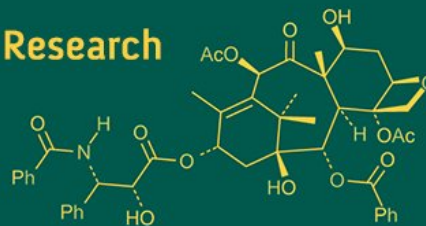


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(9): 117-122
www.biochemjournal.com
Received: 19-06-2026
Accepted: 22-07-2026

Jagadamba Kunja
Assistant Professor, Livestock
Production Management,
College of Veterinary Science,
Garividi, SVVU, Andhra
Pradesh, India

Ch. Harikrishna
Professor (LPM), Director of
Research, PVNRTVU,
Hyderabad, Telanana, India.

P Amareswari
Professor (AGB), Livestock
Farm Complex, College of
Veterinary Science, Rajendra
Nagar, PVNRTVU,
Hyderabad, Telangana, India

G Deepikakumari
Associate Professor,
Department of Veterinary
Microbiology, CVSc., Garividi,
Vizianagaram, Andhra
Pradesh, india

M Venkateswarlu
Professor and Head,
Department of Animal
Nutrition, College of
Veterinary Science, Korutla,
PVNRTVU, Telangana, India

Corresponding Author:
Jagadamba Kunja
Assistant Professor, Livestock
Production Management,
College of Veterinary Science,
Garividi, SVVU, Andhra
Pradesh, India

Influence of feeding pulse Chunni based complete diets on haematology of Nellore brown ram lambs

Jagadamba Kunja, Ch. Harikrishna, P Amareswari, G Deepikakumari and M Venkateswarlu

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i9b.9844>

Abstract

Thirty-two growing Nellore Brown ram lambs (96.30 ± 2.70 days of age; 13.27 ± 0.03 kg body weight) were used to evaluate the effect of incorporating pulse chunnies into sorghum straw-based complete diets on growth performance and haematological parameters. The lambs were randomly allotted to four dietary treatments and fed finishing diets under an intensive management system for 120 days at the Sheep Unit, Livestock Research Station, Mamnoon, Warangal. Red blood cell (RBC; mil/cu mm) and white blood cell (WBC; 10^3 /cu mm) counts did not differ significantly ($p > 0.05$) among groups at the beginning and middle of the trial. However, by the end of the experiment, the T₂ group exhibited significantly higher ($p < 0.01$) RBC and WBC values (10.07 ± 0.12 ; 12.28 ± 0.31) compared with T₃ (9.14 ± 0.14 ; 11.39 ± 0.31), T₄ (9.11 ± 0.21 ; 10.81 ± 0.25), and T₁ (9.70 ± 0.07 ; 10.45 ± 0.25). Similarly, haemoglobin (Hb) and packed cell volume (PCV) showed no significant differences at the start of the study, but highly significant variations ($p < 0.01$) emerged from the mid-point onward, with the T₂ group consistently recording the highest Hb and PCV values. Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), and mean corpuscular haemoglobin concentration (MCHC) were not significantly influenced by dietary treatments at any stage of the experiment.

Keywords: Pulse Chunni, complete diet, haemoglobin, RBC, WBC, PCV, MCV, MCH, MCHC.

Introduction

Crop residues are widely used as roughage sources in livestock feeding systems; however, their nutritive value is inherently low and insufficient to meet even the maintenance requirements of animals when offered as the sole diet. To address this limitation, complete feeds that strategically blend roughage with concentrates have been advocated, as they minimize feed wastage, reduce feed and labour costs, and enhance nutrient-use efficiency, thereby ensuring better utilization of available feed resources (Suarez *et al.*, 2007) [31].

Globally, pulses constitute an important component of livestock concentrate feeds, with their utilization estimated at 6.8 MT in developing nations and 7.3 MT in developed countries (FAO, 2009) [10]. Feed availability remains a principal constraint affecting livestock production efficiency, as feed accounts for nearly 75% of total production costs (Naik *et al.*, 2012) [18]. In India, shrinking feed and fodder resources further challenge the adoption of efficient feeding strategies (Biradar and Kumar, 2013) [3]. This situation underscores the need to explore cost-effective, nutrient-rich alternative feed resources.

Among various agro-industrial by-products, pulse chunnies represent a widely available and valuable feed ingredient for ruminants. Chunni is a dusty mixture comprising grain particles and husk in roughly equal proportions and serves as a useful feed supplement for cattle, buffaloes, sheep and goats (Saha and Ray, 1998) [25]. It consists of broken endosperm, germ coat and husk, obtained during pulse milling for human consumption (NDDDB, 2012) [20], and typically accounts for 15-20% of the total weight of pulses processed (Sudhakarreddy *et al.*, 2000) [32]. Pulses such as Red gram (*Cajanus cajan*), Black gram (*Vigna mungo*), Green gram (*Vigna radiata*) and Bengal gram (*Cicer arietinum*) are commonly cultivated across India, making their by-products easily accessible as feed resources.

Blood plays a vital role in physiological regulation and acts as a sensitive indicator of an animal's health status. Complete blood count (CBC) is essential for diagnosing disorders of the haematopoietic system, identifying systemic diseases, and detecting metabolic disturbances (Spais, 1975) [30].

Blood metabolites reflect nutritional status and physiological responses to environmental or dietary changes (O'Kelly, 1973) ^[22], making haematological assessment a reliable measure of overall animal health (Oduye, 1976) ^[21]. Considering the importance of alternative feed resources and the value of blood parameters in evaluating animal well-being, the present study was undertaken to examine the effect of diets supplemented with different pulse chunnies on the haematological profile of Nellore ram lambs.

Materials and Methods

Location of the study

The experiment was conducted at the Livestock Research Station, PVNRTVU, Mamnoon, Warangal district. The station is located at an altitude of 290 m above mean sea level, at 79.59°E longitude and 17.9°N latitude. During the study period (February 2022 to June 2022), the average maximum and minimum temperatures recorded were 35.5 °C and 25.6 °C, respectively. The total duration of the trial was 120 days.

Selection and distribution of experimental ram lambs

Thirty-two growing Nellore Brown ram lambs averaging 96.30 ± 2.70 days of age and 13.27 ± 0.03 kg body weight were selected from the Sheep Unit, Livestock Research Station, Mamnoon, for a 120-day growth trial. The lambs were randomly assigned to four treatment groups (T₁ to T₄), with eight animals per group, following a completely

randomized design (CRD). Care was taken to ensure that the initial body weights of the lambs were comparable across all groups.

Housing and management

The experimental animals were maintained in clean, well-ventilated pens measuring 24 ft × 10 ft, each with an attached open area of the same size to allow free movement during daytime. The lambs were housed under hygienic conditions and were not allowed to graze throughout the study.

All animals were dewormed at the start of the experiment and again midway through the study (after two months) using Ivermectin and Fenbendazole for control of external and internal parasites. Vaccination against Peste des Petits Ruminants (PPR) was carried out seven days after the first deworming. Standard sanitary practices were followed to maintain healthy surroundings. Each lamb was ear-tagged for proper identification and accurate data recording.

Feeding and watering of experimental ram lambs

The four experimental rations (T₁, T₂, T₃, and T₄) were randomly allotted to the respective treatment groups for the 120-day feeding trial (Ingredient composition and chemical composition shown in Table 1 and Table 2). The diets—Control, RGCC, GGCC, and BGCC—were offered twice daily at 9:00 AM and 3:00 PM.

Table 1: Ingredient composition of experimental rations (kg/100 kg) used for growth study in Nellore ram lambs

Ingredients	Complete diets			
	T ₁ (without any chunni: Control)	T ₂ (with Red gram chunni: RGCC)	T ₃ (with Green gram chunni: GGCC)	T ₄ (with Bengal gram chunni: BGCC)
Sorghum straw	50.0	50.0	50.0	50.0
Red gram chunni	-	7.5	-	-
Green gram chunni	-	-	7.5	-
Bengal gram chunni	-	-	-	7.5
Maize	13.0	14.0	15.0	13.0
Ground nut cake	21.5	20.5	19.5	21.5
Wheat bran	7.5	-	-	-
Molasses	5.0	5.0	5.0	5.0
Mineral mixture	2.0	2.0	2.0	2.0
Salt	1.0	1.0	1.0	1.0
Total*	100.0	100.0	100.0	100.0

* Vitamin A supplement was added @ 10 g/100 kg complete diet.

Animals were provided weighed quantities of complete rations ad libitum, and feed offered and leftovers were recorded daily using an electronic digital balance. Refusals were collected and weighed the following morning to determine the exact daily feed intake for each group. Clean, fresh drinking water was always made available through individual buckets.

Blood collection and estimation of haematological constituents

The whole blood was collected from the jugular vein of the experimental lambs at the beginning, in the middle and at the end of the experiment. The animals were restrained and then the area was first sterilized by using surgical spirit and about 5 ml of blood was collected from all the experimental

lambs by using hypodermic needles in the morning (before feeding) in a clean, dry, sterilized test tube with ethylene diamine tetra acetate (EDTA) as an anti-coagulant under aseptic conditions. These test tubes were kept in cool ice pack immediately after collection maintaining temperature at 5°C. These test tubes were labelled and brought to the laboratory for further analysis.

Blood samples were analyzed for various haematological parameters viz. Red Blood Cell count (RBC), White Blood Cell count (WBC), Packed Cell Volume (PCV), Haemoglobin (Hb), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC). Blood samples were analysed with the help of Haemoanalyser (ABX-MICROS-60).

Table 2: Chemical composition of experimental complete diets (on% DMB) fed to growing Nellore ram lambs

Nutrient	Complete diets*			
	T ₁ (without any chunni: Control)	T ₂ (with Red gram chunni: RGCC)	T ₃ (with Green gram chunni: GGCC)	T ₄ (with Bengal gram chunni: BGCC)
Proximate constituents				
Moisture	1.71	3.34	2.39	3.16
Dry matter	98.29	96.66	97.61	96.84
Organic matter	87.88	88.11	88.08	89.17
Crude protein	13.79	13.68	13.88	13.78
Ether extract	2.98	3.24	3.19	2.95
Crude fibre	22.86	20.56	21.03	25.02
Nitrogen free extract	48.94	48.63	49.99	47.04
Total ash	12.12	11.89	11.92	10.83
Calcium	1.57	1.61	1.13	1.15
Phosphorus	0.83	0.66	0.70	0.80
Cell wall constituents				
Neutral detergent fibre	63.86	60.11	60.85	62.55
Acid detergent fibre	33.82	34.12	33.15	35.95
Cellulose	25.43	23.95	23.27	26.86
Acid detergent lignin	6.25	7.33	5.85	4.83
Silica	2.70	2.93	2.99	3.71
Hemi cellulose	30.04	25.99	27.71	26.60

*Each value is an average of duplicate analysis

Statistical analysis

Statistical analysis of the data was carried out according to the procedures suggested by Snedecor and Cochran (1994)^[29]. Least-square Analysis of variance was used to test the significance of various treatments and the difference between treatment means was tested for significance by Duncan's Multiple Range and F Test (Duncan, 1955)^[7].

Results and Discussion

The data obtained in the present investigation of effect of feeding pulse chunni based complete diets on various haematological parameters (Mean $\pm$ SE) such as RBC, WBC, Hb, PCV and erythrocyte indices such as MCV, MCH and MCHC are presented in Table 3 and Table 4, respectively.

The influence of experimental complete diets containing different pulse chunnies on haematological parameters of Nellore ram lambs is presented below.

Red blood corpuscles (RBC)

The RBC values (mil/cu mm) recorded at the end of the study were 9.70 ± 0.07 (T₁), 10.07 ± 0.12 (T₂), 9.14 ± 0.32 (T₃) and 9.11 ± 0.21 (T₄) (Table 3). Statistical analysis revealed that the RBC count did not differ significantly ($p > 0.05$) among the groups from the beginning to the middle of the experiment. However, at the end of the trial, a highly significant difference ($p < 0.01$) was observed among treatments, with the highest RBC values recorded in lambs fed the T₂ diet, comparable to the control (T₁), and higher than T₃ and T₄. Red blood corpuscles play a vital role in transporting oxygen and carbon dioxide and in the synthesis of haemoglobin; therefore, the values obtained in the present study reflect the physiological status and health of the growing lambs. The RBC counts (mil/cu mm) recorded at the end of the experiment were 9.70 ± 0.07 (T₁), 10.07 ± 0.12 (T₂), 9.14 ± 0.32 (T₃) and 9.11 ± 0.21 (T₄) (Table 3). Statistical analysis indicated no significant difference ($p > 0.05$) in RBC counts among the treatments from the beginning to the middle of the study. However, by the end

of the experiment, RBC values differed highly significantly ($p < 0.01$) among the four groups, with lambs receiving the T₂ complete diet showing higher values comparable to the control (T₁), and superior to T₃ and T₄. These findings are in agreement with Sahoo *et al.* (2016)^[26] and Kumawat *et al.* (2017)^[13], who reported non-significant differences between treatments. Similar observations were made by Mohit *et al.* (2019)^[16], Tharuntej *et al.* (2020)^[34] and Pandu *et al.* (2021)^[23]. In contrast, Devendran *et al.* (2009)^[5], Nagalakshmi and Dhanalakshmi (2015)^[17] and Likhitha (2022)^[14] reported slightly lower RBC values. The RBC counts recorded in this study fall within the normal physiological range reported by Swensen and Ithane (1984)^[33], Dutta *et al.* (1996)^[8], Kalleswarappa (1999)^[11] and Rangamma *et al.* (2021)^[24].

White blood corpuscles (WBC)

The WBC values ($10^3/\text{cu mm}$) at the end of the experiment were 10.45 ± 0.25 (T₁), 12.28 ± 0.31 (T₂), 11.39 ± 0.31 (T₃) and 10.81 ± 0.25 (T₄) (Table 3). No significant differences ($p > 0.05$) were observed in WBC counts among the treatments from the beginning to the middle of the study. However, at the end of the experiment, a highly significant difference ($p < 0.01$) was noted, with lambs on the T₂ diet registering the highest counts, followed by T₃.

These findings are comparable with Sahoo *et al.* (2016)^[26] and Kumawat *et al.* (2017)^[13]. Mohit *et al.* (2019)^[16] and Tharuntej *et al.* (2020)^[34] also reported non-significant differences in WBC values under different management systems. Conversely, slightly lower WBC values were reported by Devendran *et al.* (2009)^[5], Nagalakshmi and Dhanalakshmi (2015)^[17], Likhitha (2022)^[14] and Pandu *et al.* (2021)^[23]. The WBC counts obtained here fall within the normal range established by Swensen and Ithane (1984)^[33], Sheikh *et al.* (2019)^[27] and Rangamma *et al.* (2021)^[24].

White blood corpuscles function in immune defence, phagocytosis and antibody transport. Animals with higher WBC counts generally exhibit stronger disease resistance and improved adaptability to local environmental conditions (Etim *et al.*, 2014)^[9].

Table 3: Haematological parameters of Nellore ram lambs fed experimental complete diets (Mean $\pm$ SE)

Complete diets	n	Haematological parameters [#] (Mean $\pm$ SE)											
		RBC (mil/cumm)			WBC (10^3 /cumm)			Hb (g%)			PCV (%)		
		Initial	Middle	At the End ^{**}	Initial	Middle	At the End ^{**}	Initial	Middle ^{**}	At the End [*]	Initial	Middle ^{**}	At the End ^{**}
T ₁ (Control)	8	8.79 $\pm$ 0.23	9.18 $\pm$ 0.17	9.70 ^{ab} $\pm$ 0.07	14.07 $\pm$ 0.93	10.35 $\pm$ 0.10	10.45 ^a $\pm$ 0.25	7.71 $\pm$ 0.28	9.01 ^a $\pm$ 0.16	9.76 ^a $\pm$ 0.04	22.43 $\pm$ 0.19	22.61 ^a $\pm$ 0.13	24.08 ^a $\pm$ 0.15
T ₂ (RGCC)	8	8.24 $\pm$ 0.72	9.51 $\pm$ 0.07	10.07 ^b $\pm$ 0.12	13.16 $\pm$ 1.36	11.15 $\pm$ 0.19	12.28 ^c $\pm$ 0.31	7.01 $\pm$ 0.51	9.85 ^b $\pm$ 0.11	10.76 ^b $\pm$ 0.44	22.36 $\pm$ 0.27	23.94 ^a $\pm$ 0.16	24.65 ^b $\pm$ 0.05
T ₃ (GGCC)	8	8.39 $\pm$ 0.51	9.24 $\pm$ 0.13	9.14 ^a $\pm$ 0.32	14.08 $\pm$ 1.18	10.93 $\pm$ 0.30	11.39 ^b $\pm$ 0.31	7.23 $\pm$ 0.34	9.68 ^b $\pm$ 0.03	10.01 ^a $\pm$ 0.08	22.75 $\pm$ 0.47	23.33 ^b $\pm$ 0.17	24.18 ^a $\pm$ 0.12
T ₄ (BGCC)	8	8.43 $\pm$ 0.74	9.29 $\pm$ 0.17	9.11 ^a $\pm$ 0.21	11.93 $\pm$ 1.50	10.66 $\pm$ 0.26	10.81 ^{ab} $\pm$ 0.25	7.01 $\pm$ 0.55	9.54 ^b $\pm$ 0.09	9.94 ^a $\pm$ 0.19	22.31 $\pm$ 0.42	23.05 ^{ab} $\pm$ 0.23	24.21 ^a $\pm$ 0.14
SEM		0.284	0.073	0.122	0.622	0.122	0.183	0.213	0.077	0.136	0.173	0.122	0.072
P value		0.921	0.401	0.006	0.589	0.107	0.000	0.638	0.000	0.039	0.824	0.000	0.017

^{ab}Means with different [#]Each value is an average of eight observations; n = Number of animals in each treatment; p = Probability Value; SEM: Standard Error Mean

Superscripts column wise differ significantly * ($p < 0.05$), ** ($p < 0.0$)

Table 4: Erythrocyte indices of Nellore ram lambs fed experimental complete diets (Mean $\pm$ SE)

Complete diets	n	Erythrocyte Indices [#] (Mean $\pm$ SE)								
		MCV ^{NS} (fl)			MCH ^{NS} (picogram)			MCHC ^{NS} (%)		
		Initial	Middle	At the End	Initial	Middle	At the End	Initial	Middle	At the End
T ₁ (Control)	8	26.05 $\pm$ 0.48	23.88 $\pm$ 0.27	24.71 $\pm$ 0.22	8.01 $\pm$ 0.19	9.51 $\pm$ 0.37	8.96 $\pm$ 0.14	29.95 $\pm$ 0.65	33.96 $\pm$ 0.32	34.76 $\pm$ 0.34
T ₂ (RGCC)	8	28.36 $\pm$ 1.26	25.06 $\pm$ 0.41	26.93 $\pm$ 0.46	8.64 $\pm$ 0.30	10.24 $\pm$ 0.46	11.60 $\pm$ 1.73	30.50 $\pm$ 0.44	34.96 $\pm$ 0.33	35.91 $\pm$ 0.21
T ₃ (GGCC)	8	28.13 $\pm$ 0.71	24.07 $\pm$ 0.36	25.96 $\pm$ 0.54	8.70 $\pm$ 0.23	9.85 $\pm$ 0.23	9.61 $\pm$ 0.20	30.93 $\pm$ 0.24	34.88 $\pm$ 0.47	35.28 $\pm$ 0.41
T ₄ (BGCC)	8	26.86 $\pm$ 0.59	23.96 $\pm$ 0.49	25.52 $\pm$ 0.85	8.39 $\pm$ 0.18	8.99 $\pm$ 0.30	9.53 $\pm$ 0.27	31.18 $\pm$ 0.20	34.07 $\pm$ 0.44	35.61 $\pm$ 0.29
SEM		0.427	0.206	0.306	0.118	0.188	0.458	0.220	0.206	0.173
P value		0.178	0.147	0.067	0.153	0.107	0.192	0.213	0.180	0.101

[#]Each value is an average of eight observations; n = Number of animals in each treatment; p = Probability Value; ^{NS}Non-significant SEM: Standard Error Mean

Haemoglobin (Hb)

The haemoglobin concentrations (g%) recorded at the end of the study were 9.76 $\pm$ 0.04 (T₁), 10.76 $\pm$ 0.44 (T₂), 10.01 $\pm$ 0.08 (T₃) and 9.94 $\pm$ 0.19 (T₄) (Table 3). A significant increase ($p < 0.05$) in Hb was observed in the middle of the study in lambs fed T₂, T₃ and T₄ diets compared to the control (T₁). At the end of the experiment, Hb values differed highly significantly ($p < 0.01$), with lambs on the T₂ diet recording the highest concentrations.

These results agree with Rangamma *et al.* (2021) [24] in Nellore sheep and are in line with the findings of Sheikh *et al.* (2019) [27], Meena *et al.* (2021) [15], Thiruvankadan *et al.* (2009) [35], Kumari *et al.* (2013) [12], Divate *et al.* (2014), Deshmukh (2017), Tharuntej *et al.* (2020) [34] and Pandu *et al.* (2021) [23], who reported non-significant treatment differences in Hb levels. Slightly higher Hb values were documented by Dutta *et al.* (1996) [8], Nayak *et al.* (2013) [19] and Nagalakshmi and Dhanalakshmi (2015) [17], whereas slightly lower values were reported by Mohit *et al.* (2019) [16], Likhitha (2022) [14] and Sireesha *et al.* (2021) [28]. The Hb concentrations in the present study lie within the normal physiological range described by Kalleswarappa (1999) [11], Bhikane and Kawitkar (2002) [2], Devendran *et al.* (2009) [5], Meena *et al.* (2021) [15] and Rangamma *et al.* (2021) [24].

Packed cell volume (PCV)

The PCV values (%) at the end of the trial were 24.08 $\pm$ 0.15 (T₁), 24.65 $\pm$ 0.05 (T₂), 24.18 $\pm$ 0.12 (T₃) and 24.21 $\pm$ 0.14 (T₄) (Table 3). No significant differences ($p > 0.05$) were observed among treatments at the beginning of the experiment. However, during the middle phase, highly significant differences ($p < 0.01$) were recorded, with T₂ and T₃ showing higher PCV levels compared to T₁ and T₄. By the end of the study, PCV values differed highly significantly ($p < 0.01$) among treatments, with T₂ showing the highest value. Similar results were reported by Tharuntej *et al.* (2020) [34]. Slightly higher PCV values were observed by

Devendran *et al.* (2009) [5], Likhitha (2022) [14], Meena *et al.* (2021) [15] and Sireesha *et al.* (2021) [28], whereas Mohit *et al.* (2019) [16] recorded slightly lower values. In contrast, Thiruvankadan *et al.* (2009) [35] and Pandu *et al.* (2021) [23] found no significant effect of management system on PCV. The PCV levels obtained in this study are within the normal range reported by Bhikane and Kawitkar (2002) [2], Etim *et al.* (2014) [9] and Rangamma *et al.* (2021) [24].

Erythrocyte indices (MCV, MCH, MCHC)

The erythrocyte indices evaluated—mean corpuscular volume (MCV; fl), mean corpuscular haemoglobin (MCH; pg) and mean corpuscular haemoglobin concentration (MCHC; %) showed no significant differences ($p > 0.05$) among the four groups throughout the experiment (Table 4). These results are supported by Mohit *et al.* (2019) [16], Tharuntej *et al.* (2020) [34] and Pandu *et al.* (2021) [23], who observed similar non-significant trends in animals reared on different floor types. Comparable findings were also reported by Beigh (2018) [1] and Likhitha (2022) [14].

Conclusion

The mean RBC (mil/cu mm) and WBC (10^3 /cu mm) values were non-significant ($p > 0.05$) at the beginning and middle of the experiment and at the end of the study, significantly ($p < 0.01$) higher RBC and WBC values recorded in T₂ group of lambs (10.07 $\pm$ 0.12; 12.28 $\pm$ 0.31) compared to T₃ (9.14 $\pm$ 0.14; 11.39 $\pm$ 0.31), T₄ (9.11 $\pm$ 0.21; 10.81 $\pm$ 0.25) and T₁ (9.70 $\pm$ 0.07; 10.45 $\pm$ 0.25) groups of lambs, indicating lambs with high WBC counts are capable of generating antibodies in the process of phagocytosis and have high degree of resistance to diseases to enhance adaptability to local environment and disease prevalent conditions. Similarly, non-significant effect was found among four groups of lambs for Haemoglobin (Hb) and packed cell volume (PCV) at the beginning of the study, while highly significant ($p < 0.01$) difference was observed

for Hb (g%) and PCV (%) from the middle of the experiment till completion. The T₂ group of lambs recorded significantly ($p < 0.01$) higher Hb and PCV values compared to other groups. Among erythrocyte indices, non-significant difference was observed in the mean values of MCV (fl), MCH (pg) and MCHC (%) at start, middle and end of the experiment in all the groups.

Funding and acknowledgements

This research was funded by P.V. Narsimha Rao Telangana Veterinary University, Hyderabad and the authors are thankful to "College of Veterinary Science, Rajendranagar, Hyderabad and Livestock Research Station of PVRVTU for providing the facilities to carry out the research work.

References

1. Beigh YA, Ganai AM, Haidar Ali Ahmad, Danish Masood Mir, Mudasir Ahmad Bhat, Showkeen Muzamil. Blood metabolic profile of lambs fed complete diet supplemented with exogenous fibrolytic enzymes cocktail. *Journal of Animal Health and Production*. 2018;6(4):97.
2. Bhikane AU, Kawitkar SB. Blood transfusion and fluid therapy. In: *Hand Book of Veterinary Clinicians*. 2002;1:325-329.
3. Biradar N, Kumar V. Analysis of fodder status in Karnataka. *Indian Journal of Animal Sciences*. 2013;83(10):1078-1083.
4. Deshmukh AK. Growth performance of Madgal lambs under different housing system [thesis]. Nagpur: Maharashtra Animal & Fishery Sciences University; 2017.
5. Devendran P, Jayachandran S, Visha P, Nanjappan K, Panneerselvam S. Hematological and blood biochemical profile of Coimbatore sheep. *Indian Journal of Small Ruminants*. 2009;15(1):98-101.
6. Divate RT. Effect of different types of flooring material on the growth performance in Osmanabadi kids [M.V.Sc. thesis]. Nagpur: Maharashtra Animal & Fishery Sciences University; 2014.
7. Duncan DB. Multiple range and multiple F tests. *Biometrics*. 1955;11:1-12.
8. Dutta A, Sarmah S, Rajkhowa NK. Haematological and biochemical studies in sheep of Assam. *Indian Veterinary Journal*. 1996;73(4):402-405.
9. Etim NN, Williams ME, Akpabio U, Offiong EE. Haematological parameters and factors affecting their values. *Agricultural Science*. 2014;2(1):37-47.
10. Food and Agriculture Organization of the United Nations. The state of food and agriculture: livestock in the balance. Rome: Food and Agriculture Organization; 2009.
11. Kalleswarappa GM. Haematological profile of UAS strain of sheep. *Indian Veterinary Journal*. 1999;76(7):673-675.
12. Kumari A, Baig MI, Kodape AH, Dagli NR, Patwardhan SH, Ghorpade PP. Growth performance of Osmanabadi kids under different housing systems. *Indian Journal of Small Ruminants*. 2013;19(2):215-216.
13. Kumawat S, Patel AK, Goswami SC, Kumar V, Saini N. Effect of supplementary feeding on haemato-biochemical and wool characters of Magra lambs in hot arid zone. *Indian Journal of Small Ruminants*. 2017;23(2):269-271.
14. Likhitha. A comparative study on heat tolerance in Deccani and Nari Suvana sheep [M.V.Sc. thesis]. Hyderabad: P.V. Narasimha Rao Veterinary University; 2022.
15. Meena MK, Monika Joshi, Manish Nagar. Effect of feeding herb (*Allium sativum*) and probiotic (*Saccharomyces cerevisiae*) alone or in combination with ground nut straw based complete feed on haemato-biochemical parameters of Sonadi sheep. *The Pharma Innovation Journal*. 2021;10(6 SP):277-280.
16. Mohit A, Bhuvaneshwar Rai, Rmachandran Natesan, Chetna Gangwar. Hemato-biochemical and physiological response of Barbari kids to different bedding materials during winter. *International Journal of Current Microbiology and Applied Sciences*. 2019;8(2):1829-1836.
17. Nagalakshmi D, Dhanalakshmi K. Effect of feeding castor seed cake based diets on growth, nutrient utilization, immune response and carcass traits in lambs. *Asian Journal of Animal Sciences*. 2015;9(6):293-305.
18. Naik PK, Swain BK, Chakurkar EB, Singh NP. Assessment of potential animal and poultry feed resources in Goa. *Animal Nutrition and Feed Technology*. 2012;12(1):127-133.
19. Nayak S, Mohapatra AK, Barik N, Sahoo GR. Haemato-biochemical studies in Ganjam sheep of Odisha reared under grazing system. *Indian Journal of Small Ruminants*. 2013;19(1):88-91.
20. National Dairy Development Board. Nutritive values of commonly available feeds and fodders in India. Anand: National Dairy Development Board; 2012.
21. Oduye OO. Haematological values of Nigeria goats and sheep. *Tropical Animal Health and Production*. 1976;8:131-136.
22. O'Kelly JC. Plasma lipid changes in genetically different types of cattle during hyperthermia. *Comparative Biochemistry and Physiology Part A: Physiology*. 1973;44(2):313-320.
23. Pandu R, Sarat Chandra A, Harikrishna Ch, Venkateswarlu M, Vidya B. A study on the effect of different floor types on the physiological responses, haematology and blood biochemical parameters and stress tolerance in Nellore Brown ram lambs. *The Pharma Innovation Journal*. 2021;10(11 SP):700-704.
24. Rangamma B, Chandra AS, Rajanna N, Prakash MG, Amareswari P, Venkateswarulu M, *et al.* Haematology of Nellore Brown ewes and lambs reared in different systems of rearing. *International Journal of Current Microbiology and Applied Sciences*. 2021;10(10):369-377.
25. Saha AK, Ray AK. Evaluation of chunni, a commercially available low-cost cattle fodder, in the diet of rohu, Labeo rohita (Hamilton), fingerlings. *Aquaculture Research*. 1998;29:761-768.
26. Sahoo C, Pradhan CR, Sahu S, Kumari A, Sarangi A. Growth and haemato-biochemical response in lambs in relation to supplementary feeding of ewes in late pregnancy. *Indian Journal of Small Ruminants*. 2016;22(2):249-251.
27. Sheikh GG, Danish Masood, Ganai AM, Muzamil S, Afzal Y, Ahmad HA. Effect of probiotics mix

- supplementation on haemato-biochemical parameters and bacterial faecal shedding in Corriedale lambs fed paddy straw based complete feed. *Indian Journal of Animal Research*. 2019;53(8):1049-1053.
28. Sireesha K, Venkata Seshaiah Ch, Sudhakar K, Kumar DS, Vinoo R. Effect of feeding TLMM based TMR on haemato biochemical profile and cost per kg weight gain in Nellore Brown lambs. *Indian Journal of AgriVet Research*. 2021;1(4):173-183.
29. Snedecor GW, Cochran WG. *Statistical methods*. 8th ed. Ames, Iowa: Iowa State University Press; 1994.
30. Spais AG. *Veterinary general medicine*. Vol. II. Thessaloniki: Publication Service A.U.Th.; 1975.
31. Suarez BJ, Van Reenen CG, Stockhofe N, Dijkstra J, Gerrits WJJ. Effect of roughage source and roughage to concentrate ratio on animal performance and rumen development in veal calves. *Journal of Dairy Science*. 2007;90(5):2390-2403.
32. Sudhakarreddy K, Rao DS, Rao ZP, Prasad JR. Effect of inclusion of varying levels of urad (*Phaseolus mungo*) chuni in concentrate mixtures on the nutrient utilization in the native male buffaloes. *Buffalo Bulletin*. 2000;19:43-47.
33. Swensen MJ, Ithane NV. *Dukes physiology of domestic animals*. 10th ed. Ithaca: Cornell University Press; 1984.
34. Tharuntej E, Rajanna N, Sarat Chandra A, Nagalakshmi D. Effect of flooring systems on the growth performance and welfare of growing Deccani lambs under intensive system. *Indian Journal of Small Ruminants*. 2020;26(2):266-269.
35. Thiruvankadan AK, Karananithi K, Babu RN, Arunachalam K. Effect of housing system on growth performance of Tellichery goats. *Indian Veterinary Journal*. 2009;86:500-502.