Indian Journal of Animal Sciences **81** (7): 730–734, July 2011

Performance and blood biochemical profile of lambs fed local unconventional feed ingredients at cold and high altitude conditions of Ladakh

S E JADHAV[1], GURU CHARAN[2], TILAK RAJ K[3], VIJAY K BHARTI[4] and SHASHI BALA SINGH[5]

Defence Research and Development Organization, Leh-Ladakh 194 101 India

Received: 22 November 2011; Accepted: 11 March 2011

ABSTRACT

The study was conducted to assess the effect of feeding local unconventional feed ingredients on performance and blood biochemical profile of lambs at high altitude cold arid conditions of Ladakh. Healthy male Muzaffarnagri × Changthangi crossbred lambs (18),3– to 4- month-old, weighing on average 12.4±0.77 kg were equally divided into control and local feed resources (LFR) groups and fed respective feeds for 130 days. LFR comprised seabuckthorn leaves, seabuckthorn pomace, willow and popular tree leaves and apricot cake as local unconventional feed ingredients along with other conventional feed ingredients that were used in control feed. Average daily temperature and relative humidity during the experimental period was –1.76°C and 64.89%, respectively. Blood samples were collected from all the animals at the end of the experiment. There was no difference in average daily gain (ADG) in body weight (BW), dry matter intake (DMI) and feed: gain ratio between the groups, however feeding of local feed resources resulted in reducing trend in feeding cost per unit BW gain of lambs. Blood hemoglobin, serum glucose, total protein, urea, blood urea nitrogen, creatinine, triglycerides, calcium, phosphorus, sodium and potassium concentrations did not differ among the groups. Serum uric acid increased significantly in LFR group as compared to control group. Moreover serum total protein concentration in lambs fed LFR feed showed increasing trend as compared to lambs fed control feed. These results indicated that feeding of local unconventional feed ingredients in complete feed of lambs had no adverse effect on performance and blood biochemical profile of lambs. On contrary, feeding of these ingredients in complete feed provided adequate nutrition to support normal body growth of lambs indicating that these ingredients are futuristic potential feed resources for animals at high altitude cold arid regions of Ladakh.

Key words: Apricot cake, High altitude, Sheep, Seabuckthorn, Willow

Ladakh, a high altitude, mountainous, cold desert, is situated between 2500 and 5000 m above mean sea level in the Himalayas on the far northern frontiers of India. This region is characterized by extreme heat and cold climatic conditions. Intensive sunlight, strong wind velocity, hypoxic air and land locked snow bound conditions characterize the general climatic condition of Ladakh. Due to long extreme winters, agricultural season is short which extend generally from May to September. This makes agricultural and animal husbandry practices very difficult in this region. Lucerne is the only fodder being grown in this region. Animal population and their projected feed requirement data revealed that there is a marked shortage (almost 85% deficit of each roughage and concentrate) of animal feed resources that would be required for optimum nutrition of animals in this region. Most of the animals remain undernourished or farmers depend on procuring animal fodder and concentrates from far away located low land regions of the country leading to uneconomical animal husbandry practices.

Seabuckthorn leaves, seabuckthorn pomace, willow and poplar tree leaves, apricot cake and wild fodder plants are important unconventional animal feed resources in this region (Jadhav *et al.* 2009). Seabuckthorn is found growing wildly in about 11,500 ha area in Ladakh (Dwivedi *et al.* 2006). Apricot is a major fruit crop of Ladakh growing in 695 ha and has a production of 2096.2 metric tons/year (Dwivedi and Dwivedi 2007). Apricot cake though rich in crude protein, exerts toxic effect due to cyanogenic compounds if fed to animals. Unfavorable feed attributes with respect to palatability and taste of these feed resources are limiting factor in their efficient utilization. Very few studies report evaluation of feeding seabuckthorn leaves, apricot cake and

Present address: [1]Scientist (e mail: balraje@rediffmail.com), Defence Research and Development Establishment, Jhansi Road, Gwalior 474 002 India. [2]Research scholar, [3]Senior technical assistant, [4]Scientist, Division of Animal science, DIHAR, [5]Director (e mails: [2]gurucharangaur@gmail.com, [3]tilakrajkundan @gmail.com, [4]vijaykbharti@gmail.com, [5]drshashisingh @gmail.com) Defence Institute of High Altitude Research (DIHAR)

willow fodder separately in animals. However, present experiment assesses effect of feeding seabuckthorn leaves, apricot cake, seabuckthorn pomace and willow and poplar tree leaves collectively in complete feed of lambs in cold high altitude conditions of Ladakh. Blood metabolite concentrations are commonly used in monitoring health and nutritional status of animals (Ndlovu *et al.* 2009). The present study was thus planned to evaluate the effect of feeding local unconventional feed ingredients in complete feed on performance and blood biochemical profile of lambs at high altitude cold arid conditions of Ladakh in trans-Himalaya.

MATERIALS AND METHODS

Location and study conditions: The study was conducted at Defence Institute of High Altitude Research situated at 3500 m above mean sea level in Ladakh, an Indian high altitude cold desert lying between 32° 15'–36° N and 75° 15'–80° 15' E. The experiment was carried out during October to February and environmental temperature during the experimental period ranged from –20°C in January to 14°C of October. Average daily temperature and relative humidity during the experimental period was –1.76°C and 64.89%, respectively.

Animals and their management: The experiment was approved by the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) in India. 18 healthy male Muzaffarnagri × Changthangi crossbred lambs of average 12.4±0.77 kg body weight and 3 to 4 months old were divided into 2 equal groups (control and Local Feed Resources, LFR) of 09 lambs in each group. All animals were treated with oral suspension of anthelmentic albendazole @10 mg/kg body weight before start of the experiment. During the day time (0900 to 1630 hrs) individual animal was confined in an iron mesh compartment of 3' × 3' with the facility of individual feeding. During rest of time and night all the animals were housed in a suitable shed without feed and water.

Feeds and feeding: Two complete feeds with roughage: concentrate ratio of 55:45 were formulated and fed to animals in either control or local feed resources (LFR) based experimental group. Ingredients and chemical composition of control and LFR complete feeds are given in Table 1. LFR feed was formulated with the inclusion of mostly local unconventional feed ingredients along with other conventional feed ingredients. Local unconventional feed ingredients used were seabuckthorn leaves, willow and poplar tree leaves, seabuckthorn pomace, apricot cake and wheat straw. These ingredients were procured from local market and farmers from Leh and adjoining area. Wheat straw used in LFR feed was treated with 4% of urea on the dry matter basis as non protein nitrogen source and to increase crude protein (CP) content of the feed. All the feed ingredients were grinded and homogenously mixed in horizontal mixer. Mineral mixture formulated as per the recommendations of ICAR (1998) was added to the feeds at the time of mixing. Experimental feeding was done for 130 days. All the animals were offered individually weighed amount of respective feed in the morning at 0900 hrs ensuring remnant of 100 g of orts, out of total amount of feed offered. Residue left was weighed in the evening and feed intake was calculated. Fresh, clean drinking water was offered to animals twice daily at 1000 hrs in morning and 1500 hrs in afternoon.

Table 1. Ingredients and chemical composition of control and LFR diets

Particulars	Control feed	LFR feed
Ingredient composition (%)		
Wheat straw	15.0	20.0*
Lucerne hay	40.0	15.0
Tree leaves (admixture of willow and polar tree leaves)		10.0
seabuckthorn leaves		10.0
seabuckthorn pomace		5.0
Mineral mixture**	0.2	0.2
Salt	0.2	0.2
Apricot cake		5.0
Soybean meal (solvent extracted)	11.0	12.0
Wheat bran	15.0	4.0
Crushed barley grains	18.6	18.6
Chemical composition (%)		
Crude protein	20.14	18.26
Ether extract	10.07	6.63
Crude fiber	17.32	18.03
Ash	9.07	11.02
Nitrogen extract (NFE)	42.90	40.59
Acid insoluble ash (AIA)	2.81	4.46
Calcium	1.58	1.39
Phosphorus	2.88	1.82

*Wheat straw treated with urea @ of 4% of the dry matter content;** each 100 g of mineral mixture composed of Ca, 11.55 g; P, 23.98 g; Na, 12 g; Mg, 1.08 g; Fe, 1.08 g; Mn, 0.032 g; Cu, 0.2 g; Zn, 0.104 g; Co, 0.023 g and I, 0.004 g

Data collection, sampling and analysis

Feed intake of individual animal was recorded daily. All the animals were weighed on digital weighing balance in the morning before offering feed and water at day 0 and at weekly interval thereafter till the end of the experiment to record the body weight changes. Feed samples were analyzed using standard procedures of AOAC (2000) : DM (920.36) after drying at 105°C for 24 h; N (990.03 and 984.13) by a Kjeldahl method after acid hydrolysis; ether extract (920.39) after extraction with petroleum ether by the Soxhlet method, total ash (923.03) by igniting at 550 °C for 3 h in a muffle furnace. Crude fiber in the feeds was analyzed by commercial kit. Ashed feed samples were used to prepare an HCl extract after dissolving the ash in 0.1N HCl and used for estimation of calcium (Ca) and phosphorus (P). The Ca content of feed samples was analyzed by the method of Talapatra *et al.* (1940), while P was determined by DM (965.17) AOAC (2000). Market prices and labour charges incurred towards collection of the feed ingredients were taken into consideration for determining economics of the feeding.

Blood samples from all the animals were collected aseptically through jugular vein puncture into the dry clean test tubes without anti coagulant in the morning before feeding and watering, at the end of the experiment. For estimation of blood hemoglobin concentration 2 ml of whole blood was collected separately into a plastic vials containing EDTA as an anti-coagulant. Hemoglobin concentration was determined immediately after blood collection by cyanomethemoglobin method (Coles 1980). Serum was collected and analyzed immediately for glucose concentration. Serum samples were stored in deep freeze at –20°C for further analysis. Serum metabolites, viz. glucose (glucose oxidase and peroxidase method), total protein (biuret method), urea (diacetylmono-oxime method), blood urea nitrogen (BUN, calculated from urea concentration; urea × 0.467), uric acid (uricase/peroxidase method), creatinine (alkaline picrate method), triglycerides (glycerol 3-phosphate oxidase-PAP method), calcium (O-cresolpthalein complexone method) and phosphorus (UV molybedate method) were analyzed using the diagnostic kits. Serum sodium and potassium concentrations were estimated by using diagnostic kits. This involved simultaneous precipitation of sodium and proteins by magnesium uramyl acetate (MAU). Precipitate was separated by centrifugation. Sodium content was calculated from loss of MAU in reagent. Residual amount of MAU was estimated by forming brown ferrous uramyl acetate which was read colorimetrically at 540 nm. Serum potassium estimation was based upon measurement of turbidity of reaction mixture containing sodium teraphenyl boron, alkaline EDTA, formaldehyde and serum potassium or standard potassium salts. All metabolites were estimated colorimetrically by semiautomatic photometer.

Statistical analysis: Data generated in the study was analyzed statistically as per the procedure of Snedecor and Cochran (1994) with the use of SPSS (1996) statistical software package. Compare means option of SPSS was used to produce overall means and standard error values. Differences in mean values of performances and blood biochemical's due to feeding of control and LFR feeds were compared using one way ANOVA procedure of SPSS which included groups as a fixed factor and other parameter as dependent variables. Significant statistical differences were calculated at $P<0.05$ and trends in differences were calculated up to $P=0.10$.

RESULTS AND DISCUSSION

Performance of lambs: Effect of feeding control and LFR feeds on performance of the lambs is given in Table 2. ADG in BW, DMI and feed: gain ratio of the lambs fed either control or LFR feed did not differ. There was decreasing trend ($P=0.073$) in cost of feeding per kg of body weight gain of lambs fed LFR feed.

Table 2. Effect of feeding control vs. LFR diets on performance of lambs

Parameters	Groups		p value
	Control	LFR	
Initial body weight (kg)	12.09±1.04	12.78±1.18	0.667
Final body weight (kg)	20.80±1.33	22.82±11.05	0.427
ADG in body weight (g)	68.79±8.22	79.36±11.05	0.454
DMI (g/d)	704.72±27.37	758.77±62.98	0.443
DMI (% body weight)	4.37±0.20	4.36±0.19	0.968
DMI (g/kgW$^{0.75}$)	86.71±2.67	88.21±3.30	0.729
CP intake (g/d)	141.9±5.51	138.5±11.5	0.795
Feed:gain ratio	11.19±1.11	10.16±0.74	0.450
Feed cost/kg gain in body weight (₹) *	98.80±9.84	77.06±5.61	0.073

*Feed cost of control and LFR diet was ₹ 7.95 and ₹ 6.82, respectively

DMI (g/d,% body weight and g/kgW$^{0.75}$) of the lambs in both groups in present investigation is higher than the dry matter requirements of growing lambs proposed by Indian Council of Agricultural Research (1998) (DM requirement of 600 to 700 g/d and 3.2 to 3.4% body weights for ADG of 50 to 100 g/d). Average environmental temperature during the experiment in present investigation was –1.76°C. Animals compensate within limits for variations in effective ambient temperature by altering food intake, metabolism and heat dissipation (NRC 1981). Lower critical temperature in full fed sheep with 5 mm fleece cover is reported to be 18°C (Blaxter 1967). Ames and Brink (1977) reported significantly higher dry matter intake at 10, 5 and 0°C temperature in lambs whose critical temperature was 13°C. Our results are in agreement with the findings reported by Jadhav *et al.* (2009a) who fed lambs either seabuckthorn leaves or lucerne hay based complete feeds under experimental conditions with an average temperature of 4.7°C at an altitude of 3500 m above mean sea level and reported DMI of 4.76 to 4.40% body weights. Though crude protein intake of animals among the groups was similar (Table 2), average daily gain in body weight of animals fed LFR diet was 15% higher than animals fed control diet. Economic animal production depends mostly on cost of feeding. Local non conventional feed ingredients used in present experiment were available in abundance naturally and cheaper as compared to costlier conventional feed ingredients used in this study. This has resulted in reducing cost of feeding/kg body weight gain in lambs fed LFR feed. Moreover, comparable gain in body weight and feed: gain ratio of lambs in LFR group with control animals reveal economic and nutritional importance of local unconventional feed ingredients in intensive system of animal

Table 3. Effect of feeding control vs. LFR diets on blood hemoglobin and biochemical profile of lambs

Parameters	Groups		p value
	Control	LFR	
Hemoglobin (%)	12.94±0.40	12.77±0.09	0.671
Glucose (mg/dl)	70.48±3.70	74.98±2.77	0.345
Total protein (g/dl)	6.08±0.55	7.42±0.47	0.083
Urea (mg/dl)	62.49±3.66	61.20±2.64	0.779
BUN (mg/dl)	29.17±1.71	28.59±1.23	0.787
Uric acid (mg/dl)	5.97±0.07	6.49±0.07	0.000
Creatinine (mg/dl)	1.67±0.53	1.87±0.31	0.313
Triglycerides (mg/dl)	73.08±2.26	72.40±3.48	0.874
Calcium (mg/dl)	10.60±0.18	10.75±0.40	0.737
Phosphorus (mg/dl)	7.05±0.53	8.30±0.68	0.168
Sodium (mMol/L)	130.86±3.83	125.58±2.73	0.279
Potassium (mMol/L)	2.62±0.15	2.95±0.17	0.169

Values are mean±SE

rearing which will further help in reducing the pressure on rapidly degrading grazing land in Ladakh.

Blood biochemical profile of lambs: There was no difference in hemoglobin, serum glucose, total protein, urea, BUN, creatinine and triglyceride concentrations of the lambs among the groups (Table 3). Similar serum glucose concentration between animals of both the groups is indicative of similar energy status of all the animals irrespective of the feeds. An increasing trend for serum total protein ($P = 0.083$) concentration in lambs fed LFR feed was observed when compared to control group. Higher trend of serum total protein concentration in lambs of LFR group may be indicative of more availability of protein through LFR feed as compared to control feed. Further, comparatively higher gain in the body weight of lambs fed LFR feed coincide well with higher trend in serum total protein concentrations in these lambs than control group. Serum urea concentration in both the groups though was in normal physiological range but was at higher side of the range. It seemed that protein in both the diets was sufficiently higher to increase serum urea and BUN levels in both the groups in present investigation. However our observations are supported by findings of Jadhav *et al.* (2009a) who reported serum urea concentration of 43.5 to 59.4 mg/dl and serum BUN concentration of 20.32 and 27.74 mg/dl with crude protein intake of 204.2 to 252.3 g/d, respectively in sheep under almost similar environmental conditions as in the present investigation.

Serum uric acid concentration was significantly higher ($P \leq 0.0001$) in lambs fed LFR feed as compared to control group (Table 3). Feeding of LFR feed might have resulted into comparatively higher ruminal microbial biomass resulting into more microbial nucleic acid available for digestion reflecting into significantly higher serum uric acid concentration.

Nutritional status, protein intake, muscle catabolism and muscle size affects serum, plasma or urine creatinine concentrations of animals. In present investigation serum creatinine concentration of lambs in both the groups was similar and values were within normal physiological limits indicating similar nutritional status and muscle mass of animal in both the groups.

Serum calcium, phosphorus, sodium and potassium concentration of lambs in both the groups was similar (Table 3). Serum calcium concentration of lambs in both the groups was in normal ranges but, serum phosphorus concentrations were towards higher limits of normal physiological range values, perhaps slightly higher than normal values. Higher dietary phosphorus in both the diets might have reflected in higher concentration of serum phosphorus in animals of both the groups. Though serum sodium and potassium concentrations were similar in both the groups but values were towards lower limits of normal ranges. This may be due to cold induced diuresis (there was tendency of higher urine output in all the animals probably due to cold environmental conditions during experimental period in present study) as reported by Yoshida *et al.* (1994) who observed an increase in urine flow and urinary sodium output during cold exposure.

Our results revealed that feeding of local unconventional feed ingredients, viz. seabuckthorn leaves and pomace, willow and poplar tree leaves and apricot cake in complete feed of lambs under unfavorable cold, high altitude arid climatic conditions of Ladakh in Indian Trans-Himalaya had no adverse effects on performance and blood biochemical status of lambs. Additionally, it resulted in reducing cost of feeding. It can be concluded that these ingredients are futuristic animal feed resources that can be utilized efficiently and safely under intensive animal production system in Ladakh where there is marked deficit of nutritious animal feeds and fodders. However, further studies for identification of anti-nutritional factors and levels of inclusion of these feed ingredients in animal feeds are needed. In addition to this, data generated in the present study will be useful for developing animal feeding standards and formulating animal feeds for high altitude cold arid regions.

ACKNOWLEDGEMENTS

The author is thankful to Defence Research and Development Organization, Head Quarter, Ministry of Defence, Government of India, New Delhi for providing financial support for conducting this study successfully.

REFERENCES

Ames D R and Brink D R. 1977. Effect of temperature on lamb performance and protein efficiency ratio. *Journal of Animal Science* **44**: 136.

AOAC. 2000. *Official Methods of Analysis.* 17th edn. Association of Official Analytical Chemists, Washington, DC, USA.

Blaxter K L. 1967. *The Energy Metabolism of Ruminants.* Hutchinson and Co., London. UK.

Coles E H. 1980. *Veterinary Clinical Pathology.* 3rd edn. W B Saunders, Philadelphia, P.A.

Dwivedi D H and Dwivedi S K. 2007. Traditional method of Chuli oil extraction in Ladakh. *Indian Journal of Traditional Knowledge* **6** (3) : 403–05.

Dwivedi S K, Singh R and Ahmed Z. 2006. *The Seabuckthorn.* Field Research Laboratory, Defence Research and Development Organization Publication, Leh, Ladakh, India.

ICAR. 1998. *Nutritional Requirement of Livestock and Poultry. 2nd* edn. Indian Council of Agricultural Research, New Delhi, India.

Jadhav S E, Tilak Raj, Guru Charan and Singh S B. 2009a. Effect of feeding Seabuckthorn leaves and Lucerne hay based complete diets on growth and blood biochemical profile of sheep at high altitude. *Advances in Agriculture, Environment and Health* pp. 415–21. (Eds) Singh S S, Chaurasia O P, Yadav A, Rimando A M and Terrill T. Satish Serial Publisher, New Delhi.

Jadhav S E, Guru Charan, Tilak Raj K and Singh S B. 2009b. Seabuckthorn leaves and various non conventional feed ingredients: Futuristic animal feed resources of Ladakh. *Souvenir of National Conference on Seabuckthorn and Environment: High Altitude Perspectives.* pp.33-34, 25–27 September 2009, Leh (Ladakh), India.

NRC. 1981. *Effect of Environment on Nutrient Requirements of Domestic Animals*, Pp-5. National research council. National Academy Press, Washington, D C.

Ndlovu T, Chimonoyo M, Okoh A I, Muchenje V, Dzama K, Dube S and Raats J G. 2009. A comparison of nutritionally related blood metabolites among Nguni, Bonsmara and Angus steers raised on sweetveld. *The Veterinary Journal* **179**: 273–81.

SPSS, 1996. Statistical Packages for Social Sciences, Version 7.5. SPSS Inc., Chicago, IL, USA.

Snedecor G W, Cochran W G, 1994. *Statistical Methods.* 8th edn, pp 217–35. Iowa state University press.

Talapatra S K, Ray S N and Sen K C. 1940. Estimation of phosphorus, chlorine, calcium, magnesium, sodium and potassium in food stuffs. *Indian Journal of Veterinary Science and Animal Husbandry* **10**: 243–46.

Yoshida T, Okuno T, Kawabata T and Morimoto T. 1994. Salt consumption and body fluid balance during cold exposure in rats. *Physiology and Behaviour* **55**: 163–67.