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**Research Article****CHANGES IN PHYSIOLOGICAL AND METABOLIC PARAMETERS OF SHEEP (*Ovis aries*) DURING TRANSHUMANCE AT WESTERN HIMLAYAN PASTURES****K. Bhatt<sup>1</sup>, N. R. Devkota<sup>2</sup>, I. C. P. Tiwari<sup>2</sup> and S. R. Barsila<sup>2\*</sup>**<sup>1</sup>Ministry of Agricultural, Land Management and Cooperatives, Department of Livestock Services, Hariharbhawan, Lalitpur, Nepal<sup>2</sup>Agriculture and Forestry University, Rampur, Chitwan, Nepal**ABSTRACT**

Transhumance is an integral part of sheep husbandry in high mountains whereas out of total sheep population, about 60 % are reared under the transhumance system. Transhumance Baruwal sheep flock from the northern part of Jumla grazed at two different altitudes were selected for this research. The main objective was to access the changes in physiological and metabolic parameters of sheep grazed at two different altitudes along transhumance route, and to suggest appropriate husbandry practices. This study consisted of 21 apparently healthy Baruwal sheep under transhumance which were divided into four groups; male below 1 year (8); male above one year (5); female below one year (5), and female above one year (2). This study was done during July 2017 to December 2017. The herd was clinically inspected for the presence of any infection. Adaptation period was set for one month. Blood sample was taken from selected herds at both grazing altitudes i.e. from lower stopover Chandannath (2431m.a.s.l) to higher stopover Khali (3885 m.a.s.l). Blood glucose, albumin and total protein (TP) were significantly ( $p<0.05$ ) increased at lower altitude during winter. Glucose, albumin and TP level were decreased at higher altitude as compared to low. Furthermore, altitude, age and sex had a significant ( $p<0.05$ ) effect on respiration rate (RR) and heart rate (HR). A significant ( $p<0.05$ ) increase in RR and HR was observed at higher altitude. Lambs as compared to adults had higher respiration and heart rates. Similarly, there was a higher RR and HR in ewes as compared to ram. The study result had showed elevated level of blood biochemistry and physiological values in response to changing environment. Finding of the study suggests reduced stress during transhumance could ensured by slow upward movement, nutritional management, and adjusting transhumance herd to adverse weather condition that needs to consider in transhumance sheep while addressing possible infection and health hazard, and thereby increasing production from herd.

**Key words:** Baruwal sheep, transhumance, metabolism, physiology, adaptation**INTRODUCTION**

Sheep farming is important in the Nepalese hill and mountain economics and is popular mainly for wool, meat, manure and pack use (Upreti et al., 1996). Sheep are integral to the subsistence life of rural people, they provide a primary source of clothing and cash earnings, meat as a source of protein and manure for maintaining soil fertility (Rauniyar et al., 2000). Lampuchre, Kage, Baruwal, and Bhanglung are four indigenous sheep breeds reared in different eco-zones of Nepal and they account 95% of the total population. Among indigenous breeds, Baruwal sheep (*Capra ovis*) is the dominating breed that accounts 63 % of the total population (LMP, 1990) and is concentrated in mountains (41%) and hills (22%) (Upreti&Pradhan, 1998). Among the total sheep population available in the country, 60% of them are reared under the transhumance system (LMP, 1993). The transhumance system is characterized by the seasonal movement of livestock to high altitude pastures for grazing in summer and progressive downward movement and lying at mixed forest areas in winter (Dong et al., 2009). Transhumant sheep farming is most common in the northern high mountainous region of Nepal. (Joshi et al., 2004). During such movement, several alterations in physiological and metabolic parameters occur in response of changing environmental conditions that can affect the production efficiency of the flock. However, limited information is available regarding physiological and metabolic parameters transhumance in Baruwal sheep in context of Nepal. Hematological and biochemical examination of animal is important to monitor and evaluate physiological changes appearing during the transhumance and are helpful to manage and regulate management practices in the rangeland in regard to optimize production efficiency of transhumant herds. (Gupta et al., 2007). Thus, this study was designed to reveal physiological adaptation and blood biochemical profile and their alteration due to transhumance effect.

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## MATERIALS AND METHODS

### Site and herd selection

Observation on the identified sheep of the transhumance flock was done at two different sites at 2431 meter and 3885 meter. A transhumant route in Chandannath to Khali of Jumla was followed that covers the altitudinal range of 2700 to 4000 m which has approximately 40-50 herds and estimated sheep population is about 4500 numbers (DLSO, Jumla 2014). This study consisted of randomly selected 21 apparently healthy Baruwal sheep under transhumance which were further divided accordingly into four categories; (male below 1 year; male above 1 year; female below 1 year and female above 1 year).

**Table 1. Experimental animal selection at transhumance stopover points**

Altitude							
High				Low			
Male		Female		Male		Female	
< 1yr	>1yr	< 1yr	>1yr	< 1yr	>1yr	< 1yr	>1yr
8	5	6	2	8	5	6	2

### Initial herd management

Selected herd was clinically inspected for the presence of any infection and adaptation period of one month is set while taking the blood samples from experimental animals. Drenching with antihelminthic Matemar (Oxyclozanide and Levamisole) at the dose rate of 7.5 mg/kg BW 1 month prior to collecting blood sample.

### Recording of Physiological parameters

Physiological parameters will be recorded throughout the duration of study at both sites. The animals will be handled with care before recording and disturbances to them were kept at minimal. Respiration rate was recorded by observation of the movement of abdominal flank and auscultation with stethoscope, while pulse rate per minute was assessed by palpation of the femoral artery.

### Blood sampling

Blood was collected from both grazing sites during different grazing season from selected herd in morning between 9:00- 11:00' am prior grazing by puncturing the jugular vein using 18 gauge, 1.5 inch needle. 3 ml of blood ml of blood was collected in blank sterile tube to separate serum used for biochemical analysis. After labeling, the samples were stored at 4°C in the icebox and transferred to Karnali Health Science Academy, Jumla for further processing. The blood samples were analyzed within 6 hours of collection.

### Climate data recording

Meteorological parameters such as Average temperature, Average rainfall, and wind velocity were collected from meteorological station situated at Khali and chandannath of Jumla.

### Data analysis

All the collected data were subjected to statistical analysis using ANOVA (R version.98.501-. © R studio.Inc) to test collected data for the weighed mean procedure. The data were analyzed by comparing mean of the treatments set by DMRT.

## RESULTS AND DISCUSSION

### Climatic Variables

High humidity and rainfall and warm temperature with abundant vegetation was recorded at high site. A significant decrease in temperature at lower site was observed, accompanied by low humidity (51.38±9.67) and low rainfall (0.05±0.32). Higher site during transhumance was more humid (69.84±8.7) with higher rainfall (3.37±6.52). During the observation period in the high site maximum temperature recorded was (24.52±2.52) with minimum (11.91±4.33) °C. Similarly, at low site significant decrease in temperature was

measured with minimum ( $1.89 \pm 3.58$ ) ranging from  $-8.7$  to  $5.6$  °C. Meteorological parameters indicates relatively hardy environmental conditions such as low humidity, high wind velocity and lower temperature in lower site, exaggerated by scarcity of feed sources and minimum pasture availability during winter.

### Blood Biochemistry

Site had a significant ( $p < 0.001$ ) effect on glucose level, while age, sex and their respective interactions had no any significant effect on blood glucose ( $p > 0.05$ ). Glucose level detected higher in lower site. Maximum blood glucose value observed was 93 mg/dl in female above one year at lower grazing site, value was similar in male below and above one year (81.43mg/dl and 87.84 mg/dl) respectively and female below one year (83.50mg/dl) at low grazing site during winter. Minimum blood glucose value observed was 77.01 mg/ dl in male below one year at high grazing site. Blood glucose values were found to vary from 77 to 93 mg/ dl. Similarly, maximum value of albumin observed was 5.44 g/dl in male below one year at lower grazing altitude with minimum at higher site was 2.82 g/dl in male below one year. Albumin value observed was ranges between 3 to 5 g/dl. Site and combined interaction effect of site, age and sex had significant ( $p < 0.05$ ) effect on total protein value. Total protein value was observed higher at lower grazing altitude. Maximum value observed was 10.75 g/dl in female above one year at lower grazing site. Minimum value was 4.6 g/dl in male below one year at higher altitudes which were found similar in female below and above one year (5.28g/ dl and 4.8 g/dl) and male above one year (5.3g/dl) at high site. Total protein observed vary from 5 to 11 g/dl.

**Table 2a. Biochemical values of transhumance Baruwal sheep, Jumla**

Parameters	High site				Low site				Sem
	Male		Female		Male		Female		
	<1yr	>1yr	<1yr	>1yr	<1yr	>1yr	<1yr	>1yr	
Glucose	77.01 <sup>b</sup>	79.5 <sup>b</sup>	77.33 <sup>b</sup>	78.75 <sup>b</sup>	81.43 <sup>b</sup>	87.84 <sup>ab</sup>	83.50 <sup>ab</sup>	93 <sup>a</sup>	1.26
Albumin	2.82 <sup>b</sup>	2.88 <sup>b</sup>	3.25 <sup>b</sup>	3.45 <sup>b</sup>	5.01 <sup>a</sup>	5.44 <sup>a</sup>	4.78 <sup>a</sup>	5 <sup>a</sup>	0.17
TP	4.66 <sup>c</sup>	5.3 <sup>c</sup>	5.28 <sup>c</sup>	4.8 <sup>c</sup>	8.80 <sup>b</sup>	7.24 <sup>b</sup>	8.43 <sup>b</sup>	10.75 <sup>a</sup>	0.33

TP= total blood protein

**Table 2b. P-value of blood chemistry value at different site, age, sex and their interactions (con. From table 2a).**

Parameters	site	Age	Sex	site <sup>×</sup> age	site <sup>×</sup> sex	age <sup>×</sup> sex	site <sup>×</sup> age <sup>×</sup> sex
Glucose	<0.001	0.076	0.54	0.33	0.54	0.85	0.7
Albumin	<0.001	0.2	0.59	0.28	0.02	0.92	0.62
TP	<0.001	0.82	0.17	0.42	0.53	0.1	< 0.05

This result had indicated animal's physiological adaptation to cold stress during winter as regulatory mechanism by enhancing hepatic gluconeogenesis under influence of cortisol hormone for thermoregulation to supply more glucose for the respiratory muscular activities to dissipate more heat (Sejian & Srivastava, 2010). A similar result was observed by Zemp et al., (1998) in dairy cow; Titaouine & Meziane (2015) in ewes from semi-arid area of Algeria, where they had observed higher blood glucose in cold stressed above mentioned animals. Blood glucose at low site may be due to lipolysis process and brown fat utilization during winter grazing where feed deficit is prominent, indicating lower body mass gain at low site.

Results had showed higher values of Albumin and Total Protein in low grazing site. The decrease in serum albumin and TP value may be explained by the depression of protein synthesis in liver under low oxygen tension by (Ozesmi, 1990). Synthesis of albumin responds to changes in plasma colloidal pressure and regulated by nutritional and hormonal status including insulin, glucagon and thyroid hormones (Farrugia, A., 2010). These result showed cold stress and feed deficit during winter grazing at low altitude elevates blood biochemical values. Raised biochemical values in lower grazing site indicates flocks are at risk of infection and susceptible to other health disorders during winter. Management of herd during adverse climatic conditions and provision of quality feed resource helps to normalize biochemical values in transhumance sheep.



### Physiological response of transhumance Baruwal sheep

Site, sex and combined interaction of site, sex and age had a significant ( $p < 0.05$ ) effect on respiration. While, age and individual interaction had no any significant ( $p > 0.05$ ) effect on Respiration rate. RR observed was found higher in high grazing sites. Maximum RR recorded was 40 breaths per minute in female below one year at high grazing site during summer grazing. Higher heart rate was observed in high grazing altitude. Maximum HR recorded was 101.53 beats per minute in female below one year at higher site which was found similar in male below and above one year (100.09 beats/minute and 99.2 beats/minute) and female above one year (100.5 beats/minute) at high altitude. Minimum value observed was 96.28 beats/min in male above one year at higher altitude, value was similar with female below and above one year (98.70 beats/minute and 98.80 beats/minute) and male below one year at grazed at lower site. The range of Heart rate observed was varied from 96 to 102 beats per minute. Similar results had been shown by Bhan et al., (2013) which reported significant ( $p < 0.05$ ) increase in heart rate in young and adult Karanfrie cattle during summer higher over spring. Das et al. (1999) also reported an increase in respiration and pulse rate in young buffalo calves exposed to solar radiation.

**Table 3a. Physiological values observed in transhumance Baruwal sheep in Jumla, Nepal**

Parameters	High		Low				SEM		
	Male		Female		Male			Female	
	<1yr	>1yr	<1yr	>1yr	<1yr	>1yr		<1yr	>1yr
HR (beats/ min.)	100.09 <sup>b</sup>	99.2 <sup>bc</sup>	101.53 <sup>a</sup>	100.05 <sup>b</sup>	97.97 <sup>d</sup>	96.28 <sup>c</sup>	98.70 <sup>cd</sup>	98.80 <sup>cd</sup>	0.11
RR(breath/min.)	39.08 <sup>b</sup>	39.15 <sup>b</sup>	40 <sup>a</sup>	39.38 <sup>ab</sup>	38 <sup>cd</sup>	37.36 <sup>d</sup>	38.36 <sup>c</sup>	38.40 <sup>c</sup>	0.07

**Table 3b. p-value of physiological parameters observed (continuous from table 3a).**

Parameters	p-value						
	site	Age	Sex	site: age	site: sex	age: sex	site: age: sex
HR (beats/ min.)	<0.001	<0.001	<0.001	0.97	0.97	0.55	<0.05
RR(breath/min.)	<0.001	<0.01	<0.001	0.39	0.59	0.5	<0.05

This result shows changes in these physiological parameters were due to climatic variability may be the strategies for maintaining homoeothermic/homeostasis specifically during dry and hot humid summer to combat stress during adverse climatic conditions.

### CONCLUSION

High altitude grazing environment possesses a number of unique physiological changes in animal. Understanding the metabolic and physiological mechanism enables high-altitude animals to survive and function under hypoxic conditions that can provide important insights into the nature of physiological adaptation. The results showed significant elevation of biochemical and physiological parameters in transhumance sheep. Stress imposed on animals during transhumance had been reflected as revealed from biochemical and physiological parameters that need to consider in terms of adaptive and slow upward movement in order to prevent sheep from possible infection and possible health hazards. Cold stress and nutritional deficit in low grazing altitudes during winter is the major obstacle for obtaining sustainable production from transhumance Baruwal sheep herds. Thus, special strategies to cope adverse environmental conditions ensured by slow upward movement and quality feed availability need to be considered in order to increase production efficiency of sheep.

### ACKNOWLEDGEMENTS

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