402.9±41.62	444.9±49.53
TDN/kg $W^{0.75}$ (g)	049.3±6.52	049.4±4.69	048.5±7.61	052.0±6.98

R2 in both the breed groups (Table 3). The breed differences in the digestibility coefficients of various nutrients on the two rations, however, did not reach the level of significance. The lower daily DMI in Malpura might have resulted in better digestibility. The higher digestibility estimates on high energy ration (R2) in both the breeds would be partially attributed to its lower fibre content and partly to lower DM consumption as compared to those on low energy (R1). Nitrogen and phosphorus intakes on both the rations and in both the breeds did not differ significantly. The calcium intakes were higher ($p<0.01$) on R1 than those on R2 in both the breeds. The nitrogen balances on ration R2 were higher ($p<0.01$) than on R1 in both the breeds (Table 4). The higher retention of nitrogen on R2 might be related to high energy content of the diet, because of better utilization of nitrogen for microbial protein synthesis in the rumen. The DCP and TDN intakes per unit metabolic body size ranged between 8.89 to 10.10 g and 48.5 to 52.0 g on R1 and R2, respectively with no significant differences between breeds (Table 5). While lower values of DCP and TDN intakes were reported by Thakur and Patanayak (1986) in Marwari lambs maintained on barley based diet, Kearl (1986) had suggested higher DCP and TDN requirement for growing lambs.

Least square means of carcass traits are presented in Table 6. Dressing yield expressed on empty live weight basis ranged from 50 to 51% in both the breeds. Similar

Table 6. Least squares means of important carcass traits

Items	Main effects comparisons					
	Ration 1	Ration 2	Targets weights 20 kg	Targets weights 25 kg	Malpura	Mutton synthetic
Number of lambs	24	23	23	24	23	24
Age at slaughter (d)	129.91	131.0	120.2[a]	140.7[b]	133.5	127.4
Pre-slaughter weight (kg)	20.85	20.83	18.88[a]	22.80[b]	20.83	20.85
Empty live weight (kg)	18.16	17.81	16.11[a]	19.85[b]	18.06	17.81
Hot carcass weight (kg)	10.74	10.48	9.53[a]	11.69[b]	10.63	10.59
Carcass weight/day of age (g)	81.28	79.20	78.65	81.66	77.58	82.72
Dressing percentage (%)	51.6	50.2	50.5	51.3	51.0	50.8
Bones in half carcass (%)	10.2	11.4	11.0	10.6	10.4	11.2
Rib eye area cm^2	13.83	13.93	12.68	15.08	13.46	14.30
Edible offals (%)	7.3	7.2	7.0[b]	7.5[a]	7.7[b]	6.8[a]
Inedible offals (%)	35.2	35.9	36.3[b]	34.8[a]	35.4	35.7
Carcass cut-ability (%)						
Leg	32.6	32.8	33.4	32.0	32.6	32.8
Loin	14.2	14.1	14.1	14.2	14.1	14.2
Rack	12.4	12.3	12.2	12.4	12.3	12.3
Neck and shoulder	23.4	23.6	23.7	23.4	23.7	23.4
Breast and fore shank	17.4	17.2	16.6[a]	17.9[b]	17.3	17.2
Loin composition (%)						
Lean	69.7	69.9	70.9	68.8	68.7	70.9
Fat	23.3	22.6	21.7[a]	24.1[b]	24.2[b]	21.6[a]
Bone	7.0	7.5	7.4	7.2	7.1	7.5
Meat quality						
Cooking loss (%)	37.8	38.5	37.6	38.7	36.9	39.4
Shear value (kg)	3.84	4.07	3.97	3.93	4.49[b]	3.41[a]
Juiciness value	5.7	5.0	5.6	5.1	5.3	5.4

[a, b] Means of main effects with unlike superscript differ significantly ($p<0.05$)

dressing yield was reported by Prasad et al. (1981) and Nivsarkar and Acharya (1982) in Malpura crossbreds and Malpura natives maintained on feedlot rations. Rations (R1 and R2) did not have any significant effect on any of the carcass traits. The two target weights (20 kg and 25 kg), however, were considered as the main effects irrespective of breed and ration. Higher ($p<0.01$) values were observed for 25 kg for rib eye area and total carcass fat content. The rib eye area was larger ($p<0.01$) in Mutton synthetics than Malpura and the carcass fat content was higher in Malpura than Mutton synthetic. Karim et al. (2002) reported lower carcass fat content in Malpura and Malpura×Awassi cross breeds maintained on 50:50 concentrate roughage based feedlot ration. Meat quality studied in terms of cooking losses was higher ($p<0.01$) in Mutton synthetic (39.4%) as compared to Malpura (36.9%).

It can safely be concluded from this study that the mutton production potential of our sheep may be substantially improved by feeding the male weaner lambs of indigenous breeds on high energy feedlot rations upto a slaughter weight of 25 kg, irrespective of age and crossbreeding of sheep with exotic mutton breeds in India may not be required.

REFERENCES

AOAC. 1990. Official Method of Analysis (15th edition). Association of Official Analytical Chemist, Washington, D. C.

Bhatia, D. R., M. Mohan, B. C. Patnayak and Q. Sheikh. 1973. Nutritive value of the available pasture in semi arid areas of Rajasthan. Indian J. Anim. Sci., 43:838-843.

Bhatia, D. R., M. Mohan and B. C. Patnayak. 1978. A note on the plane of nutrition of Malpura rams grazing on available pasture in the semi arid areas of Rajasthan. Indian J. Anim. Sci., 48:759-761.

ISI.1963. Indian Standard Specification for Mutton and Goat Flesh, Fresh, Chilled and Frozen. IS 2536, Bureau of Indian Standard Institution, New Delhi, India.

Kaushish, S, K., P. S. Rawat and S. C. Sharma. 1990. Performance of native sheep (Malpura) and its crosses with Avikaline under semi arid condition. World Rev. Anim. Prod.XXV: pp.43-46.

Karim, S. A. 2000. Feeding small ruminants for meat and wool production. In: Proceeding of National Workshop on Animal Nutrition in Health and Diseases, Veterinary College, University of Agricultural Sciences (17-19 February) Bangalore, India. pp. 28-46.

Karim, S. A. and A. Santra. 2000. Growth performance of Malpura and crossbred lambs under intensive feeding. Small Rumin. Res. 37:287-291.

Karim, S. A., A. Santra and D. L. Verma. 2002. Growth, feed conversion efficiency and carcass characteristics of Malpura and Malpura X Awassi crossbred lambs in hot semi arid environment. Asian-Aust. J. Anim. Sci. 13 (3):377-381.

Kearl, K. C. 1982. Nutrient Requirement of Ruminants in Developing Countries, International Feedstuffs Institute, Utah Agricultural Experimental Station, Logon.

Misra, A. K., A. S. Mishra, O. H. Chaturvedi and S. A. Karim. 2000. Utilization of urea treated mustard straw with tree leaves in sheep feeding. Indian J. Anim. Prod. Mgmt. 16:73-76.

Nivsarkar, A. E. and R. M. Acharya. 1982. Note on feedlot and carcass characteristics of Malpura sheep. Indian J. Anim. Sci. 52:1262-1264.

Prasad, V. S. S., C. L. Arora., R. P. Singh and S. D. J. Bohra. 1981. Assessment of carcass and mutton quality in native and crossbred sheep. Indian J. Anim. Sci. 51:638-642.

Sehgal, J. P. and P. S. Rawat. 1983. Differences in utilization of nutrient in feedlot ration by crossbred mutton lambs. Indian J. Anim. Sci. 53:968-972.

Singh, N. P. 1982. A note on the growth and nutrient utilization in crossbred lambs on a feedlot ration at two growth stage. Indian J. Anim. Sci. 52:96-98.

Singh, N. P. and M. Singh. 1987. Growth performance and nutrient utilization in Mutton synthetic lambs. Indian J. Anim. Sci. 57: 986-990.

Singh, N. P. and B. C. Patnayak. 1987. Feeding of sheep and goats for meat production. Lead paper presented in the National seminar on Small Ruminant production (Session IV: Meat, Meat product and pelt Technology) held at CSWRI, Avikanagar (5-7 January 1987). pp. 17-28.

Thakur, S. S. and B. C. Patnayak. 1986. Growth and wool production in grazing and stall fed Marwari weaner lambs. Indian J. Anim. Nutr. 3:179-183.