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EFFECT OF FEEDING MORINGA LEAF-BASED DIETS ON HAEMATOLOGICAL AND BIOCHEMICAL PARAMETERS IN GROWING DECCANI SHEEP UNDER DIFFERENT REARING SYSTEMS

S.M. Bhokre[1]. N. Rajanna[2*], D. Nagalakshmi[3], and D.B.V. Ramana[4]

[1]Department of Livestock Production & Management, Krantisinh Nana Patil College of Veterinary Science, Maharashtra Animal & Fishery Science University, Shirwal, Satara - 412 801, Maharashtra (India)
[2]Department of Livestock Production & Management, [3]Department of Animal Nutrition, College of Veterinary Science, P.V. Narsimha Rao Telangana Veterinary University, Rajendranagra, Hyderabad - 500 030, Telangana (India)
, [4]Indian Council of Agriculture Research - Central Research Institute for Dryland Agriculture (ICAR-CRIDA), Santhoshnagar - 500 059, Hyderabad, Telangana (India)
**e-mail: rajlpm2001@gmail.com*

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ABSTRACT

Sheep play a vital role in supporting rural livelihoods, especially in arid, semi-arid, and marginal farming regions where crop and dairy production are less viable. This study evaluated the impact of *Moringa oleifera* leaf meal-based diets on the blood biochemical profiles of 'Deccani' sheep reared under intensive and semi-intensive systems. Thirty-six growing lambs (14-18 kg) were randomly allotted to three dietary treatments *viz*., T_1 (control), T_2 (75% groundnut cake + 25% Moringa leaf meal), and T_3 (50% groundnut cake + 50% Moringa leaf meal) with six lambs per group in each system. The experiment lasted 90 days. Hematological and biochemical data were analysed using Student's t-test. No significant differences ($P < 0.01$) in hematological parameters were observed among the diets in either system. Hb concentrations ranged from 9.83 to 11.25 g dL^{-1} across the treatments, while PCV values were higher in T_2 than in T_1 and T_3. Total protein levels were significantly higher ($P < 0.01$) in T_3 in both systems. Glucose levels showed a non-significant decrease in T_2 as compared to T_1 and T_3. SGOT and SGPT values remained within the normal range. Overall, better blood biomolecule levels indicate that 25% Moringa inclusion under intensive rearing is superior to semi-intensive management.

Keywords: Blood biochemical, *Moringa oleifera* leaf meal, rearing systems, small ruminants

INTRODUCTION

In India the availability of feed and fodder remains a major area of concern as there is a gap between its demand and supply. The utilization of fodder trees and shrubs could be a potential strategy for enhancing the quality and availability of feeds for resource-limited livestock farmers during dry season (Bhokre *et al.*, 2023). India is the largest producer of moringa (Radovich *et. al., 2011*), with annual production of 1.1-1.3 million tonnes fruit pods and an average green leaf fodder yield of 120 t^{-1} ha^{-1} yr^{-1} (Sagbo *et. al.*, 2006). Moringa is a perineal plant that can be harvested several times in a growing season, and as a protein source has the potential to reduce the feed-cost of livestock ration.

India holds the 2nd largest sheep population (74.26 million sheep) in the world, representing over 4.03% of global total. Among Indian states, Telangana contributes highest (25.72%) of the country's sheep population, followed by Andhra Pradesh with 23.70% and Karnataka with 14.95%. (Bhateshwar *et al.*, 2022). The population of indigenous sheep in recent years has shown 9.64% decline, while the recognized breeds showed 21.9% decline (Behl *et al.*, 2020). This decline could be ascribed to the seasonal droughts, unpredictable weather patterns, diminishing land resources, and an unstable economy with fluctuating meat prices. The global trend in animal production is a systematic transition from small-scale extensive production to large-scale intensive production systems (Venkatata Raju *et al.*, 2015).

Haematological studies are useful in the selection of animals that are genetically resistant to certain environmental conditions (Mmereole, 2008). The various functions of blood are made possible by the individual and collective actions of its constituent's haematological components. Generally, both the biochemical and haematological components are influenced by the quantity and quality of feed, and the level of anti-nutritional elements or factors present in the feed including elements of toxicity (Akinmutimi, 2004). They can also be used to monitor protein quality of feeds. The haematological characteristics of livestock suggest their physiological disposition to the plane of nutrition (Gbolabo *et al.*, 2015). Divya *et al.* (2024) reported that most of the haematological parameters were non-significant, with the exception of exception of haematocrit (PCV) which was significantly higher in control than in *Moringa oleifera* leaf meal (MOLM)-supplemented lambs. However, Al-Mufarji *et al.* (2023) contrarily documented that *Moringa oleifera* supplementation during gestation resulted in significant improvement in hematological (RBCs, Hb, Ht, WBCs, neutrophils, and lymphocytes) and plasma parameters (total protein, albumin, globulin, glucose, urea, and minerals) of ewes and lambs. Hamzah and Dawood (2023) observed decrease in the concentration of blood glucose, cholesterol, triglyceride and urea in local Awassi male lambs fed with Moringa leaf meal in comparison to the control group. The concentrations of serum calcium, total protein, albumin, and globulin in Sahiwal calves fed with Moringa leaf meal were significantly higher as compared to the control group (Jaiswal *et al.*, 2024). In India, scanty literature is available on effect of feeding Moringa leaves on blood biochemistry in sheep. Keeping this in view, the present study was aimed to evaluate the impact of feeding different levels of Moringa leaf meal on blood biochemical parameters in growing 'Deccani' lambs.

MATERIALS AND METHODS

Selection of animals

Feeding of moringa (*Moringa oliefera*) leaf meal (MOLM) diets on blood biomolecules in 'Deccani' sheep was carried out in two different rearing systems at Livestock Farm, Hayathnagar Research Farm, ICAR-Central Research Institute for Dryland Agriculture (ICAR-CRIDA) during the year 2021. The semi-intensive rearing system experiment was carried out on 18 growing lambs with average body weight of 18.77 ± 0.97 kg. While intensive system of rearing involving 18 growing 'Deccani' sheep with uniform body weight (14.22 ± 1.5 kg) was carried at Livestock Farm Complex (LFC) Rajendranagar (India). The animals in both farming systems were divided randomly into three groups (3 males and 3 females in each) taking into consideration the group averages of body weights in all 3 groups uniformly. Each group of animals was kept in a pen size of 30.48 m^2 on concrete floor with orientation of east-west direction through its long axis. Animals had free access to clean drinking water throughout the day. In both groups, the animals were randomly allotted to three treatment groups with 6 lambs in each group in a completely randomized design. Three experimental diets were prepared: i) control having 100% groundnut cake (GNC) without moringa (T_1), ii) 75% GNC + 25% MOLM (T_2), and iii) 50% groundnut cake + 50% MOLM (T_3) as protein source in concentrate mixture. The ration was offered @ 1% body weight (b.w.) along with *ad libitum* green fodder. The feeding schedule of experimental animals in intensive farming system was stall feeding with concentrate mixture and roughage @ 1% b.w. whereas in semi-intensive farming system grazing for 4 h was done with 1% b.w. concentrate mixture and green fodder *ad libitum.*

Analysis of blood samples

The blood samples were collected from jugular vein in all experimental animal before the start and at the end of experiment (after 90 days feeding trail). Whole blood samples (5-7 mL) were aseptically collected from the jugular vein using disposable needles and EDTA containing vacutainer tubes and another sample was placed in plain tubes without anti-coagulant. Hematological analysis for red blood cell (RBC) and white blood cell (WBC) counts were performed within 1-2 h after blood collection by using hemocytometer (ABX-MICROS-60). The serum was obtained by allowing the blood to clot at room temperature for 2 h, then centrifuged, collected in a special Eppendorf tubes and stored at -20°C until use. Blood serum metabolites such as glucose, albumin, and total protein in treatments were examined for any alterations or deviations from the normal range. For liver function test, serum SGOT and SGPT levels were estimated to assess whether feeding moringa leaf-based diets in two different rearing systems caused any change. Biochemical parameters were evaluated by using an A15 Biochemical Automatic Analyser (Biosystems Diagnostics Pvt. Ltd.) using standard kits as per the methods of Kaneko *et al.* (2008). Data obtained from hematological and biochemical parameters were statistically analysed by Student's t-test (Snedecor and Cochran, 1994) to compare intensive and semi-intensive systems. Variables with $p < 0.05$ and $p < 0.01$ were considered significant and highly significant, respectively while the variables with $p > 0.05$ were considered non-significant.

RESULTS AND DISCUSSION

The result of feeding growing 'Deccani' sheep with various levels of moringa leaf meal (MOLM) on haematological and biochemical parameters are given in Table 1 & 2.

Haematological parameters

The mean WBC (10^{-3} m³) and RBC (10^{-3} m^{-3}) levels in intensive farming system were 9.83 ± 0.45, 13.16 ± 0.60, and 11.33 ± 0.77; and 9.47 ± 0.54, 11.28 ± 0.28 and 10.45 ± 0.25, respectively; while in semi-intensive farming system the above values were 9.83 ± 0.46 and 12.83 ± 0.33, and 11.33 ± 0.77 and 9.28 ± 0.46; 11.40 ± 0.30 and 10.50 ± 0.45, respectively. WBC values were similar between the two systems, reflecting no significant immune or physiological stress. Management system had minimal impact on immunological status. Swenson and Reece (1993) confirmed that unless any disease or stress is present, WBC counts remain unchanged in healthy animals. RBC values remained consistent across the intensive and semi-intensive systems in all treatments, with no significant differences ($P > 0.05$). The similarity in RBC values suggests that both management systems provided adequate nutrients for erythropoiesis. Moringa leaves are protein-rich and supply essential micronutrients such as iron and folate, which support RBC formation. The results are in agreement with NseAbasi *et al.* (2014) and Jain (1993), who reported that RBC values remain stable unless animals undergo severe stress, anaemia, or nutrient deficiency. However, levels were within the normal range of sheep (Swensen and Ithae,1984). The estimated Hb levels in T_1, T_2, and T_3 groups were 9.83 ± 0.31, 10.93 ± 0.52 and 10.33 ± 0.44, and 10. 80 ± 0.33, 11.25 ± 0.31 and 9.67±0.44, g dL^{-1}, respectively, reared in intensive and semi intensive farming systems. The haemoglobin values were higher in T_2 diets as compared to the T_1 and T_3 rations. Hb values showed no significant differences between intensive and semi-intensive systems. Hb stability revealed that oxygen-carrying capacity and iron metabolism were not compromised in any group. Since moringa leaves are rich in iron, vitamins, and antioxidants, they support hemoglobin synthesis in both systems. However, the haemoglobin values in intensive rearing system were within the normal range of 8-16. Asaolu *et al.* (2012) and Babeker and Bdalbagi (2015) reported similar results in goats fed with moringa based diets.

Table 1: Effect of experimental rations on haematological parameters in 'Decanni' sheep reared under intensive (I) and semi-intensive (SI) farming systems

Parameters	Groups		Control, 100% GNC without MOLM (T_1)			75% GNC + 25% MOLM (T_2)			50% GNC + 50% MOLM (T_3)		
	Time	Farming system	Mean ±SE	t' value	P-Value	Mean ±SE	t' value	P-value	Mean ±SE	t' value	P-value
RBC (10^{-3} m³)	Before	I	9.45±0.46	0.85	0.42	10.28±0.25	1.09	0.30	10.02±0.36	0.69	0.51
		SI	8.90±0.46			9.62±0.56			9.68±0.33		
	After	I	9.47±0.54	0.26	0.80	11.28±0.28	1.87	0.09	10.45±0.25	0.29	1.00
		SI	9.28±0.46			11.40±0.30			10.50±0.76		
WBC (10^{-3} m³)	Before	I	9.67±0.42	0.12	1.00	12.00±0.58	1.87	0.09	10.50±0.76	0.07	1.00
		SI	9.67±0.73			10.67±0.42			10.50±0.76		
	After	I	9.83±0.46	0.65	1.0	13.17±0.60	0.49	0.64	11.33±0.77	0.65	1.00
		SI	9.83±0.46			12.83±0.33			11.33±0.77		
PCV (%)	Before	I	22.17±0.83	1.05	0.32	23.50±0.89	0.91	0.38	23.17±0.40	0.24	1.00
		SI	21.00±0.73			22.17±1.17			23.17±0.40		
	After	I	22.33±0.76	0.46	0.16	24.92±0.82	1.07	0.30	24.17±0.31	0.26	1.00
		SI	21.83±0.79			23.55±1.03			24.17±0.31		
Hb (g dL^{-1})	Before	I	9.83±0.31	1.53	0.16	10.00±0.58	1.78	0.10	9.50±0.43	1.65	0.13
		SI	9.17±0.31			8.83±0.31			8.50±0.43		
	After	I	9.83±0.31	0.56	0.59	10.93±0.52	0.53	0.61	10.33±0.44	1.07	0.31
		SI	10.08±0.33			11.25±0.31			9.67±0.44		

**P<0.01, *P<0.05 P-value are probability values; SE = Standard error mean, GNC = Groundnut cake; MOLM = *Moringa olifera* leaf meal; The parameters were measured before and after feeding in both rearing systems

Table 2: Effect of experimental rations on biochemical parameters in 'Decanni' sheep reared under intensive (I) and semi-intensive (SI) farming systems

Parameters	Groups		Control, 100% GNC without MOLM (T_1)			75% GNC + 25% MOLM (T_2)			50% GNC + 50% MOLM (T_3)		
	Time	Faming system	Mean ±SE	t' value	P-value	Mean ±SE	t' value	P-value	Mean ±SE	t' value	P-value
Total protein (g dL^{-1})	Before	I	7.10±0.16	1.33	0.21	7.18±0.14	1.88	0.09	7.13±0.20	2.96	0.01
		SI	6.75±0.21			6.54±0.31			5.70±0.44		
	After	I	7.04±0.16	0.20	0.85	7.85±0.14	2.17	0.05	7.42±0.10	6.19	0.00
		SI	6.98±0.29			7.09±0.32			6.03±0.20		
Albumin (g dL^{-1})	Before	I	3.46±0.08	2.48	0.03	3.24±0.07	2.00	0.07	3.18±0.03	1.88	0.09
		SI	3.03±0.15			3.06±0.05			2.88±0.16		
	After	I	3.45±0.08	4.15	0.10	3.53±0.08	2.98	0.01	3.52±0.03	4.23	0.01
		SI	2.86±0.12			3.05±0.14			2.83±0.16		
Glucose (g dL^{-1})	Before	I	51.48±2.24	4.01	0.52	56.63±5.42	-1.62	0.14	57.35±5.27	-0.97	0.36
		SI	69.62±3.92			70.84±6.91			64.81±5.63		
	After	I	51.17±2.21	4.62	0.25	51.67±4.80	-0.61	0.56	54.83±5.29	-0.92	0.38
		SI	70.53±3.56			56.08±5.42			61.84±5.41		
SGOT (IU dL^{-1})	Before	I	38.49±0.99	5.23	0.25	39.68±0.42	-5.66	0.00	38.92±0.85	-7.38	0.00
		SI	51.17±2.21			52.17±2.17			52.83±1.68		
	After	I	38.60±0.98	5.97	0.12	40.45±0.40	-6.38	0.00	39.60±0.80	-5.63	0.00
		SI	51.28±1.88			54.37±2.15			53.50±2.33		
SGPT (IU dL^{-1})	Before	I	6.87±0.12	0.10	1.00	6.98±0.07	-1.39	0.19	6.97±0.15	-0.07	0.95
		SI	7.07±0.25			7.17±0.11			6.98±0.19		
	After	I	6.83±0.09	0.10	1.00	7.15±0.04	-2.71	0.02	7.50±0.46	0.00	1.00
		SI	6.83±0.09			7.43±0.10			7.50±0.46		

**P<0.01, * P<0.05 P- value: Probability value; SE = Standard Error mean, GNC = Groundnut cake; MOLM = *Moringa olifera* leaf meal; The parameters were measured before and after feeding in both rearing systems

The PCV levels of lambs in T_1, T_2 and T_3 treatments were 22.33 ± 0.76, 24.92 ± 0.82, and 24.17 ± 0.31 and 21.83 ± 0.79, 23.55 ± 1.03, and 24.17 ± 0.31%, respectively, in intensive and semi-intensive systems of rearing. PCV uniformity demonstrated that both systems maintained adequate hydration, red cell volume, and overall circulatory health. Balanced moringa supplementation likely contributed in maintaining the PCV at healthy levels, consistent with Tambuwal *et al.* (2002) who found minimal effect of management system on PCV when diets were nutritionally adequate.

Biochemical parameters

Across all the treatments, total protein values were consistently higher in intensive system as compared to the semi-intensive system both before and after feeding. The difference was highly significant in T_3 ($p = 0.01$) before feeding and significant in T_2 ($p = 0.05$) over control. The total proteins were significantly reduced in T_3 after feeding, indicating a clearer nutritional advantage for lambs raised under intensive rearing system. The total protein concentration increased linearly with the age of lambs and the findings are in line with the Ramesh Kumar *et al* (2003). The superior values observed in T_2 group showed that high level of total protein is safe and beneficial, and not detrimental, because the levels of some chemical composition of moringa leaves are beneficial as they impact some qualities of rumen undegradable protein, thus improving protein availability and utilization (Garg *et al.*, 1992).

Albumin concentration followed almost similar pattern as that of total protein, and was consistently higher in intensive group across the treatments. The difference was significant in T_1 ($p = 0.03$) group before feeding as compared to T_2 and T_3 groups, whereas significantly higher values were observed after feeding ($p = 0.01$) in T_2 and T_3 groups. Albumin is a key indicator of long-term protein adequacy and hepatic protein synthesis. The lambs in semi-intensive system probably experienced variable forage availability and less consistent intake of Moringa-based feed, explaining their lower albumin values. Similar findings were reported by Moyo *et al.* (2011) who observed enhanced albumin levels in small ruminants supplemented with *Moringa oleifera* due to its high-quality amino acids. The values for serum albumin in present study were lower than the values reported by Karim and Varma (2000).

The concentration of glucose decreased non-significantly in group T_2 in comparison to T_1 and T_3 groups before and after the experiment in both rearing systems. The glucose values were in normal range (50-75 mg dL^{-1}) as per Dhanotiya (2004). The observations in the present study were in concurrence with Damor *et al.* (2017) and Sayed Ali *et al.* (2017) who noticed non-significant differences in serum glucose values in goat kids fed with different levels of Moringa leaves. It may be concluded that the observed decrease in serum glucose in group T_2 is not due to Moringa leaf meal intoxication but may be attributed to the dietary energy which was sufficiently utilized for growth and the animals were not surviving at the expense of body tissues.

The SGOT and SGPT are two important amino-transferase enzymes that catalyse the inter-conversion of amino groups and oxoacids by transfer of amino groups. Normal values of SGOT and SGPT are indicators of healthy functional liver. SGOT values were higher in semi-intensively managed lambs, with significant elevations in pre- and post-feeding, treatments T_2 and T_3. Higher SGOT levels in semi-intensive lambs may be attributed to increased muscular activity, grazing stress, or mild hepatic strain caused by grazing-associated plant metabolites. Boyd (1988) also observed rise in SGOT in response to muscular exertion and hepatic cell leakage. The lower levels in intensive lambs suggest that controlled feeding reduces metabolic stress and stabilizes liver function. SGPT values showed fewer differences between systems as compared to SGOT values. Post-feeding SGPT was significantly higher in semi-intensive lambs ($p = 0.02$) in T_2 group. SGPT remained largely within normal physiological limits under both the systems, revealing the absence of liver damage which confirmed that Moringa supplementation is non-hepatotoxic. A minor elevation in semi-intensive system reflects environmental stress rather than dietary influence. The hepatoprotective nature of Moringa, due to its antioxidant constituents, is well documented by Anwar *et al.* (2007).

Conclusion: The higher haematological counts and higher levels of blood bio-molecules in Deccani sheep suggest that feeding of moringa leaves as 25% replacement of GNC in intensive system is better as compared to the semi-intensive system of rearing. The study confirmed that Moringa feeding can help small and medium scale farmers in overcoming the shortage of quality feeds, thereby sustain/ improve their productivity.

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