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Profiling of serum biochemical indices in Changra goats reared under pastoral system in traditional areas of Changthang and under intensive management in Ladakh

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Abstract
Blood samples for serum biochemical studies were collected from representative number of goats of both sexes and different age groups. The biochemical studies included blood glucose, total protein, albumin, globulin, albumin: globulin ratio, AST, ALT, ALP, BUN, creatinine, and total cholesterol using diagnostic kits and semi-automatic blood chemistry analyser. The overall mean values of various biochemical indices observed in Changra goats were blood glucose 62.967±0.884 mg/dL, total serum protein 5.932 ± 0.037gm/dL, albumin 3.091 ± 0.024gm/dL, globulin 2.838 ± 0.035gm/dL, albumin: globulin ratio 1.157 ± 0.031, ALP 234.163 ± 5.380 IU/L, AST 78.095 ± 1.932 IU/L, ALT 19.972 ± 0.704 IU/L, blood urea 28.755 ± 0.677 mg/dL, creatinine 0.814 ± 0.024 mg/dL, and cholesterol 138.093 ± 1.275 mg/dL. In general, age and sex did not appear to have any significant effect on the biochemical indices studied. However, significant area effects were observed on all the biochemical indices.

Keywords: Serum biochemical, Changra goats, intensive management

Introduction
Clinical biochemistry is an important field of investigation in determining the health status of animals providing a viatl aid in disease diagnosis and understanding disease process. Besides providing valuable information about functional status of vital organs (Belewu and Ogunsola, 2010) [3], they are indicators of metabolism and production performance potenstial in given conditions (Orheruata and Akhuomobhogbe 2006) [19]. However, the logistic evaluation warrants comparison with the baseline profile or reference range vis-a-vis species, breed, age, sex, physiological status, nutrition, environmental fctors, stress, etc. (Tambuwal *et al*. 2002; Balikei *et al*., 2007; Opara and Fgbemi, 2009). Besides, the values are greatly influenced by pre-analytical and analytical factors like nutrition, meals, preservative, time of sampling, transportation, storage, and laboratory techniques (Braun *et al*., 2010). Understanding sources of individual variations is critical in interpreting clinical data, thus warranting tailored profiling.

Reference serum biochemistry data are available for different goat breeds throughout the world. Marked breed differences have been reported for different parameters (Tambuwal *et al*., 2002; Madan *et al*., 2016; Al-Bulushi *et al*., 2017) [24, 14, 1]. The Changra breed of pashmina goats native to Changthang region of Ladakh are ecologically and economically important bioresource (Maryiam *et al.*, 2016) [15]. Their habit and habitat are markedly different than other goat breeds. Inhabiting high altitudes of cold arid regions, they are adapted to harsh climate and sparsely vegetated pastures, yet producing world's best quality pashmina (undercoat) (Wani *et al.*, 2009; Maryiam *et al.*, 2016) [25, 15]. Its high climate resistance and adaptability makes the breed a unique model for biological research. Understand its biology under natural rearing conditions is prerequisite to ensure good management practice. Descephering basic biological parameters serve as indicators of unique adaptive mechanisms on one hand and provide reference ranges for clinical and paraclinical evaluations.

The aim of present study was to establish reference ranges for serum biochemical indices of Changra goats under natural pastoral conditions in their native tract.

Materials and Methods

The study was conducted in Changthang area of Ladakh in Jammu and Kashmir representing Trans-Himalayan high Altitude Cold arid desert. Its elevations range from 3500-4500 m above the MSL. It experiences harsh dry climate with temperature ranging from -40 to +40ºC, has undulated land topography, and sparse vegetation. Blood samples for serum biochemical studies were collected from representative number of goats of both sexes and different age groups from Kharnak, Sumdho, Chushul, Mughlib and Kargyam in the traditional Changra rearing belt, and Digger, Turtuk and Stakna in non-traditional belt. Sample size varied depending upon the flock strength. Age of the animals was determined based on dentition, horn rings and owners information.

Collection of blood and serum

Blood sampling was performed during early morning before animals were let out for grazing. Goats were restrained for venipuncture and site cleansed with tincture of iodine. Approximately 7 mL of blood samples were collected from the jugular vein using standard techniques and transferred to sterile tubes containing clot activator for separation of serum. The serum was separated by centrifugation at 5000 rpm for 10 min and stored in multiple aliquots at -20°C until used.

SERUM Biochemistry

The serum biochemical parameters studied included blood glucose (Glucometer/GOD POD method); plasma proteins viz. total protein (Biuret method), albumin (BCG Dye binding method), globulin (difference method) and albumin: globulin (A:G) ratio; plasma enzymology viz. asparatate transaminase (AST); alanine transaminase (ALT) (IFCC method/ Reitman and Frankel's method); and alkaline phosphatase (Modified DGKC method) kidney function tests (KFT) viz. blood urea nitrogen (BUN) (Berthelot method) and creatinine (modified Jaffe's method) and plasma lipids viz. total cholesterol (CHOD-POD method) using diagnostic kits (Aspen Laboratories Pvt. Ltd, Rapid Diagnostic Group of Companies, Karnal Road Industrial Area, Delhi, India) and semi-automatic blood chemistry analyser (model ERBA CHEM-PRO) as per manufacturer's literature.

Statistical Analysis

Results are expressed as Mean ± S.E. with n equal to number of animals. Data were analyzed by t-test, one-way ANOVA followed by Dunnet's test and two-way ANOVA followed with Bonferroni's multiple comparison tests using SPSS software (Snedecor and Cochran, 1994) [23].

Results

Blood glucose

The mean blood glucose (BG) levels observed in male and female Changra goats, respectively, was 60.633± 1.208mg/dL and 64.570±1.226 mg/dL, with an overall mean of 62.967±0.884 mg/dL. The mean blood glucose values observed were significantly ($P \leq 0.05$) higher in goats reared at Kargyam (77.415 ± 2.130mg/dL) followed by Mughlib (72.977 ± 0.897mg/dL), Digger (72.105 ± 0.694mg/dL), Stakna (70.046 ± 0.576mg/dL), Turtuk (68.346 ± 1.128mg/dL), Kharnak (55.920 ± 0.615mg/dL), Sumdho (45.483 ± 1.436mg/dL) and Chushul (43.878 ± 1.320mg/dL) in that order. The overall mean value was higher in females (64.570 ± 1.226mg/dL) than in males (60.633 ± 1.208mg/dL). The mean glucose values did not differ significantly between sexes except significantly ($P \leq 0.05$) higher values in males of Sumdho and Chushul and females of Kargyam and Turtuk. The difference in the mean glucose values between areas within sexes were significant ($P \leq 0.05$) (Table 1).

Age-wise evaluations revealed that the overall mean blood glucose levels in 2 tooth (55.768 ± 1.725mg/dL), 4 tooth (54.480 ± 2.024mg/dL), 6 tooth (52.190 ± 2.285mg/dL) and full mouth (52.890 ± 2.456mg/dL) Changra goats were comparable. However, significantly ($P \leq 0.05$) higher mean blood glucose levels were observed in 2 tooth goats reared at Sumdho and Chushul when compared with other age groups in that area. No significant differences were observed between male and female goats within age groups. Similar trend was observed in all areas except for significantly ($P \leq 0.05$) higher mean blood glucose levels in 2 tooth, 4 tooth and full mouth males at Sumdho, and 4 tooth males at Chushul. The differences observed within sexes between age groups in different areas were non-significant except for significantly ($P \leq 0.05$) lower mean value in 6 tooth males at Sumdho and 4 tooth. 6 tooth and full mouth females at Chushul (Table 2).

Table 1: Effect of area and sex on Serum Glucose (mg/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Kharnak	Sumdho	Chushul	Stakna	Digger
57.360 ± 0.780^{aA}	49.180 ± 1.872^{bA}	45.279 ± 1.649^{bA}	69.849 ± 0.878^{cdA}	72.759 ± 1.109^{dA}
54.481 ± 0.825^{aA}	41.786 ± 1.790^{bB}	42.478 ± 2.055^{bB}	70.243 ± .772^{cA}	71.726 ± 0.899^{cA}
55.920 ± 0.615^{a}	45.483 ± 1.436^{b}	43.878 ± 1.320^{b}	70.046 ± 0.576^{ce}	72.105 ± 0.694^{c}

Mean (along rows bearing at least one common lowercase superscript, and between along columns (between sexes) bearing at least one common uppercase superscript, does not differ significantly

Table 2: Effect of area and age on Serum Glucose (mg/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area	Age→ Sex↓	2T	4T	6T	FM	Overall
Kharnak	Male	54.227 ± 0.518^{aA}	56.962 ± 0.379^{aA}	57.147 ± 1.007^{aA}	61.102 ± 1.655^{aA}	57.360 ± 0.780
	Female	53.777 ± 2.337^{aA}	55.075 ± 2.265^{aA}	55.422 ± 1.159^{aA}	53.650 ± 0.935^{aA}	54.481 ± 0.825
	Total	54.002 ± 1.111^{a}	56.018 ± 1.121^{a}	56.285 ± 0.782^{a}	57.376 ± 1.666^{a}	55.920 ± 0.615
Sumdho	Male	54.245 ± 2.791^{aA}	55.017 ± 1.615^{aA}	39.462 ± 2.670^{bA}	47.997 ± 0.838^{Aa}	49.180 ± 1.872
	Female	45.265 ± 4.530^{aB}	44.460 ± 4.475^{aB}	38.212 ± 2.045^{aA}	39.210 ± 2.553aB	41.786 ± 1.790
	Total	49.755 ± 2.991^{a}	49.738 ± 2.971^{a}	38.837 ± 1.574^{b}	43.603 ± 2.074^{b}	45.483 ± 1.436
Chushul	Male	48.590 ± 3.385^{aA}	48.090 ± 3.320^{aA}	46.172 ± 2.754^{aA}	38.265 ± 1.187^{bA}	45.279 ± 1.649
	Female	53.227 ± 5.328^{aA}	37.305 ± 1.171^{bB}	40.557 ± 1.073^{bA}	38.822 ±.697^{bA}	42.478 ± 2.055
	Total	50.908 ± 3.050^{a}	42.697 ± 2.609^{b}	43.365 ± 1.731^{b}	38.543 ± 0.646^{b}	43.878 ± 1.320
Stakna	Male	65.540 ± 1.045^{aA}	69.890 ± 0.875^{aA}	71.165 ± 0.523^{aA}	72.802 ± 1.905^{aA}	69.849 ± 0.878
	Female	71.277 ±.242aA	69.042 ± 0.551^{aA}	69.382 ± 1.628^{aA}	71.270 ± 2.734^{aA}	70.243 ± 0.772
	Total	68.408 ± 1.192^{a}	69.466 ± 0.504^{a}	70.273 ± 0.860^{a}	72.036 ± 1.569^{a}	70.046 ± 0.576

Overall	Male	55.650 ± 1.886^{aA}	57.490 ± 2.206^{aA}	53.486 ± 3.225^{aA}	55.041 ± 3.436^{aA}	55.417 ± 1.362
	Female	55.886 ± 2.956^{aA}	51.470 ± 3.296^{aA}	50.893 ± 3.311^{aA}	50.738 ± 3.537^{aA}	52.247 ± 1.623
	Total	55.768 ± 1.725^{a}	54.480 ± 2.024^{a}	52.190 ± 2.285^{a}	52.890 ± 2.456^{a}	53.832 ± 1.064

Mean along rows (between age groups) bearing at least one common lowercase superscript, and between sex within the age groups (along columns) bearing at least one common uppercase superscript, does not differ significantly

Serum Proteins

Total protein: The mean total protein (TP) levels observed in male and female Changra goats, respectively, was 5.826 ± 0.061gm/dL and 6.004 ± 0.046gm/dL, with an overall mean of 5.932 ± 0.037gm/dL. The mean TP values were significantly ($P \leq 0.05$) higher in goats reared at Stakna (6.322 ± 0.083gm/dL) followed by Kargyam (6.313 ± 0.084gm/dL), Turtuk (6.171 ± 0.099gm/dL), Digger (6.024 ± 0.063gm/dL), Mughlib (5.867 ± 0.060gm/dL), Chushul (5.757 ± 0.092gm/dL), Kharnak (5.520 ± 0.125gm/dL), Sumdho (5.519 ± 0.105gm/dL). Significant ($P \leq 0.05$) differences were also observed between areas within sexes. Evaluation between sexes within an area revealed significantly ($P \leq 0.05$) higher values in females of Kharnak and Kargyam and in males at Sumdho (Table 3).

Comparison between age groups revealed significantly ($P \leq 0.05$) higher overall mean values in 6 tooth goats (6.021 ± 0.134gm/dL) followed by 2 tooth (5.821 ± 0.099gm/dL), 4 tooth (5.699 ± 0.097gm/dL) and full mouth (5.576 ± 0.123gm/dL). Significant ($P \leq 0.05$) differences between age groups within an area, however no definite trend was evident. Comparison between age groups within sexes revealed significantly ($P \leq 0.05$) higher overall mean value in 6 tooth males. The overall means observed in females were comparable within age groups. Significant ($P \leq 0.05$) differences within sex between age groups were observed in goats at different areas, however no general trend was evident. No significant difference was observed between sexes within an age group except in Chushul where 2 tooth and 4 tooth females showed significantly ($P \leq 0.05$) higher values than males of same age group (Table 4).

Table 3: Effect of area and sex on Serum Total Protein (gm/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area→ Sex↓	Kharnak	Sumdho	Chushul	Stakna	Digger	Kargyam	Mughlib	Turtuk	Total
Male	5.381 ± 0.207^{aA}	5.570 ± 0.116^{adA}	5.550 ± 0.133^{aeA}	6.463 ± 0.122^{bA}	6.030 ± 0.131^{cA}	5.968 ± 0.104^{cdeA}	5.984 ± 0.080^{cdA}	5.982 ± 0.156^{cdA}	5.826 ± 0.061
Female	5.658 ± 0.137^{abB}	5.468 ± 0.179^{aeB}	5.964 ± 0.109^{bceA}	6.181 ± 0.106^{cdA}	6.021 ± 0.067^{ceA}	6.461 ± 0.096^{dB}	5.816 ± 0.077^{cA}	6.252 ± 0.122^{deA}	6.004 ± 0.046
Total	5.520 ± 0.125^{a}	5.519 ± 0.105^{a}	5.757 ± 0.092^{b}	6.322 ± 0.083^{c}	6.024 ± 0.063^{de}	6.313 ± 0.084^{c}	5.867 ± 0.060^{bd}	6.171 ± 0.099^{ce}	5.932 ± 0.037

Mean (along rows bearing at least one common lowercase superscript, and between along columns (between sexes) bearing at least one common uppercase superscript, does not differ significantly

Table 4: Effect of area and age on Serum Total Protein (gm/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area	Age→Sex↓	2T	4T	6T	FM	Overall
Kharnak	Male	5.880 ± 0.203^{abA}	5.225 ± 0.201^{aA}	6.162 ± 0.096^{bA}	4.260 ± 0.240^{cA}	5.381 ± 0.207
	Female	5.960 ± 0.221^{abA}	5.387 ± 0.216^{abA}	6.015 ± 0.252^{aA}	5.270 ± 0.270^{bB}	5.658 ± 0.137
	Total	5.920 ± 0.139^{a}	5.306 ± 0.140^{bA}	6.088 ± 0.128^{aA}	4.765 ± 0.254^{c}	5.520 ± 0.125^{a}
Sumdho	Male	5.682 ± 0.232^{abA}	5.950 ± 0.202^{bA}	5.205 ± 0.130^{aA}	5.445 ± 0.242^{abA}	5.570 ± 0.116
	Female	4.962 ± 0.357^{aA}	5.640 ± 0.232^{bA}	5.222 ± 0.406^{aA}	6.050 ± 0.259^{bA}	5.468 ± 0.179
	Total	5.322 ± 0.239^{ab}	5.795 ± 0.154^{b}	5.213 ± 0.197^{a}	5.747 ± 0.200^{ab}	5.519 ± 0.105^{a}
Chushul	Male	5.475 ± 0.170^{abA}	5.120 ± 0.312^{aA}	5.675 ± 0.193^{abA}	5.930 ± 0.271^{bA}	5.550 ± 0.133
	Female	6.300 ± 0.163^{aB}	6.107 ± 0.209^{abB}	5.967 ± 0.192^{abA}	5.482 ± 0.112^{bA}	5.964 ± 0.109
	Total	5.887 ± 0.190^{a}	5.613 ± 0.255^{a}	5.821 ± 0.137^{a}	5.706 ± 0.160^{a}	5.757 ± 0.092^{b}
Stakna	Male	6.262 ± 0.165^{aA}	6.290 ± 0.193^{aA}	7.150 ± 0.120^{bA}	6.152 ± 0.083^{aA}	6.463 ± 0.122
	Female	6.050 ± 0.086^{Aa}	5.875 ± 0.060^{Aa}	6.775 ± 0.231^{bA}	6.025 ± 0.032^{aA}	6.181 ± 0.106
	Total	6.156 ± 0.095^{a}	6.082 ± 0.122^{a}	6.962 ± 0.140^{b}	6.088 ± 0.047^{a}	6.322 ± 0.083^{c}
Overall	Male	5.825 ± 0.114^{abA}	5.646 ± 0.163^{abA}	6.048 ± 0.196^{aA}	5.446 ± 0.213^{bA}	5.741 ± 0.090
	Female	5.818 ± 0.166^{aA}	5.752 ± 0.110^{aA}	5.995 ± 0.189^{aA}	5.706 ± 0.124^{aA}	5.818 ± 0.075
	Total	5.821 ± 0.099^{ab}	5.699 ± 0.097^{ab}	6.021 ± 0.134^{a}	5.576 ± 0.123^{b}	5.779 ± 0.058

Mean along rows (between age groups) bearing at least one common lowercase superscript, and between sex within the age groups (along columns) bearing at least one common uppercase superscript, does not differ significantly

Albumin: The mean albumin levels observed in male and female Changra goats, respectively, was 3.027 ± 0.038gm/dL and 3.136 ± 0.031gm/dL, with an overall mean of 3.091 ± 0.024gm/dL. The overall mean albumin values were significantly higher in reared at Stakna (3.333 ± 0.050gm/dL), followed by Kargyam (3.189 ± 0.069gm/dL), Mughlib (3.181 ± 0.060gm/dL), Turtuk (3.186 ± 0.061gm/dL), Digger (3.104 ± 0.048gm/dL), Sumdho (2.983 ± 0.079gm/dL), Kharnak 2.937 ± 0.078gm/dL), and Chushul (2.837 ± 0.061gm/dL). Significant differences were also observed between areas within sexes. The differences between sexes within an area were non-significant, except for significantly higher value in female goats at Kargyam (Table 5).

The overall mean albumin values in 2 tooth (3.062 ± 0.079gm/dL), 4 tooth (3.067 ± 0.068gm/dL), 6 tooth (3.033 ± 0.077gm/dL) and full mouth (2.927 ± 0.076gm/dL) Changra goats were comparable. Also, no significant differences were observed in overall means between age groups within sexes, or between age groups within an area or between sexes within age groups. Comparison between sexes within age groups in different areas, also, did not show any significant difference except for significantly ($P \leq 0.05$) lower values in 2 tooth males at Chushul (Table 6).

Table 5: Effect of area and sex on Serum Albumin (gm/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area→ Sex↓	Kharnak	Sumdho	Chushul	Stakna	Digger	Kargyam	Mughlib	Turtuk	Total
Male	3.044 ± 0.097^{abcdA}	2.867 ± 0.126^{acA}	2.777 ± 0.090^{aA}	3.331 ± 0.054^{bA}	3.104 ± 0.078^{bcdA}	2.934 ± 0.071^{acdA}	3.077 ± 0.107^{abcdA}	3.185 ± 0.122^{bdA}	3.027± 0.038^{A}
Female	2.830 ± 0.119^{aA}	3.098 ± 0.090^{abcA}	2.896 ± 0.084^{acA}	3.335 ± 0.087^{bA}	3.104 ± 0.064^{abcA}	3.299 ± 0.084^{bB}	3.225 ± 0.073^{bA}	3.186 ± 0.071^{bcA}	3.136± 0.031^{A}
Total	2.937 ± 0.078^{a}	2.983 ± 0.079^{a}	2.837 ± 0.061^{b}	3.333 ± 0.050^{c}	3.104 ± 0.048^{ad}	3.189 ± 0.069^{cd}	3.181 ± 0.060^{cd}	3.186 ± 0.061^{cd}	3.091± 0.024

Mean (along rows bearing at least one common lowercase superscript, and between along columns (between sexes) bearing at least one common uppercase superscript, does not differ significantly

Table 6: Effect of area and age on Serum Albumin (gm/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area	Age→ Sex↓	2T	4T	6T	FM	Overall
Kharnak	Male	2.927 ± 0.180^{aA}	3.092 ± 0.040^{aA}	3.170 ± 0.094^{aA}	2.987 ± 0.369^{aA}	3.044 ± 0.097
	Female	2.687 ± 0.158^{aA}	3.070 ± 0.364^{aA}	2.875 ± 0.125^{aA}	2.690 ± 0.279^{aA}	2.830 ± 0.119
	Total	2.807 ± 0.120^{a}	3.081 ± 0.169^{a}	3.022 ± 0.091^{a}	2.838 ± 0.221^{a}	2.937 ± 0.078
Sumdho	Male	3.270 ± 0.154^{aA}	2.950 ± 0.290^{abA}	2.775 ± 0.229^{abA}	2.475 ± 0.217^{bA}	2.867 ± 0.126
	Female	2.902 ± 0.221^{aA}	3.305 ± 0.154^{aA}	2.987 ± 0.233^{aA}	3.200 ± 0.040^{aB}	3.098 ± 0.000
	Total	3.086 ± 0.142^{a}	3.127 ± 0.166^{a}	2.881 ± 0.156^{a}	2.837 ± 0.171^{a}	2.983 ± 0.079
Chushul	Male	2.510 ± 0.176^{Aa}	2.727 ± 0.139^{aA}	2.785 ±0.227^{aA}	3.087 ± 0.077^{aA}	2.777 ± 0.090
	Female	3.162 ± 0.031^{abB}	2.545 ± 0.047^{aA}	3.195 ± 0.099^{bA}	2.685 ± 0.138^{abA}	2.896 ± 0.084
	Total	2.836 ± 0.148^{a}	2.636 ± 0.076^{a}	2.990 ± 0.138^{a}	2.886 ± 0.105^{a}	2.837 ± 0.061
Stakna	Male	3.332 ± 0.085^{aA}	3.307 ± 0.108^{aA}	3.417 ± 0.183^{aA}	3.267 ± 0.041^{aA}	3.331 ± 0.054
	Female	3.707 ± 0.112^{aA}	3.267 ± 0.208^{abA}	3.337 ± 0.110^{aA}	3.030 ± 0.064^{bA}	3.335 ± 0.087
	Total	3.520 ± 0.096^{a}	3.287 ± 0.109^{a}	3.377 ± 0.100^{a}	3.148 ± 0.057^{a}	3.333 ± 0.050
Overall	Male	3.010 ± 0.108^{aA}	3.019 ± 0.093^{aA}	3.036 ± 0.110^{aA}	2.954 ± 0.123^{aA}	3.005 ± 0.053
	Female	3.115 ± 0.118^{aA}	3.046 ± 0.127^{aA}	3.098 ± 0.082^{aA}	2.901 ± 0.091^{aA}	3.040 ± 0.053
	Total	3.062 ± 0.079^{a}	3.033 ± 0.077^{a}	3.067 ± 0.068^{a}	2.927 ± 0.076^{a}	3.022 ± 0.037

Mean along rows (between age groups) bearing at least one common lowercase superscript, and between sex within the age groups (along columns) bearing at least one common uppercase superscript, does not differ significantly

Globulin: The mean globulin levels observed in male and female Changra goats, respectively, was 2.795 ± 0.055gm/dL and 2.868 ± 0.046gm/dL, with an overall mean of 2.838 ± 0.035gm/dL. The overall mean globulin values were highest in goats reared at Kargyam (3.124 ± 0.080gm/dL), Stakna (2.978 ± 0.093gm/dL), Turtuk (2.974 ± 0.108gm/dL), Digger (2.921 ± 0.068 gm/dL), Chushul (2.920 ± 0.096gm/dL), Mughlib (2.697 ± 0.073gm/dL), Kharnak (2.582 ± 0.133gm/dL), and Sumdho (2.532 ± 0.087gm/dL) in that order. The values were comparable between the areas except for significantly ($P \leq 0.05$) lower values in Kharnak and Sumdho. A similar trend was observed within sexes between different areas. Comparison of means between sexes within an area revealed no significant differences except significantly lower values observed in male's goats at Kharnak (Table 7).

The overall mean globulin values observed in 2 tooth (2.758 ± 0.090 gm/dL), 4 tooth (2.666 ± 0.116gm/dL), 6 tooth (2.950 ± 0.109gm/dL) and full mouth (2.639 ± 0.114gm/dL) Changra goats were comparable. Comparison between age groups with an area did not reveal any significant differences except significantly lower values in full mouth goats at Kharnak and 6 tooth goats at Stakna. Comparison within sexes between age groups revealed significantly higher overall mean value ($P \leq 0.05$) in 6 tooth male, whereas the values were comparable among females. Although significant differences were observed between age groups within sexes in different areas, no generalized trend was evident. No significant differences were found between sexes within age groups except significantly lower values in full mouth males at Kharnak and 4 tooth males at Chushul (Table 8).

Table 7: Effect of area and sex on Serum Globulin (gm/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area→ Sex↓	Kharnak	Sumdho	Chushul	Stakna	Digger	Kargyam	Mughlib	Turtuk	Total
Male	2.337 ± 0.203^{aA}	2.701 ± 0.111^{abcA}	2.772 ± 0.147^{bcA}	3.111 ± 0.127^{cA}	2.925 ± 0.097^{cA}	3.034 ± 0.049^{cA}	2.906 ± 0.078^{cA}	2.796 ± 0.167^{cA}	2.795± 0.055 ^{A}
Female	2.827 ± 0.156^{acB}	2.363 ± 0.124^{bA}	3.067 ± 0.118^{acA}	2.845 ± 0.133^{acA}	2.918 ± 0.093^{acA}	3.162 ± 0.113^{cA}	2.608 ± 0.094^{abA}	3.050 ± 0.136^{acA}	2.868± 0.046 ^{A}
Total	2.582 ± 0.133^{a}	2.532 ± 0.087^{a}	2.920 ± 0.096^{bd}	2.978 ± 0.093^{b}	2.921 ± 0.068^{bc}	3.124 ± 0.080^{b}	2.697 ± 0.073^{acd}	2.974 ± 0.108^{b}	2.838± 0.035

Mean (along rows bearing at least one common lowercase superscript, and between along columns (between sexes) bearing at least one common uppercase superscript, does not differ significantly

Table 8: Effect of area and age on Serum Globulin (gm/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area	Age→ Sex↓	2T	4T	6T	FM	Overall
Kharnak	Male	2.952 ± 0.249^{aA}	2.132 ± 0.166^{bA}	2.992 ± 0.144^{aA}	1.272 ± 0.234^{cA}	2.337 ± 0.203
	Female	3.272 ± 0.118^{aA}	2.317 ± 0.378^{bA}	3.140 ± 0.137^{Aa}	2.580 ± 0.323^{abB}	2.827 ± 0.156
	Total	3.112 ± 0.141^{a}	2.225 ± 0.194^{b}	3.066 ± 0.096^{a}	1.926 ± 0.308^{b}	2.582 ± 0.133
Sumdho	Male	2.412 ± 0.096^{aA}	3.000 ± 0.108^{aA}	2.425 ± 0.345^{aA}	2.970 ± 0.050^{aA}	2.701 ± 0.111
	Female	2.060 ± 0.158^{aA}	2.335 ± 0.187^{abA}	2.210 ± 0.281^{abA}	2.850 ± 0.232^{bA}	2.363 ± 0.124
	Total	2.236 ± 0.108^{a}	2.667 ± 0.160^{a}	2.317 ± 0.210^{a}	2.910 ± 0.112^{abA}	2.532 ± 0.087

Chushul	Male	2.965 ± 0.247^{aA}	2.392 ± 0.374^{aA}	2.890 ± 0.327^{aA}	2.842 ± 0.249^{aA}	2.772 ± 0.147
	Female	3.137 ± 0.172^{abA}	3.562 ± 0.247^{Bb}	2.772 ± 0.168^{aA}	2.797 ± 0.157^{aA}	3.067 ± 0.118
	Total	3.051 ± 0.143^{a}	2.977 ± 0.303^{a}	2.831 ± 0.172^{a}	2.820 ± 0.137^{a}	2.920 ± 0.096
Stakna	Male	2.922 ± 0.074^{aA}	2.982 ± 0.301^{aA}	3.732 ± 0.129b^{A}	2.810 ± 0.184^{aA}	3.111 ± 0.127
	Female	2.342 ± 0.186^{aA}	2.607 ± 0.257^{Aa}	3.437 ± 0.157^{bA}	2.995 ± 0.045^{abA}	2.845 ± 0.133
	Total	2.632 ± 0.143^{a}	2.795 ± 0.196^{a}	3.585 ± 0.109^{b}	2.902 ± 0.094^{a}	2.978 ± 0.093
Overall	Male	2.813 ± 0.102^{abA}	2.626 ± 0.151^{abA}	3.010 ± 0.166^{bA}	2.473 ± 0.200^{aA}	2.730 ± 0.081
	Female	2.703 ± 0.150^{aA}	2.705 ± 0.180Aa	2.890 ± 0.146^{aA}	2.805 ± 0.103^{aA}	2.776 ± 0.072
	Total	2.758 ± 0.090^{a}	2.666 ± 0.116^{a}	2.950 ± 0.109^{a}	2.639 ± 0.114^{a}	2.753 ± 0.054

Mean along rows (between age groups) bearing at least one common lowercase superscript, and between sex within the age groups (along columns) bearing at least one common uppercase superscript, does not differ significantly

Albumin: globulin ratio: The mean albumin: globulin (A: G) ratio observed in male and female Changra goats, respectively, was 1.168 ± 0.062 and 1.150 ± 0.030, with an overall mean of 1.157 ± 0.031. The overall mean A: G ratio were significantly higher in goats at Kharnak (1.373 ± 0.192), when compared with Chushul (1.017 ± 0.055), Digger (1.082 ± 0.039), Kargyam (1.042 ± 0.046) and Turtuk (1.117 ± 0.053), but comparable to those at Sumdho (1.225 ± 0.056), Stakna (1.164 ± 0.056), and Mughlib (1.230 ± 0.073). The differences within sexes between areas were non-significant except significantly higher values in male goats at Kharnak and female goats at Sumdho. No significant differences were observed between sexes within an area except at Kharnak where mean A: G ratios in male goats was significantly higher than female goats (Table 9).

The overall mean A: G ratio observed in 2 tooth (1.155 ± 0.057), 4 tooth (1.241 ± 0.089), 6 tooth (1.084 ± 0.050) and full mouth (1.298 ±.183) Changra goats were comparable. Comparison between age groups with an area did not reveal any significant differences except significantly higher value in full mouth goats at Kharnak. Similarly no significant differences were observed in overall and area-wise means within sexes between age groups, and between sexes within age groups, except significantly higher overall mean value ($P \leq 0.05$) in full mouth male at Kharnak when compared with males of other age groups or females of same age group in the area (Table 10).

Table 9: Effect of area and sex on Serum Albumin: Globulin ratio of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area→ Sex↓	Kharnak	Sumdho	Chushul	Stakna	Digger	Kargyam	Mughlib	Turtuk	Total
Male	1.641 ± 0.347^{aA}	1.101 ± 0.081^{bB}	1.067 ± 0.097^{bA}	1.097 ±0.054^{bA}	1.067 ± 0.043^{bA}	0.962 ± 0.021^{bA}	1.068 ± 0.068^{bA}	1.174 ± 0.094^{bA}	1.168± 0.062^{A}
Female	1.105 ± 0.149^{bB}	1.348 ± 0.067^{abA}	0.968 ± 0.054^{bA}	1.231 ± 0.098^{bA}	1.091 ± 0.058^{bA}	1.077 ± 0.064^{bA}	1.299 ± 0.098^{abA}	1.092 ± 0.065^{bA}	1.150± 0.030^{A}
Total	1.373 ± 0.192^{a}	1.225 ± 0.056^{ab}	1.017 ± 0.055^{b}	1.164 ± 0.056^{ab}	1.082 ± 0.039^{b}	1.042 ± 0.046^{b}	1.230 ± 0.073^{ab}	1.117 ± 0.053^{b}	1.157± 0.031

Mean (along rows bearing at least one common lowercase superscript, and between along columns (between sexes) bearing at least one common uppercase superscript, does not differ significantly

Table 10: Effect of area and age on Serum Albumin: Globulin ratio of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area	Age→ Sex↓	2T	4T	6T	FM	Overall
Kharnak	Male	1.017 ± 0.129^{Aa}	1.470 ± 0.098^{aA}	1.065 ± 0.085^{aA}	3.012 ± 1.227^{bA}	1.641 ± 0.347
	Female	0.817 ± 0.048^{Aa}	1.550 ± 0.499^{aA}	0.910 ± 0.020^{Aa}	1.142 ± 0.294^{aB}	1.105 ± 0.149
	Total	0.917 ± 0.074^{a}	1.510 ± 0.236^{ab}	0.987 ± 0.049^{a}	2.077 ± 0.682^{b}	1.373 ± 0.192
Sumdho	Male	1.352 ± 0.047^{aA}	0.990 ± 0.122^{aA}	1.237 ± 0.235^{Aa}	0.827 ± 0.069^{Aa}	1.101 ± 0.081
	Female	1.410 ± 0.080^{aA}	1.445 ± 0.154^{aA}	1.397 ± 0.184^{Aa}	1.140 ± 0.083^{Aa}	1.348 ± 0.067
	Total	1.381 ± 0.044^{a}	1.217 ± 0.125^{a}	1.317 ± 0.141^{a}	0.983 ± 0.077^{a}	1.225 ± 0.056
Chushul	Male	0.872 ± 0.133^{aA}	1.275 ± 0.314^{aA}	1.017 ± 0.184^{aA}	1.105 ± 0.105^{Aa}	1.067 ± 0.097
	Female	1.012 ± 0.064^{aA}	0.725 ± 0.061^{aA}	1.162 ± 0.080^{Aa}	0.972 ± 0.108^{Aa}	0.968 ± 0.054
	Total	0.942 ± 0.073^{a}	1.000 ± 0.181^{a}	1.090 ± 0.097^{a}	1.038 ± 0.074^{a}	1.017 ± 0.055
Stakna	Male	1.137 ± 0.008^{Aa}	1.155 ± 0.168^{aA}	0.917 ± 0.072^{Aa}	1.180 ± 0.101^{Aa}	1.097 ± 0.054
	Female	1.625 ± 0.195^{aA}	1.320 ± 0.242^{aA}	0.970 ± 0.038^{Aa}	1.010 ± 0.034^{aA}	1.231 ± 0.098
	Total	1.381 ± 0.129^{a}	1.237 ± 0.140^{a}	0.943 ± 0.039^{a}	1.095 ± 0.059^{a}	1.164 ± 0.056
Overall	Male	1.095 ± 0.062^{aA}	1.222 ± 0.098^{aA}	1.059 ± 0.077^{Aa}	1.531 ± 0.355^{aA}	1.227 ± 0.096
	Female	1.216 ± 0.096^{Aa}	1.260 ± 0.153^{aA}	1.110 ± 0.067^{Aa}	1.066 ± 0.075^{aA}	1.163 ± 0.051
	Total	1.155 ± 0.057^{a}	1.241 ± 0.089^{a}	1.084 ± 0.050^{a}	1.298 ± 0.183^{a}	1.195 ± 0.054

Mean along rows (between age groups) bearing at least one common lowercase superscript, and between sex within the age groups (along columns) bearing at least one common uppercase superscript, does not differ significantly

Liver function tests (LFT)

Alkaline phosphatase (ALP): The mean ALP value observed in male and female Changra goats, respectively, was 237.691 ± 7.819 IU/L and 231.739 ± 7.332 IU/L, with an overall mean of 234.163 ± 5.380 IU/L. Significantly ($P \leq 0.05$) higher values were observed in goats reared at Kharnak (295.896 ± 9.896 IU/L) and Sumdho (289.540 ± 12.187 IU/L) when compared with those at Chushul (198.723 ±7.909 IU/L), Stakna (223.705 ±10.103 IU/L), Digger (203.132 ± 19.561 IU/L), Kargyam (210.772 ± 12.698 IU/L), Mughlib (236.517 ± 23.445 IU/L) and Turtuk were (210.272 ± 10.048 IU/L) which were comparable among themselves. Similar trend was observed within sexes between the areas. Differences between sexes within areas were non-significant except significantly lower values in male goats than female goats at Mughlib (Table 11).

The overall mean ALP values in 2 tooth (250.905 ± 12.750 IU/L), 4 tooth (256.610 ± 14.505 IU/L), 6 tooth (249.099 ± 11.584 IU/L) and full mouth (251.250 ± 11.310 IU/L) Changra goats did not differ significantly. Also, no significant differences were observed between the age groups in different areas as well as within sexes between age groups or between sexes within age groups (Table 12)

Table 11: Effect of area and sex on Serum Alkaline Phosphatase activity (IU/L) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area→ Sex↓	Kharnak	Sumdho	Chushul	Stakna	Digger	Kargyam	Mughlib	Turtuk	Total
Male	298.663 ± 10.903^{aA}	317.73± 17.951^{aA}	190.56± 11.92^{bcA}	235.810 ± 17.242^{bA}	224.844± 30.336^{bcA}	211.765 ± 18.665^{bcA}	160.900 ± 20.102^{cA}	214.450 ± 19.084^{bcA}	237.691± 7.819 ^{A}
Female	293.130 ± 16.879^{aA}	261.35± 13.627	206.87± 10.36^{bcA}	211.599 ± 10.253^{bcA}	190.562± 25.563^{bA}	210.346 ± 16.560^{bcA}	268.925 ± 29.905^{acB}	208.481 ± 12.090^{bcA}	231.739± 7.332 ^{A}
Total	295.896 ± 9.896^{a}	289.54± 12.187^{a}	198.72± 7.909^{b}	223.705 ± 10.103^{b}	203.132± 19.561^{b}	210.772 ± 12.698^{b}	236.517 ± 23.445^{b}	210.272 ± 10.048^{b}	234.163± 5.380

Mean (along rows bearing at least one common lowercase superscript, and between along columns (between sexes) bearing at least one common uppercase superscript, does not differ significantly

Table 12: Effect of area and age on Serum Alkaline Phosphatase activity (IU/L) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area	Age→ Sex↓	2T	4T	6T	FM	Overall
Kharnak	Male	297.195 ± 27.312^{abA}	286.245 ± 19.455^{aA}	275.520 ± 16.765^{abA}	335.692 ± 16.866^{bA}	298.663 ± 10.903
	Female	273.640 ± 35.826^{aA}	352.690 ± 33.020^{aA}	310.165 ± 25.254^{aA}	236.025 ± 13.915^{aB}	293.130 ± 16.879
	Total	285.417 ± 21.323^{a}	319.467 ± 21.735^{a}	292.842 ± 15.484^{a}	285.858 ± 21.382^{a}	295.896 ± 9.896
Sumdho	Male	320.542 ± 27.202aA	360.812 ± 33.190^{aA}	299.485 ± 52.092^{aA}	290.080 ± 30.046^{aA}	317.730 ± 17.951
	Female	290.682 ± 26.290^{aA}	269.490 ± 17.673^{aB}	220.860 ± 35.017^{aA}	264.372 ± 25.024^{aA}	261.351 ± 13.627
	Total	305.612 ± 18.399^{a}	315.151 ± 24.512^{a}	260.172 ± 32.634^{a}	277.226 ± 18.741^{a}	289.54± 12.187
Chushul	Male	158.122 ± 1.044^{aA}	202.612 ± 36.215^{aA}	204.972 ± 16.689^{aA}	196.567 ± 27.826^{aA}	190.568 ± 11.928
	Female	220.090 ± 18.966^{aA}	217.470 ± 27.143^{aA}	202.925 ± 16.545^{aA}	187.027 ± 23.372^{aA}	206.878 ± 10.365
	Total	189.106 ± 14.644^{a}	210.041 ± 21.137^{a}	203.948 ± 10.885^{a}	191.797 ± 16.918^{a}	198.72± 7.909
Stakna	Male	239.685 ± 51.466^{abA}	173.997 ± 6.736^{bA}	278.517 ± 22.494^{aA}	251.042 ± 27.958^{abA}	235.810 ± 17.242
	Female	207.285 ± 8.726^{aA}	189.565 ± 10.859^{aA}	200.350 ± 12.187^{aA}	249.197 ± 32.841^{aA}	211.599 ± 10.253
	Total	223.485 ± 24.927^{ab}	181.781 ± 6.606^{a}	239.433 ± 18.933^{ab}	250.120 ± 19.968^{b}	223.705 ± 10.103
Overall	Male	253.886 ± 21.640^{aA}	255.916 ± 22.355^{aA}	264.623 ± 16.544^{aA}	268.345 ± 17.649^{aA}	260.693 ± 9.644
	Female	247.924 ± 14.228^{Aa}	257.303 ± 19.233^{aA}	233.575 ± 15.774^{aA}	234.155 ± 13.352^{Aa}	243.239 ± 7.814
	Total	250.905 ± 12.750^{a}	256.610 ± 14.505^{a}	249.099 ± 11.584^{a}	251.250 ± 11.310^{a}	251.966 ± 6.230

Mean along rows (between age groups) bearing at least one common lowercase superscript, and between sex within the age groups (along columns) bearing at least one common uppercase superscript, does not differ significantly

Aspartate aminotransferase (AST): The mean AST value observed in male and female Changra goats, respectively, was 80.866 ± 3.271 IU/L and 76.191±2.357 IU/L, with an overall mean of 78.095 ± 1.932 IU/L. Area-wise evaluation revealed significantly (P≤0.05) higher mean AST activity in goats reared at Digger (113.553 ± 7.017 IU/L) than other areas. The mean AST activity in goats at Kargyam (84.939 ± 2.513 IU/L), Mughlib (85.820 ± 7.251 IU/L) and Turtuk (90.616 ± 3.930 IU/L) were comparable among themselves differed significantly (P≤0.05) from those at Kharnak (69.257 ± 1.335 IU/L), Sumdho (59.406 ± 2.903 IU/L), Chushul (60.120 ± 5.819 IU/L), and Stakna (64.960 ± 1.532 IU/L). Significant (P≤0.05) differences were observed among male and female goats reared in different areas (Table 13).

The overall mean AST values in 2 tooth (64.345 ± 3.680 IU/L), 4 tooth (62.858 ± 3.004 IU/L), 6 tooth (65.003 ±3.785 IU/L) and full mouth (61.537 ±3.366 IU/L) Changra goats did not differ significantly. Similarly no significant differences were observed between the age groups in different areas as well as within sexes between age groups except significantly (P≤0.05) higher value in 6 tooth goats at Chuschul. In general the difference between sexes within age groups were non-significant except significantly (P≤0.05) higher mean AST values in male goats in all age groups at Chuschul and 6 tooth goats at Sumdho (Table 14).

Table 13: Effect of area and sex on Serum Aspartate Aminotransferase activity (IU/L) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area→ Sex↓	Kharnak	Sumdho	Chushul	Stakna	Digger	Kargyam	Mughlib	Turtuk	Total
Male	67.758 ± 1.625^{acA}	51.560 ± 2.636^{aA}	82.150 ± 7.717^{cdA}	66.191 ± 2.864^{acA}	115.274± 8.177^{bA}	84.617 ± 3.226^{cdA}	117.807 ± 18.719^{bA}	94.844 ± 11.522^{dA}	80.866± 3.271 ^{A}
Female	70.756 ± 2.104^{adeA}	67.252 ± 4.437^{adeA}	38.090 ± 3.964^{bB}	63.728 ± 1.138^{aA}	112.556± 10.178^{cA}	85.077 ± 3.361^{dA}	72.111 ± 4.185^{adeB}	88.804 ± 2.949^{eA}	76.191± 2.357 ^{A}
Total	69.257 ± 1.335^{a}	59.406 ± 2.903^{a}	60.120 ± 5.819^{a}	64.960 ± 1.532^{a}	113.553± 7.017^{b}	84.939 ± 2.513^{c}	85.820 ± 7.251^{c}	90.616 ± 3.930^{c}	78.095± 1.932

Mean (along rows bearing at least one common lowercase superscript, and between along columns (between sexes) bearing at least one common uppercase superscript, does not differ significantly

Table 14: Effect of area and age on Serum Aspartate Aminotransferase (IU/L) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area	Age→ Sex↓	2T	4T	6T	FM	Overall
Kharnak	Male	72.817 ± 5.535^{aA}	67.052 ± 2.040^{aA}	65.015 ± 2.252^{aA}	66.150 ± 0.948^{aA}	67.758 ± 1.625
	Female	70.882 ± 3.588^{aA}	63.677 ± 4.279^{aA}	73.307 ± 3.396^{aA}	75.157 ± 4.527aA	70.756 ± 2.104
	Total	71.850 ± 3.075^{a}	65.365 ± 2.285	69.161 ± 2.452^{a}	70.653 ± 2.735^{a}	69.257 ± 1.335
Sumdho	Male	42.357 ± 5.709^{aA}	58.472 ± 2.787^{aA}	45.127 ± 3.313^{aA}	60.285 ± 2.081^{aA}	51.560 ± 2.636
	Female	64.352 ± 8.402^{aA}	77.832 ± 1.511^{aA}	71.997 ± 14.124^{aB}	54.828 ± 4.733^{aA}	67.252 ± 4.437
	Total	53.355 ± 6.276^{a}	68.152 ± 3.942^{a}	58.562 ± 8.419^{a}	57.556 ± 2.606^{a}	59.406 ± 2.903
Chushul	Male	85.242 ± 21.792^{abA}	82.312 ± 5.326^{abA}	99.117 ± 11.318^{Aa}	61.930 ± 18.006^{bA}	82.150 ± 7.717
	Female	46.882 ± 4.312^{aB}	26.360 ± 3.108^{aB}	47.390 ± 11.458^{aB}	31.727 ± 6.392^{aB}	38.090 ± 3.964
	Total	66.062 ± 12.582^{ab}	54.336 ± 10.952^{ab}	73.253 ± 12.294^{a}	46.829 ± 10.526^{b}	60.120 ± 5.819
Stakna	Male	69.377 ± 4.715^{aA}	66.627 ± 3.430^{aA}	56.437 ± 2.068^{Aa}	72.325 ± 8.835^{aA}	66.191 ± 2.864
	Female	62.852 ± 1.224^{aA}	60.530 ± 0.280^{aA}	61.635 ± 1.868^{aA}	69.897 ± 1.747^{aA}	63.728 ± 1.138
	Total	66.115 ± 2.570^{a}	63.578 ± 1.966^{a}	59.036 ± 1.621^{a}	71.111 ± 4.194^{a}	64.960 ± 1.532
Overall	Male	67.448 ± 6.658^{aA}	68.616 ± 2.748^{aA}	66.424 ± 5.872^{aA}	65.172 ± 4.671^{aA}	66.915 ± 2.542
	Female	61.242 ± 3.220^{aA}	57.099 ± 5.034^{aA}	63.582 ± 4.947^{aA}	57.902 ± 4.824^{aA}	59.956 ± 2.253
	Total	64.345 ± 3.680^{a}	62.858 ± 3.004^{a}	65.003 ± 3.785^{a}	61.537 ± 3.366^{a}	63.436 ± 1.719

Mean along rows (between age groups) bearing at least one common lowercase superscript, and between sex within the age groups (along columns) bearing at least one common uppercase superscript, does not differ significantly

Alanine aminotransferase (ALT): The mean ALT value observed in male and female Changra goats, respectively, was 18.700 ± 1.261 IU/L and 20.846 ± 0.809 IU/L, with an overall mean of 19.972 ± 0.704 IU/L. The mean ALT value was highest in goats at Chushul (35.749 ± 2.704 IU/L) followed by Mughlib (26.186 ± 1.402 IU/L), Digger (24.316 ± 0.950), Turtuk (20.131 ± 0.893 IU/L), Kargyam (19.271 ± 1.061 IU/L), Stakna (17.352 ± 0.547 IU/L), Sumdho (8.543 ± 0.481 IU/L), and Kharnak (8.852 ± 0.642 IU/L) in that order. The values differed significantly ($P \leq 0.05$). Similar trend was observed within sexes between areas. However, no significant difference was observed between sexes within an area except significantly higher values in female goats at Mughlib (Table 15).

The overall mean ALT values in 2 tooth (17.909 ± 2.740 IU/L), 4 tooth (20.683 ± 3.149 IU/L), 6 tooth (16.417 ± 1.791 IU/L) and full mouth (15.487 ± 1.692 IU/L) were comparable. Similarly, no significant differences were observed between age groups within sexes. Area-wise evaluation also revealed non-significant differences between age group means as well as within sex means between age groups, except at Chushul where significantly higher values were observed in 4 tooth goats. No significant differences were observed between sexes within age groups except for significantly higher value in 4 tooth males at Chushul (Table 16).

Table 15: Effect of area and sex on Serum Alanine Aminotransferase activity (IU/L) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area→ Sex↓	Kharnak	Sumdho	Chushul	Stakna	Digger	Kargyam	Mughlib	Turtuk	Total
Male	9.401 ± 0.968^{aA}	7.626 ± 0.578^{aA}	37.348 ± 4.747^{bA}	15.855 ± 0.719^{cA}	22.865 ± 1.529^{dA}	18.608 ± 2.460^{cdA}	21.891 ± 1.295^{cdA}	18.904 ± 1.275^{cdA}	18.700± 1.261 ^{A}
Female	8.303 ± 0.854^{aA}	9.460 ± 0.714^{aA}	34.149 ± 2.712^{bA}	18.850 ± 0.648^{cA}	25.155 ± 1.198^{deA}	19.555 ± 1.133^{cdA}	28.026 ± 1.794^{eB}	20.657 ± 1.152^{cdA}	20.846± 0.809 ^{A}
Total	8.852 ± 0.642^{a}	8.543 ± 0.481^{a}	35.749 ± 2.704^{b}	17.352 ± 0.547^{c}	24.316 ± 0.950^{d}	19.271 ± 1.061^{c}	26.186 ± 1.402^{d}	20.131 ± 0.893^{c}	19.972± 0.704

Mean (along rows bearing at least one common lowercase superscript, and between along columns (between sexes) bearing at least one common uppercase superscript, does not differ significantly

Table 16 Effect of area and age on Serum Alanine Aminotransferase (IU/L) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area	Age→ Sex↓	2T	4T	6T	FM	Overall
Kharnak	Male	11.562 ± 0.857^{aA}	9.727 ± 3.352^{aA}	7.970 ± 1.958^{aA}	8.347 ± 0.554^{aA}	9.401 ± 0.968
	Female	5.327 ± 1.332^{aA}	6.502 ± 0.985^{aA}	10.210 ± 0.978^{aA}	11.175 ± 1.705aA	8.303 ± 0.854
	Total	8.445 ± 1.387^{a}	8.115 ± 1.728^{a}	9.090 ± 1.098^{a}	9.761 ± 0.987^{a}	8.852 ± 0.642
Sumdho	Male	5.200 ± 0.935^{aA}	8.637 ± 0.633^{aA}	7.512 ± 1.446^{aA}	9.155 ± 0.485^{aA}	7.626 ± 0.578
	Female	9.060 ± 1.367^{aA}	10.335 ± 1.927^{aA}	9.995 ± 0.525^{aA}	8.450 ± 1.898^{aA}	9.460 ± 0.714
	Total	7.130 ± 1.058^{a}	9.486 ± 0.992^{a}	8.753 ± 0.853^{a}	8.802 ± 0.916^{a}	8.543 ± 0.481
Chushul	Male	43.847 ± 10.929^{aA}	55.645 ± 4.521^{bA}	28.417 ± 2.355^{cA}	21.482 ± 8.313^{cA}	37.348 ± 4.747
	Female	35.445 ± 4.151^{abA}	40.674 ± 5.916^{bB}	30.910 ± 6.742^{abA}	29.570 ± 4.914^{aA}	34.149 ± 2.712
	Total	39.646 ± 5.640^{a}	48.159 ± 4.459^{b}	29.663 ± 3.339^{c}	25.526 ± 4.724^{cA}	35.749 ± 2.704
Stakna	Male	16.605 ± 1.526^{aA}	14.695 ± 1.854^{aA}	14.772 ± 1.486^{aA}	17.347 ± 0.781^{aA}	15.855 ± 0.719
	Female	16.227 ± 1.441^{aA}	19.250 ± 0.667^{aA}	21.555 ± 0.586^{aA}	18.370 ± 0.828^{aA}	18.850 ± 0.648
	Total	16.416± 0.974^{a}	16.972 ± 1.254^{a}	18.163 ± 1.479^{a}	17.858 ± 0.561^{a}	17.352 ± 0.547
Overall	Male	19.303 ± 4.543^{aA}	22.176 ± 5.197^{aA}	14.668 ± 2.331^{aA}	14.083 ± 2.357^{aA}	17.557 ± 1.915
	Female	16.515 ± 3.183^{aA}	19.190 ± 3.699^{aA}	18.167 ± 2.723^{aA}	16.891 ± 2.452^{aA}	17.691 ± 1.495
	Total	17.909 ± 2.740^{a}	20.683 ± 3.149^{a}	16.417 ± 1.791^{a}	15.487 ± 1.692^{a}	17.624 ± 1.210

Mean along rows (between age groups) bearing at least one common lowercase superscript, and between sex within the age groups (along columns) bearing at least one common uppercase superscript, does not differ significantly

Kidney function tests (KFT)

Urea: The mean blood urea level observed in male and female Changra goats, respectively, was 28.340 ± 0.917 mg/dL and 29.040 ± 0.954 mg/dL, with an overall mean of 28.755 ± 0.677 mg/dL. The mean blood urea levels in goats at Kharnak (24.681 ± 0.432 mg/dL), Sumdho (47.191 ± 2.236 mg/dL), Chushul (35.617 ± 1.337 mg/dL), Stakna (27.275 ± 0.581 mg/dL), Digger (29.495 ± 1.602 mg/dL), Kargyam (21.064 ± 0.541 mg/dL), Mughlib (21.958 ± 0.635 mg/dL) and Turtuk (21.446 ± 0.519 mg/dL) differed significantly. Also significant differences were observed within sexes between different areas. No significant differences were observed between sexes within an area except significantly higher levels in female goats at Sumdho and male goats at Chushul (Table 17)

The overall mean blood urea levels in 2 tooth, 4 tooth, 6 tooth and full mouth Changra goats were 35.188 ± 2.136 mg/dL, 33.145 ± 1.797 mg/dL, 32.855 ± 2.262 mg/dL and 33.576 ± 2.059 mg/dL, respectively. No significant differences were observed in overall mean blood urea levels or area-wise means between age group. Also no significant differences were observed between age groups within sexes, or between sexes within age groups, except in goats reared at Sumdho. At Sumdho comparison of age groups within sexes revealed significantly lower mean values in full mouth males and 4 tooth females; and comparison between sexes within age groups showed significantly lower values in male goats (Table 18).

Table 17: Effect of area and sex on Serum Urea (mg/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area→ Sex↓	Kharnak	Sumdho	Chushul	Stakna	Digger	Kargyam	Mughlib	Turtuk	Total
Male	24.159 ± 0.448^{acA}	38.493 ± 2.087^{bA}	38.818 ± 2.068^{bA}	27.087 ± 0.854^{cA}	27.175 ± 2.165^{cA}	19.340 ± 1.055^{dA}	20.745 ± 1.299^{adA}	20.592 ± 1.191^{adA}	28.340± 0.917 ^{A}
Female	25.203 ± 0.733^{aeA}	55.890 ± 2.497^{bB}	32.415 ± 1.321^{cB}	27.464 ± 0.815^{deA}	30.837 ± 2.180^{cdA}	21.803 ± 0.569^{aA}	22.477 ± 0.707^{aA}	21.812 ± 0.541^{aA}	29.040± 0.954 ^{A}
Total	24.681 ± 0.432^{adf}	47.191 ± 2.236^{b}	35.617 ± 1.337^{c}	27.275 ± 0.581^{d}	29.495 ± 1.602^{d}	21.064 ± 0.541^{e}	21.958 ± 0.635^{ae}	21.446 ± 0.519^{ef}	28.755± 0.677

Mean (along rows bearing at least one common lowercase superscript, and between along columns (between sexes) bearing at least one common uppercase superscript, does not differ significantly

Table 18: Effect of area and age on Serum Urea (mg/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area	Age→ Sex↓	2T	4T	6T	FM	Overall
Kharnak	Male	24.657 ± 0.450^{aA}	22.630 ± 1.264^{aA}	23.722 ± 0.561^{aA}	25.627 ± 0.505^{aA}	24.159 ± 0.448
	Female	24.392 ± 1.032^{aA}	24.225 ± 0.456^{aA}	28.420 ± 2.112^{aA}	23.775 ± 0.586^{aA}	25.203 ± 0.733
	Total	24.525 ± 0.524^{a}	23.427 ± 0.691^{aa}	26.071 ± 1.346^{a}	24.701 ± 0.500^{a}	24.681 ± 0.432
Sumdho	Male	46.925 ± 2.214^{aA}	41.072 ± 2.391^{abA}	35.750 ± 4.923^{bcA}	30.225 ± 1.055^{cA}	38.493 ± 2.087
	Female	53.075 ± 4.560^{abA}	50.680 ± 3.406^{bA}	60.270 ± 5.846^{aB}	59.535 ± 5.967^{aB}	55.890 ± 2.497
	Total	50.000 ± 2.618^{a}	45.876 ± 2.647^{a}	48.010 ± 5.830^{a}	44.880 ± 6.208^{a}	47.191 ± 2.236
Chushul	Male	45.222 ± 5.297^{aA}	38.000 ± 3.975^{abA}	36.687 ± 3.398^{bA}	35.365 ± 3.281^{bA}	38.818 ± 2.068
	Female	32.820 ± 3.065^{aB}	33.070 ± 2.975^{aA}	29.367 ± 1.382^{aA}	34.405 ± 3.184^{aA}	32.415 ± 1.321
	Total	39.021 ± 3.676^{a}	35.535 ± 2.480^{a}	33.027 ± 2.190^{a}	34.885 ± 2.124^{a}	35.617 ± 1.337
Stakna	Male	29.222 ± 1.809^{aaA}	24.130 ± 0.575^{aA}	24.625 ± 0.882^{aA}	30.372 ± 0.389^{aA}	27.087 ± 0.854
	Female	25.195 ± 0.772^{aA}	31.357 ± 0.443^{aA}	24.000 ± 0.657^{aA}	29.305 ± 0.409^{aA}	27.464 ± 0.815
	Total	27.208 ± 1.186^{a}	27.743 ± 1.406^{a}	24.312 ± 0.522^{a}	29.838 ± 0.330^{a}	27.275 ± 0.581
Overall	Male	36.506 ± 2.849^{aA}	31.458 ± 2.370	30.196 ± 2.067aA	30.^{397} ± 1.185^{aA}	32.139 ± 1.122
	Female	33.870 ± 3.241^{aA}	34.833 ± 2.712	35.514 ± 3.992^{aA}	36.755 ± 3.845^{aA}	35.243 ± 1.705
	Total	35.188 ± 2.136^{a}	33.145 ± 1.797	32.855 ± 2.262^{a}	33.576 ± 2.059^{a}	33.691 ± 1.026

Mean along rows (between age groups) bearing at least one common lowercase superscript, and between sex within the age groups (along columns) bearing at least one common uppercase superscript, does not differ significantly

Creatinine: The mean serum creatinine level observed in male and female Changra goats, respectively, was 0.805 ± 0.040 mg/dL and 0.821 ± 0.030 mg/dL, with an overall mean of 0.814 ± 0.024 mg/dL. The mean blood urea levels in goats at Kharnak (0.696 ± 0.048 mg/dL), Sumdho (0.800 ± 0.055 mg/dL), Chushul (0.643 ± 0.063 mg/dL), Stakna (1.128 ± 0.054 mg/dL), Digger (0.920 ± 0.072 mg/dL), Kargyam (0.856 ± 0.059 mg/dL), Mughlib (0.661 ± 0.070 mg/dL) and Turtuk (0.810 ± 0.087 mg/dL) differed significantly ($P \leq 0.05$). Similar trend was observed within sexes between areas. The difference in mean creatinine values between sexes within an area were non-significant except significantly ($P \leq 0.05$) higher values in male goats at Turtuk (Table 19).

The overall mean creatinine values in 2 tooth (0.743 ± 0.051 mg/dL), 4 tooth (0.865 ± 0.073 mg/dL), 6 tooth (0.843 ± 0.070 mg/dL) and full mouth (0.815 ± 0.060 mg/dL) Changra goats were comparable. Also, no significant differences, in general, were observed between age groups, within sexes between age groups or between sexes within age groups (Table 20).

Table 19: Effect of area and sex on Serum Creatinine (mg/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area→ Sex↓	Kharnak	Sumdho	Chushul	Stakna	Digger	Kargyam	Mughlib	Turtuk	Total
Male	0.637 ± 0.053^{acA}	0.687 ± 0.083^{acA}	0.631 ± 0.089^{acA}	1.225 ± 0.072^{bA}	0.836 ± 0.109^{cA}	0.700 ± 0.094^{acA}	0.515 ± 0.107^{aA}	1.222 ± 0.146^{bA}	0.805± 0.040 ^{A}
Female	0.755 ± 0.078^{abcA}	0.912 ± 0.065^{bcA}	0.656 ± 0.093^{aA}	1.031 ± 0.075^{bA}	0.968 ± 0.095^{bcA}	0.923 ± 0.071^{bcA}	0.723 ± 0.087^{acA}	0.633 ± 0.084^{aB}	0.821± 0.030 ^{A}
Total	0.696 ± 0.048^{ad}	0.800 ± 0.055^{acd}	0.643 ± 0.063^{a}	1.128 ± 0.054^{b}	0.920 ± 0.072^{c}	0.856 ± 0.059^{cd}	0.661 ± 0.070^{a}	0.810 ± 0.087^{ac}	0.814± 0.024

Mean (along rows bearing at least one common lowercase superscript, and between along columns (between sexes) bearing at least one common uppercase superscript, does not differ significantly

Table 20: Effect of area and age on Serum Creatinine (mg/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area	Age→ Sex↓	2T	4T	6T	FM	Overall
Kharnak	Male	0.575 ± 0.103^{aA}	0.550 ± 0.119^{aA}	0.625 ± 0.137^{aA}	0.800 ± 0.040aA	0.637 ± 0.053
	Female	0.575 ± 0.175^{abA}	1.070 ± 0.105^{bB}	0.725 ± 0.131^{abA}	0.650 ± 0.132^{abA}	0.755 ± 0.078
	Total	0.575 ± 0.094^{a}	0.810 ± 0.122^{a}	0.675 ± 0.090^{a}	0.725 ± 0.070^{a}	0.696 ± 0.048
Sumdho	Male	0.450 ± 0.086^{aA}	0.525 ± 0.193^{aA}	0.875 ± 0.165^{aA}	0.900 ± 0.108^{aA}	0.687 ± 0.083
	Female	0.975 ± 0.160^{aB}	0.925 ± 0.154^{aA}	0.700 ± 0.091^{aA}	1.050 ± 0.064^{aA}	0.912 ± 0.065
	Total	0.712 ± 0.130^{a}	0.725 ± 0.137a	0.787 ± 0.093^{a}	0.975 ± 0.064^{a}	0.800 ± 0.055
Chushul	Male	0.775 ± 0.149^{aA}	0.725 ± 0.217^{aA}	0.500 ± 0.227^{aA}	0.525 ± 0.143^{aA}	0.631 ± 0.089
	Female	.775 ± 0.062^{aA}	0.625 ± 0.205^{aA}	0.700 ± 0.230^{aA}	0.525 ± 0.252^{aA}	0.656 ± 0.093
	Total	0.775 ± 0.075^{a}	0.675 ± 0.139^{a}	0.600 ±0.154^{a}	0.525 ± 0.134^{a}	0.643 ± 0.063
Stakna	Male	1.050 ± 0.132^{aA}	1.450 ± 0.144^{aA}	1.200 ± 0.057^{aA}	1.200 ± 0.187^{aA}	1.225 ± 0.072
	Female	0.775 ± 0.047^{aA}	1.050 ± 0.132^{abA}	1.425 ± 0.075^{bA}	0.875 ± 0.085^{aA}	1.031 ± 0.075
	Total	0.912 ± 0.083^{a}	1.250 ± 0.118^{b}	1.312 ± 0.061^{b}	1.037 ± 0.113^{ba}	1.128 ± 0.054
Overall	Male	0.712 ± 0.079^{aA}	0.812 ± 0.124^{aA}	0.800 ± 0.099^{aA}	0.856 ± 0.085^{aA}	0.795 ± 0.048
	Female	0.775 ± 0.066^{aA}	0.917 ± 0.082^{aA}	0.887 ± 0.103^{aA}	0.775 ± 0.085^{aA}	0.838 ± 0.042
	Total	0.743 ± 0.051^{a}	0.865 ± 0.073^{a}	0.843 ± 0.070^{a}	0.815 ± 0.060^{a}	0.817 ± 0.032

Mean along rows (between age groups) bearing at least one common lowercase superscript, and between sex within the age groups (along columns) bearing at least one common uppercase superscript, does not differ significantly

Total Cholesterol

The mean serum cholesterol level observed in male and female Changra goats, respectively, was 141.979 ± 1.751 mg/dL and 135.423 ± 1.755 mg/dL, with an overall mean of 138.093 ± 1.275 mg/dL. The mean blood urea levels in goats at Kharnak (141.483 ± 1.781 mg/dL), Sumdho (149.545 ± 0.883 mg/dL), Chushul (149.077 ± 1.987 mg/dL), Stakna (159.101 ± 1.107 mg/dL), Digger (151.083 ± 1.107 mg/dL), Kargyam (119.263 ± 2.793 mg/dL), Mughlib (117.505 ± 3.520 mg/dL) and Turtuk (114.565 ± 2.263 mg/dL) differed significantly ($P \leq 0.05$). Similar trend was observed within sexes between areas. The difference in mean creatinine values between sexes within an area were non-significant except significantly ($P \leq 0.05$) higher values in male goats at Mughlib (Table 21).

The overall mean cholesterol values in 2 tooth (151.256 ± 2.216 mg/dL), 4 tooth (148.716 ±1.908 mg/dL), 6 tooth (148.491 ± 1.488 mg/dL) and full mouth (150.743 ± 1.792 mg/dL) Changra goats were comparable. Also, no significant differences, in general, were observed between age groups, within sexes between age groups or between sexes within age groups except significantly ($P \leq 0.05$) high values in full mouth male and 4 tooth female goats at Kharnak; and 2 tooth female goats at Chushul (Table 22).

Table 21: Effect of area and sex on Serum Total Cholesterol (mg/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area→ Sex↓	Kharnak	Sumdho	Chushul	Stakna	Digger	Kargyam	Mughlib	Turtuk	Total
Male	140.010 ± 2.561^{abA}	149.84± 0.948^{dA}	148.02± 0.952^{bdA}	159.150 ± 1.656^{cA}	150.918± 2.458^{cdA}	119.322 ± 5.091^{eA}	133.942 ± 7.659^{aA}	111.932 ± 4.282^{eA}	141.979± 1.751 ^{A}
Female	142.956 ± 2.502^{abA}	149.25± 1.522^{bA}	150.131± 3.908^{bcA}	159.053 ± 1.525^{cA}	151.178± 1.084^{bcA}	119.237 ± 3.423^{dA}	110.461 ± 2.709^{dB}	115.694 ± 2.693^{dA}	135.423± 1.755 ^{A}
Total	141.483 ± 1.781^{a}	149.545 ± 0.883^{b}	149.077 ± 1.987^{b}	159.101 ± 1.107^{c}	151.083 ± 1.107^{b}	119.263 ± 2.793^{d}	117.505 ± 3.520^{d}	114.565 ± 2.263^{d}	138.093± 1.275

Mean (along rows bearing at least one common lowercase superscript, and between along columns (between sexes) bearing at least one common uppercase superscript, does not differ significantly

Table 22: Effect of area and age on Serum Cholesterol (mg/dL) of Changra goats reared in different areas of Ladakh (Mean ± SE)

Area	Age→ Sex↓	2T	4T	6T	FM	Overall
Kharnak	Male	134.302 ± 6.084^{aA}	135.672 ± 6.049^{aA}	142.370 ± 2.884^{abA}	147.695 ± 3.254^{bA}	140.010 ± 2.561
	Female	147.072 ± 2.47271^{abB}	151.095 ± 1.379^{bB}	138.465 ± 4.409^{acA}	135.192 ± 6.574^{cB}	142.956 ± 2.502
	Total	140.687 ± 3.881^{a}	143.383 ± 4.091^{a}	140.417 ± 2.548^{a}	141.443 ± 4.137^{a}	141.483 ± 1.781
Sumdho	Male	146.987 ± 2.549^{aA}	153.572 ± 0.950^{aA}	148.827 ± 1.605^{aA}	149.972 ± 0.557^{aA}	149.840 ± 0.948
	Female	146.592 ± 4.584^{aA}	144.735 ± 2.209^{aA}	153.852 ± 0.857^{Aa}	151.820 ± 1.140^{aA}	149.250 ± 1.522
	Total	146.790 ± 2.429^{a}	149.153 ± 2.007^{a}	151.340 ± 1.269^{a}	150.896 ± 0.683^{a}	149.545 ± 0.883
Chushul	Male	149.355 ± 2.337^{aA}	145.812 ± 2.535^{aA}	149.240 ± 1.078^{aA}	147.685 ± 1.531^{aA}	148.023 ± 0.952
	Female	171.658 ± 5.784^{aB}	137.256 ± 3.467^{bA}	143.680 ± 5.369^{bA}	147.930 ± 2.444^{bA}	150.131 ± 3.908
	Total	160.506 ± 5.109^{a}	141.534 ± 2.562^{b}	146.460 ± 2.744^{b}	147.807 ± 1.336^{b}	149.077 ± 1.987
Stakna	Male	157.890 ± 3.463^{aA}	161.077 ± 3.673^{aA}	153.870 ± 2.010^{aA}	163.765 ± 2.682^{aA}	159.150 ± 1.656
	Female	156.195 ± 2.580^{aA}	160.507 ± 3.039^{aA}	157.625 ± 4.136^{aA}	161.885 ± 2.595^{aA}	159.053 ± 1.525
	Total	157.042 ± 2.024^{a}	160.792 ± 2.209^{a}	155.747 ± 2.244^{a}	162.825 ± 1.764^{a}	159.101 ± 1.107
Overall	Male	147.133 ± 2.793^{aA}	149.033 ± 2.963^{aA}	148.576 ± 1.386^{aA}	152.279 ± 2.002^{aA}	149.255 ± 1.181
	Female	155.379 ± 3.198^{aA}	148.398 ± 2.502^{aA}	148.405 ± 2.690^{aA}	149.206 ± 2.992^{aA}	150.347 ± 1.442
	Total	151.256 ± 2.216^{a}	148.716 ± 1.908^{a}	148.491 ± 1.488^{a}	150.743 ± 1.792^{a}	149.801 ± 0.929

Mean along rows (between age groups) bearing at least one common lowercase superscript, and between sex within the age groups (along columns) bearing at least one common uppercase superscript, does not differ significantly

Discussion

The overall mean values of various serum biochemical indices observed in Changra goats were blood glucose 62.967±0.884 mg/dL, total serum protein 5.932 ± 0.037gm/dL, albumin 3.091 ± 0.024gm/dL, globulin 2.838 ± 0.035gm/dL, albumin: globulin ratio 1.157 ± 0.031, ALP 234.163 ± 5.380 IU/L, AST

78.095 ± 1.932 IU/L, ALT 19.972 ± 0.704 IU/L, blood urea 28.755 ± 0.677 mg/dL, creatinine 0.814 ± 0.024 mg/dL, and cholesterol 138.093 ± 1.275 mg/dL. The values were comparable with reference range of goats except for urea which was higher in Changra goats which may be due to efficient utilization of urinary nitrogen at the times of poor grazing or water deprivation to overcome the effects of negative nitrogen balance, possibly an adaptation of Changra goats to cold and harsh climate and snowcapped pasture lands. Our findings are in agreement with earlier report in changra (Pampori *et al.*, 2010) [20] and other goats (Daramola *et al*., 2005) [9]. However, higher ALT values (77.1±74.2 U/L) were reported by Kiran *et al*. (2012) [13] which may be attributed to demographic differences besides other factors.

In general, age and sex did not appear to have any significant effect on the biochemical indices studied. However, significant area effects were observed on all the biochemical indices warranting area specific profiling vis-à-vis epidemiological and physiological status of the animals, as well as its correlation with mineral profile of the soil and nutritional status of the pastures. Various authors have reported significant effect of age and sex on different serum biochemical indices (Sharma *et al.*, 1990; Pampori *et al.* 2010) [21, 20], the observations, in general are inconsistent. Consistent with our observation, Nazifi *et al.* (2002) [16] reported non-significant differences between different age groups with respect to many serum biochemical parameters. Kiran *et al*. (2012) [13] and Bhat *et al.* (2014) [5] also reported that age had no effect on blood glucose cholesterol, AST, ALT, and LDH. Contrary to this, higher values of total protein, ALT, cholesterol, triglycerides, and creatinine in adult when compared with young goats (Deangelino *et al*., 1990; Sharma *et al.*, 1990; Pampori *et al.*, 2010) [8, 20, 21] However, Njidda *et al*. (2013) [17] reported that values for creatinine, cholesterol and glucose were higher for kids than in adult goats.

Consistent with our observations, no effect of sex on blood glucose, AST, ALT, LDH and cholesterol has been reported by various workers (Kasuma, 2006; Kiran *et al*., 2012; Njidda *et al.*, 2013; Khan, 2013; Bhat *et al.*, 2014) [13, 5, 17, 12]. However, contrary to this, various authors have reported significant differences in serum biochemical indices between sexes (Smith, 1975; Coles, 1986; Kaneko, 1989; Benjamin, 1989; Patodkar *et al.*, 2010) [22, 7, 10]. In general, the discrepancies may be attributed to multiple factors including animal species, physiological status, geoclimatic conditions, nutritional factors, season, technical factors etc., hence warranting comprehensive area-specific and species-specific evaluations vis-à-vis all possible variables. Present study partially establishes the baseline values of serum biochemical indices for Changra goats.

Conclusion

Baseline data with respect to some serum biochemical indices were established in Changra goats. Area seemed to have significant effect on these parameters warranting area specific profiling vis-à-vis physiological status, and their correlation with demographic factors including mineral profile of the soil, nutrient status of the pastures, health, etc..

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