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Development of Region Specific Hybrid Goat and their Performance Evaluation under High Altitude Condition

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ABSTRACT

Goat meat (chevon) comprises an important source of protein to provide essential amino acids in addition to other meat and plant sources of proteins. Therefore, demands for chevon are huge from civil and defence sector in this region. However, there is limited availability of fresh tender chevon in Ladakh region round the year. Hence, there was a need of augmenting local availability of fresh goat meat by developing animal technology for fast growing region-specific crossbred goat for meat purpose that can efficiently perform under adverse climatic conditions prevailing in this region. The present crossbred goat was developed by using mixing genes of adaptive and meat traits through cross breeding between local goats (Changthangi and Gaddi breeds of goats) and Sirohi/Black Bengal goats. To develop this technology, we introduced Black Bengal and Sirohi from plain areas and native breed of goats viz. Gaddi and Changthangi goats for further adaptation and growth performance studies at Leh-Ladakh. After initial studies goats were divided into high altitude resistant/adapted and susceptible groups. High altitude resistant/adapted goats were taken for further cross breeding and pure breeding. All the kids produced out of this breeding were studied for physiological responses, growth performance, and blood biochemical parameters to know their adaptive and growth performance at high altitude. Crossbred kids of Sirohi ♂/Black Bengal ♂ X Changthangi ♀ had significantly ($P<0.05$) higher weight gain, adaptive physiological responses and blood biochemicals level as compared to exotic pure bred and other cross bred kids. These crossbred kids attained market weight faster than local as well as breeds from plain areas (Sirohi and Black Bengal goats). Average meat yield is 7-10 kg per adult crossbred goat if slaughtered at 9-12 month age. These cross bred (broiler goat) may be reared at Leh-Ladakh for meat purpose. Hence, this animal technology may help in increasing of fresh goat meat (chevon) supply to meet army's and civil requirements in Leh-Ladakh.

Keywords: Broiler goat; Changthangi goat; Growth; High altitude; Crossbred goat; Meat

1. INTRODUCTION

Hard work, difficult terrains of Ladakh region and formidable task demands increase nutrition of our armed forces for their efficient performance at high altitude. Meat is an excellent source of animal proteins, minerals, and vitamins that are required for our health. Due to limited availability of fresh meat locally, procurement of tinned and frozen meat from the plain region is cost bearing affair with compromised nutritional and hygienic qualities. Chevon (goat meat) is preferred over mutton (sheep meat) by the troops of Indian Army as well as civilian population. This region is characterised by extreme heat and cold (+35 ^{0}C to -35 ^{0}C) climatic conditions. There are also alternating daily extreme of climate, strong winds, low humidity, low air pressure, and hypobaric-hypoxia at high altitude that contribute high altitude (HA) stress and leads to several high-altitude maladies and low livestock productivity[2,3]. Though Ladakh is known for its unique breeds of sheep and goats, including the Pashmina producing Changluk breed of goat, their rearing in concentrated primarily in the higher reaches of the region[1]. While, the requirement of meat for the local population and the troops has been growing exponentially, the availability of the same was not enough. Goat husbandry for meat purpose has not shown good growth in Leh-Ladakh due to poor genetic potential for meat traits, lack of awareness among farmers about modern goat production technologies for meat purpose, etc.

Livestock has an important role in providing nutritional security to armed forces and socioeconomic development as well as employment to local people at Leh-Ladakh[4]. Importance of animal protein (milk and meat proteins) for human health is well documented by physician and dietician. Meat is an excellent source of animal proteins, minerals and vitamins that are required for our health[5]. The genetic improvement of the goat for higher meat production should be the primary aim[6]. Selective breeding and crossbreeding is the recommended breeding strategy for commercial meat goat production. This target can be achieved in two ways:

i. Existing local breed of goat can be propagated by selective breeding of superior individuals.
ii. By combining the desired traits of other high producing

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animals and local well adapted animals by means of crossbreeding methods.

Plain areas are having number of good meat breeds of goat[7]. Thus, it was decided to introduce those breeds for rearing at high altitude for meat purpose. However, they could not survive there due to adverse climate. Black Bengal, *Sirohi* goats are known their outstanding body conformation, better kidding, growth rate, and meat quality, while local goats *(Bakharwal, Chegu, Changra/Malra, Gaddi,* and *Changthangi)* from Western Himalayan region are hardier and well adapted in cold climate of Leh-Ladakh region[3]. Local goats are poor in genetic value for carcass/meat quality and growth[8,9]. They are primarily bred for fibre purpose. However, they are hardy breeds and best adapted to harsh climate of Leh-Ladakh. Hence, these cross breeding takes advantage of the faster growth and meat quality from Black Bengal, Sirohi breeds of goats and adaptation traits from local germplasm. Hence, we have taken this breeding methodology in present study. So, evolving a region-specific meat purpose goat breed (broiler goat) would be probable solution for meat production under adverse climatic conditions prevailing in this region. Therefore, keeping above facts in mind, this study was undertaken to investigate adaptation of meat breeds of goats at high altitude region and develop region specific hybrid goat for meat purpose.

2. MATERIALS AND METHODS

2.1 Feeding and Husbandry Management

Dry Lucerne, tree leaves (poplar and willow plants), commercial concentrate mixture and grains are fed on stall feeding. PPR vaccination was given to all goats for controlling this contagious viral disease prevalent in this area. Regular deworming with albendazole broad spectrum antihelminthic was performed for gastrointestinal parasite control.

2.2 Breeding of Animals

Selective breeding and crossbreeding were taken as breeding strategy for present study to produce crossbred goat for commercial meat production. Black Bengal (West Bengal/ Orissa), Sirohi goats (Ajmer/ Aravalli ranges of Rajasthan) are known their outstanding body conformation, better kidding, growth rate, and meat quality, while local germplasm/goats i.e. Changthangi (Changthang region of Leh-Ladakh) from Western Himalayan region are hardier and well adapted in cold climate of Leh-Ladakh region.

Thus it was decided to introduce those breeds for rearing at high altitude for meat purpose. All the goat breeds were taken at Leh-Ladakh for studies on adaptation, survivability, growth and reproductive performance before cross breeding (reciprocal cross/criss cross manner) for crossbred goat production. After acclimatisation of these breeds, only high altitude resistant animals were taken for further cross breeding. Then native Changthangi, Gaddi, and exotic low lander (plain areas) Sirohi and Black Bengal goats were selected for rearing and further breeding at Leh-Ladakh (high altitude, 11500 feet msl) based on their meat quality, growth performance, prolificacy, stress tolerance ability, etc. at high altitude (Table 1)[3,4,7].

Reproductive performance parameters viz. age at first estrous, conception rate (percent), age (month) at first kidding, and kidding interval were recorded for all the breeds and crosses up to two generation. Body size, sex libido, etc. of male (buck) as well as body size of Changthangi female is vital for successful breeding to get large number of crossbred goat kids. Therefore, larger Black Bengal buck (male goat) and medium size Sirohi buck were selected for matting with Changthangi doe. Large/medium body size Changthangi doe was mated with Sirohi buck, whereas small and medium body size was matted with Black Bengal buck. F-1 generation (crossbred kid of either sex) were not used for further breeding.

2.3 Blood Sample Collection and Analysis

Blood was collected by venipuncture of the jugular vein during spring, between 15:00 hrs -18:00 hrs, into vacuum tubes containing EDTA (BD Franklin Lakes, NJ, USA) for analysis of biochemical parameters like glucose (Glu), total protein (TP), albumin (Alb), urea (U), uric acid (UA) and cholesterol (Cho) using serum semi-auto analyzer (BIOTRON BTR- 830).

2.4 Measurement of Adaptive Physiological Responses and Minerals in Meat

The body temperature (Bt), respiration rate (RR), pulse rate (PR), oxygen saturation (SaO_2) and heart rate (HR) were monitored before providing of feeds in every morning at 09:30 hrs to 10:30 hrs in intensive housing system up to 5th week. Body temperature (rectal temperature) was measured by infra-red thermometer/mercury thermometer. Heart rate was taken

Table 1. Important traits of different breeds of goat observed during rearing at high altitude for meat purpose

Traits/attributes	Sirohi Goat Breed	Black Bengal Goat Breed	Changthangi goat breed	Region specific crossbred goat
Adaptability to hypoxic conditions/ high altitude stress tolerance	+	+	+++	++
Fast body growth rate	+++	+++	+	+++
Survivability and disease resistance power	+	+	+++	++
Reproductive performance	++	++	+	+
Protective physical/ body confirmation	+	+	+++	++
Meat/carcass quality (tenderness)	++	+++	+	++
Higher weaning weight	+++	++	+	++
Feed conversion efficiency	++	++	+	++

Note: * (+) indicates level/intensity/presence of particular traits/attributes in different breeds of goat at high altitude.

with the help of stethoscope. Pulse rate and oxygen saturation rate were measured by the pulse-oxy-meter. All the minerals in meat were determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) (Perkin-Elmer Analyst, Optima 7000 DV)[9]. Nutritional value of meat was measured by the AOAC method[10].

2.5 Statistical Analysis

Data were analysed using statistical software SPSS 22 version. ANOVA test was applied to determine the growth performance and biochemical changes among all the hybrid goat breeds. P value <0.05 was considered statistically significant.

3. RESULTS

The present investigations findings on breeding and adaptation study revealed that Black Bengal/Sirohi buck can adapt very well to the harsh conditions of Ladakh. Crossbreeding offers two distinct advantages over pure breeding i.e. heterosis and breed complementarity. The kids borne from male Black Bengal/Sirohi and female Changthangi goats were well adapted and exhibited highest birth weight. It has also exhibited maximum weight gain at weaning.

3.1 Physiological Responses of Crossbred Kids at High Altitude

Adults of F1 of pure and crossbred goat kids were evaluated for survivability and physiological responses (heart beat, respiration rate, pulse rate, arterial blood oxygen saturation i.e. SaO_2) at rest to know their adaptability to high altitude cold conditions. As shown in Table 2, it was observed that Changthangi ♀ X Sirohi/Black Bengal ♂ crosses exhibited better adaptation as compared to its purebred kids of Sirohi and Black Bengal (Table 3). However, all the values were towards the higher side within the normal range of these physiological values.

3.2 Blood Biochemical Profile of Crossbred Kids at High Altitude

All the crossbred kids were compared with purebred kids for their blood biochemical parameter viz. proteins, albumin, glucose, cholesterol, urea, and uric acid under similar managemental and feeding conditions to assess their acclimatisation ability at high altitude (Table 4). We observed significant (P<0.05) high level of plasma glucose in female Changthangi and male Sirohi cross than others kids, higher total protein in pure Changthangi and Changthangi and black Bengal cross, lower level of urea in all crossbred kids, high level of cholesterol in all kids as compared to pure Changthangi (Table 4). However, uric acid level was significantly low in pure Changthangi, black Bengal, and Changthangi-Black Bengal kids as compared to pure bred Sirohi and Changthangi-Sirohi crossbred kids (Table 4).

Table 3. Comparative evaluation of physiological responses of hybrid kids (2-3 months) from different breeds at high altitude

Breed	Heart beat / (min)	Respiration rate/(min)	Pulse rate / (min)	SaO_2 (%)
Chang ♀ X Chang ♂	112-133	20-30	72-83	62-86
BB ♀ X BB ♂	118-142	23-36	78-92	62-72
Sirohi ♀ X Sirohi ♂	116-138	23-33	76-90	66-75
Chang ♀ X Sirohi ♂	120-132	27-36	74-86	68-81
Chang ♀ X BB ♂	112-130	27-33	70-88	63-84

3.3. Growth Rate, Meat Yield, Reproductive Performance of Goat Breeds and Crossbred Goat

Birth weight of Sirohi ♂/Black Bengal ♂ X Changthangi ♀ kids (1.6-2.8 Kg) is higher as compared to other cross bred kids (1.0-2.0 Kg) and purebred kids (1.0-3.0 Kg) (Table 5). As shown in Table 5, significant higher body weight gain was recorded in crossbred kids of Sirohi ♂/Black Bengal ♂ X Changthangi ♀ kids than purebred kids. These crossbred kids attain market weight (12-16 Kg) after 8-10 months that is faster than local as well as breeds from plain areas (Sirohi and Black Bengal goats). Average meat yield is 7-10 kg per adult crossbred goat if slaughtered at 9-12 month age.

Studies on reproductive parameters (age at first estrous, age at first kidding, birth weight, kidding rate, etc.) of adult parental stocks and their progenies indicated that low Lander Black Bengal and Sirohi goats can adapt very well to the harsh conditions of Ladakh and attain age at maturity little later (30 to 45 days) at high altitude than their plain areas (Table 5). Similarly, age at first estrus and age at first kidding were longer than their age at plain areas. Poor estrus induction behaviour was evident in all parents and their F-1 progenies of pure bred and cross-bred goats at high altitude.

The Black Bengal goat has been giving twin birth (65 percent), whereas no twinning was observed in Sirohi goats. Reproductive health of progenies (F-1 generation) of pure bred and crossbred goat (broiler goat) is also similar to their parents at high altitude. The average age at first kidding was observed to be 11-12 months (Sirohi) and twice kidding in a year is common in all breeds (Table 6).

Table 2. Mean levels of different adaptive physiological responses in female goats at high altitude

Physiological parameters	Goat Breeds	Experimental period (Week)				
		1st	2nd	3rd	4th	5th
Pulse rate/min (Normal= 60-70/min)	Native	73	74	73	74	74
	B. Bengal	75	78	77	76	73
	Sirohi	84	84	81	78	77
Respiration rate/min (Normal= 18-30)	Native	21	20	21	23	23
	B. Bengal	25	28	26	28	29
	Sirohi	31	29	28	27	28
Heart rate/min (Normal= 70-135/min)	Native	94	90	88	96	86
	B. Bengal	132	128	116	120	112
	Sirohi	124	126	132	116	118
Body Temp (°F) (Normal= 101.5-103.5)	Native	101	102	102	102	102
	B. Bengal	102	103	103	103	103
	Sirohi	103	103	103	103	102

Table 4. Blood biochemical profile of crossbred kids from different breeds at high altitude

Particulars	Chang ♀ X Chang ♂	BB ♀ X BB ♂	Sirohi ♀ X Sirohi ♂	Chang ♀ X Sirohi ♂	Chang ♀ X BB ♂
Glucose (mg/dl)	$46.50^{ab} \pm 3.21$	$44.20^{ab} \pm 4.20$	$37.11^{a} \pm 3.11$	$48.00^{b} \pm 5.32$	$46.05^{ab} \pm 4.25$
Cholesterol (mg/dl)	$102.32^{a} \pm 1.20$	$113.55^{d} \pm 1.18$	$108.30^{b} \pm 1.60$	$108.93^{b} \pm 1.30$	$110.70^{c} \pm 1.25$
Total protein (g/dl)	$9.31^{b} \pm 0.45$	$7.93^{a} \pm 0.60$	$8.10^{a} \pm 0.50$	$8.67^{a} \pm 0.52$	$9.60^{b} \pm 0.24$
Albumin (g/dl)	$1.45^{a} \pm 0.28$	$1.38^{a} \pm 0.20$	$1.32^{a} \pm 0.22$	$1.20^{a} \pm 0.27$	$1.68^{a} \pm 0.21$
Urea (mg/dl)	$47.89^{b} \pm 4.60$	$45.21^{b} \pm 4.21$	$47.89^{b} \pm 6.20$	$40.13^{a} \pm 6.50$	$41.31^{a} \pm 4.60$
Uric acid (mg/dl)	$1.58^{a} \pm 0.32$	$1.95^{a} \pm 0.27$	$2.15^{b} \pm 0.22$	$2.76^{b} \pm 0.19$	$1.45^{a} \pm 0.12$

*values in the same row (^{a,b,c,d}) bearing different superscripts vary significantly (P<0.05).

Chang: Changthangi; BB: Black Bengal

Table 5. Growth performance of crossbred kids from different breeds at high altitude

Age	Chang ♀ X Chang ♂	BB ♀ X BB ♂	Sirohi ♀ X Sirohi ♂	Chang ♀ X Sirohi ♂	Chang ♀ X BB ♂
0 day	$1.96^{a} \pm 0.26$	$1.20^{a} \pm 0.37$	$1.80^{a} \pm 0.40$	$1.90^{a} \pm 0.60$	$2.20^{a} \pm 0.40$
3 month	$8.30^{b} \pm 0.56$	$6.50^{a} \pm 0.81$	$8.32^{b} \pm 0.35$	$9.20^{c} \pm 0.53$	$10.60^{d} \pm 1.00$
6 month	$9.80^{a} \pm 0.78$	$8.75^{a} \pm 0.35$	$10.10^{b} \pm 0.96$	$10.70^{b} \pm 0.61$	$13.90^{c} \pm 0.45$
9 month	$13.10^{b} \pm 0.70$	$11.25^{a} \pm 0.51$	$12.85^{b} \pm 0.80$	$13.56^{b} \pm 1.12$	$16.40^{c} \pm 1.42$

*Values in the same row (^{a,b,c,d}) bearing different superscripts vary significantly ($p < 0.05$).

3.4 Nutrient Composition of Crossbred Goat Meat

The nutritive evaluation like Caloric values, protein level, amino acids, total fat, fatty acids profile, essential minerals, and vitamins in fresh meat of crossbred goat (broiler) and native goat was performed and results (mean value) on dry matter basis are given in Table 7.

These findings indicated comparable nutritional composition of meat from crossbred goat with the meat from native breed., whereas some of the nutrients like iron, protein, phosphorus, Vit. C, Vit. E, Vit. B_{12}, Vit. B_6, were higher in crossbred goat meat than the native goat meat. However, calcium, cobalt, and zinc were high in native goat meat than the crossbred goat meat. Further, user's trials (Organoleptic test) were conducted among human volunteers to evaluate meat palatability, tenderness, and acceptability. They accepted crossbred goat meat with 8.2/10 Hedonic Score points.

4. DISCUSSION

This technology was developed by using novel ideas of mixing genes of adaptive and meat traits through cross breeding between local goats (Changthangi and Gaddi breeds of goats) and Sirohi/black Bengal goats. It is crossbred of male Sirohi/Black Bengal and female Changthangi goat, where 50 percent of each trait was inherited. It took advantage of the faster growth, meat quality from Black Bengal, Sirohi breeds of goats and adaptation traits from local germplasm.

4.1 Comparative Study on Adaptive Physiological Responses in Different Breeds

The present study findings indicated no mortality in Sirohi and Changthangi cross, however 16 percent mortality (25-30 percent normal mortality at plain areas) was observed within 04 months of age in Black Bengal goats. There was no any mortality after this age in any crosses. Experimental findings on physiological response (70-87 percent SpO_2, 65-85/min pulse rate), blood biochemicals, and growth performance clearly indicated the better acclimatisation and performance in Sirohi breeds than Black Bengal, also reflected by high survivability in Sirohi goats. No significant changes were observed in physiological responses among any crosses of crossbred goat kids. Based on above findings, we identified the HA Resistant and Susceptible animals for further experimentation to find therapeutic agents (minerals and antioxidants) for amelioration of HA stress[3]. The findings from acclimatisation/initial adaptation and production performance studies revealed that low lander BB and SRH goats can adapt very well to the harsh conditions of Ladakh with optimum reproductive and growth performance.

Table 6. Growth and reproductive performance of different goat breeds and hybrid goat at high altitude

Goat breed	Avg. birth weight (Kg)	Avg. body weight (Kg) at 180 days	Daily weight gain (g) (up to 6 months)	Age (month) at first estrous	Avg. ception rate (%)	Age (month) at first kidding	Kidding interval (month)	Twinning (%)
Sirohi	2.6	15.5	76-86	12-13	80	17-18	10-11	10-15
Black Bengal	1.4	8.7	49-66	10-11	90	15-16	9-10	40-50
Changthangi	1.9	10.0	60-70	11-12	75	16-17	9-10	Nil
Crossbred goat	2.1	12.5	68-77	10-11	80	15-16	10-11	Nil

Table 7. Nutrient composition (mean value) of fresh meat samples of crossbred goat and native goat

Nutrient	Native Goat	Crossbred goat (Broiler goat)
Energy (Kcal/100g)	149.9	148.36
Total Fat (g/100g)	4.10	4.26
Saturated Fat (g)	0.79	0.81
Cholesterol (mg/100g)	19.1	20.2
Oleic acid (%)	2.17	2.53
Linoleic acid (%)	0.10	0.12
α-Linolenic acid (%)	0.01	0.01
Iron (mg/100g)	10.42	15.19
Calcium (mg/100g)	82.58	69.2
Phosphorus (mg/100g)	57.9	83.38
Cobalt (mg/100g)	0.14	0.10
Copper (mg/100g)	0.5	0.57
Zinc (mg/100g)	84.74	43.20
Protein (g/100g)	19.70	21.56
Methionine (g/100g)	0.25	0.36
Cysteine (g/100g)	0.73	1.00
Vit. C (mg/kg)	3.80	4.60
Vit. E (mg/kg)	2.10	2.43
Vit B_{12} (mg/kg)	3.7	6.9
Vit. B_6 (mg/kg)	0.90	1.10

4.2 Blood Biochemical Profile of Hybrid Kids at High Altitude

All the hybrid kids were compared for blood biochemical parameter viz. proteins, albumin, glucose, cholesterol, urea, and uric acid under similar managemental and feeding conditions to asses their acclimatisation ability at high altitude. We observe significant high level of plasma glucose, total protein, albumin, cholesterol and low urea and uric acid as compared to pure bred kids. High level of plasma glucose concentration indicates better metabolic performance[12]. Similarly, increased levels of albumin in hybrid kids show significant immuno-protection towards cold stress conditions[13,14]. The higher levels of cholesterol in hybrid and Sirohi/Black Bengal kids with respect to pure Changthangi kids show that these animals have a higher potential to reproduce as compared to the local breeds[14]. Low level of plasma cholesterol in pure Changthangi kids indicates lower reproducibility due to lesser availability of precursors of steroid derived hormone[14].

These above findings indicate body metabolism, health of the vital organs as well as normal liver function of kids. Hence, we concluded that crossbred (Black Bengal ♂ X Changthangi ♀, Sirohi ♂ X Changthangi ♀) and pure Changthangi kids are well acclimatised at high altitude.

4.3 Growth Rate, Meat Yield, Reproductive Performance of Goat Breeds and Crossbred Goat

Birth weight of Sirohi ♂/Black Bengal ♂ X Changthangi ♀ kids (1.6-2.8 Kg) is higher as compared to other cross bred kids (1.0-2.0 Kg) and pure bred kids (1.0-3.0 Kg) (Table 6). As shown in Table 6, significant higher body weight gain was recorded in hybrid kids of Sirohi ♂/Black Bengal ♂ X Changthangi ♀ kids than purebred kids. Hybrid vigour is the main factor for better growth performance. These hybrid kids attained market weight (12-16 Kg) after 8-10 months that is faster than local as well as breeds from plain areas (Sirohi and Black Bengal goats)[9,15]. Average meat yield is 7-10 kg per adult hybrid goat if slaughtered at 9-12 months age. However, these goats can be reared for more meat yields if slaughtered at older age but meat quality will be compromised. Some of them attained 30-35 kg body weight.

4.4 Nutritive Value of Goat Meat

Some amino acid levels were higher in crossbred goat meat than the native goat meat. Therefore, broiler goat meat would be good source of essential amino acid for human consumption[16]. In case of total lipid profile of goat meat, it was found that total fat content, oleic acid, linoleic acid, α-linolenic acid content was a higher in the broiler goat meat (chevon) than the native goat meat. It was found that, higher levels of these unsaturated fatty acids (PUFA) are beneficial for reduction in incidence of the cardiac and chronic vascular disease[17]. In the high altitudinal region, frequency of this disease is higher. Therefore, these goat meat is very suitable for the health purpose[2,18]. The vitamin (Vit. C, E, B_{12}, and B_6) profile were higher in the crossbred goat meat than in the native goat meat. Vitamin B help in the metabolism and vitamin C, and E help in the attenuation of oxidative stress after improving the body antioxidant defence system[19]. Therefore, chevon is very suitable for the human consumption at high altitude region.

Depending on the age, sex, stage of growth, production, breed and genotype, requirements of trace minerals varies in animals like livestock, poultry etc. [20,21]. Trace minerals are essential for animal health, which affects growth performances, immunity, hormonal regulation and reproduction, etc. of animals. In this study, the essential minerals viz. Ca, P, Fe, Cu, Co and Zn content in fresh crossbred goat meat (chevon) were higher than native goat (Changthangi). Levels of calcium, cobalt, and zinc were above the normal level in crossbred goat. Therefore, crossbred goat breed might have the higher immunity level, growth performances, higher reproduction level[22-27]. Very high Hedonic score (8.2/10) indicated better meat palatability, tenderness, and acceptability of crossbred goat meat[13]. Therefore, crossbred goat meat has become very popular among native people and troops at high altitude[28]. Therefore, many farmers have been adopting this animal technology for further breeding and production of broiler goat for meat purpose.

5. CONCLUSION

The present study resulted in development of region specific crossbred goat (Sirohi ♂ X Changthangi ♀), which is well adapted to high altitude, fast growing, and giving high quality tender meat. These crossbred goats have good reproductive performance as compared to local goat breeds. Hence, region specific crossbred goat (broiler goat) is the excellent source of meat, and it can be raised in Leh-Ladakh. Further propagation and transfer of this breeding technology to suitable entrepreneurs for commercial production is

undergoing. Farmers have enough opportunities for getting high profit during winter period, since broiler goat meat would fetch high market price due to high quality and more meat yield. Hence, this would help local people in socioeconomic development and troops to get fresh availability of chevon and reducing their dependency on frozen meat supply up to some extent.

6. CONFLICT OF INTEREST AND DISCLOSURE STATEMENT

All authors declare that they have no proprietary, financial, professional, nor any other personal interest of any kind in any product or services and/or company that could be construed or considered to be a potential conflict of interest that might have influenced the views expressed in this manuscript.

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