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Effect of *Moringa oleifera* leaves feeding on hemato - biochemical profile of sirohi goat kids

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Abstract
A 6 months study was carried out to evaluate the effect of *Moringa oleifera* leaves feeding on hemato-biochemical profile of forty kids of Sirohi goat. They were randomly divided into five groups of eight in each group on the basis of same age and uniform conformation. The group T_1 offered 60% methi straw and 40% commercially available readymade concentrate and in groups T_2, T_3, T_4 and T_5, the commercially available readymade concentrate were replaced by *Moringa oleifera* leaves at 25%, 50%, 75% and 100% levels, respectively. The hemato-biochemical parameters were measured individually at the beginning and at 3 months and at 6 months. Results showed that the RBC were increased significantly ($p<0.05$) in T_5 ($14.35\pm0.31\times10^{12}$/L) whereas WBC were lowest in T_5 ($10.57\pm0.25\times10^{9}$/L) and highest in T_1 ($11.02\pm0.16\times10^{9}$/L) and hemoglobin (9.68±0.37 g/dl in T_1 and 10.58±0.31g/dl in T_5) and PCV (28.85±0.45% in T_1 and 29.92±0.55% in T_5) were improved by *Moringa oleifera* leaves diet. The serum total protein and serum albumin were increased significantly ($p<0.05$) in T_5 (6.84±0.06 g/dl) and (3.03±0.07g/dl), respectively. Serum globulin level (3.86±0.09 g/dl in T_5 and 3.69±0.11 g/dl in T_1) improved and serum glucose level (58.27±1.06 mg/dl in T_5) decreased by *Moringa oleifera* leaves diet. It was concluded that hematology and biochemical profile showed improvement when concentrate feed were replaced with 100% *Moringa oleifera* leaves in diet of sirohi goat kids. Thus, the *Moringa oleifera* leaves could be used to improve livestock system of small ruminant without any adverse effect on hemato-biochemical profile.

Keywords: Goat, moringa leaves, feed intake, hematology, biochemical profile

1. Introduction
India is predominantly an agricultural country, where livestock and agriculture are closely associated with each other. In spite of 2 per cent of geographical area, India has the pride of place on the livestock map of the world due to enormity of livestock wealth with amazing genetic diversity [1].

In India, there are 135.17 million goats, 26.40% of total livestock population out of which 16.03% goats found in the state of Rajasthan (Indian livestock census) [1]. India ranks first among the countries of the world in respect to goat population. Goat is most hardy animal and during draught and famine conditions the goat is the last animal to die. Goats are very adaptable and versatile animals and they can thrive on diverse types of grasses and tree leaves. It is also well known that goat is superior to other ruminants in efficiency of nutrient utilization (NBAGR) [2].

This huge population of livestock requires about 475 million tones dry fodder, 800 million tones green fodder and 78 million tones concentrates annually whereas one of the estimates indicates that there is availability of 358 million tons of dry fodder, 641 million tones of green fodder and 53 million tonesof concentrates to meet the nutritional demand of existing livestock strength Gorti *et al.*, [3]. In present scenario the acute shortage of feed and fodder existing to the tune of 32.05% for concentrate, 24.63% for dry fodder and 19.87% for green fodder appear to be worse. The situation seems to aggravate further, as probably no food grain would be spread for the feeding of livestock due to the ever-growing human population Jain AK [4].

A major constraint to animal production in developing countries is the scarcity and fluctuating quantity and quality of the year-round feed supply. These countries experience serious shortages in animal feeds of the conventional type Singh and Makkar [5]. Usually, farmers tried to feed their animals through crop residues and poor quality hay that are little in nitrogen, high in lingo-cellulose Sultana *et al.*, [6] and poor in vitamin and mineral contents, which leads to low digestibility and reduced voluntary intake Gerbregiorgis *et al.*, [7].

Poor quality roughages fed to ruminants without supplementation, especially during the dry season caused considerable weight losses and sometimes resulted in the death of the animals Tona *et al*., [8]. Utilization of fodder trees and shrubs could be a potential strategy for increasing the quality and availability of feeds for resource-limited livestock farmers during the dry season. The trees provide a good and cheaper source of protein and micronutrients Moyo *et al*., [9]. One of the abundantly available top feed resources, *Moringa oleifera* tree is a drought-tolerant, fast-growing, multi-purpose and one of most useful tree due to its medicinal and nutritional properties in world and therefore described as a 'miracle tree' Fuglie [10], Amaglo [11], Yisehak *et al.* [12], Ashfaq *et al*. [13]. On a dry matter basis, *Moringa oleifera* leaves contain 27.2% protein, 17.1% fat, 5.9% moisture and 38.6% carbohydrates. Yameogo *et al*. [14]. Moringa leaves also reduces blood pressure and cholesterol and acts as an anticancer, Antioxidant, antimicrobial, anti-atherosclerotic, anti-diabetic agents and neuro-protectant. Rockwood *et al*. [15], Mbikay [16], Fuglie [17], Ijarotimi *et al*. [18], Choudhary *et al*. [19], Jung [20]. Recently, focus has been given to the use of moringa leaf meal as a protein source and feed components in animal production especially in goats Sarwatt *et al*. [21], Asaolu *et al*. [22], Moyo *et al*. [9], Sultana *et al*. [23]. Various studies conducted shown that feeding of moringa leaves in diet of goats, sheep and cattle influenced blood metabolites Khalel *et al*. [24], Kholif *et al*. [25], Azzaz *et al*. [26]. Keeping the aforesaid facts in view, the present investigation was planned to find out the possibilities of utilization of *Moringa oleifera* leaves feeding on hematological and biochemical profile of sirohi goat kids.

2. Materials and Method

A six months study was carried out on forty post-weaned kids of Sirohi goat of same age and uniform conformation were selected from the Livestock Research Station, Bojunda, Chittorgarh. They were allocated into five groups with eight kids per treatment using completely randomized block design. All the experimental kids were housed separate from other animals in well ventilated and protected shed and provided individual feeder and water buckets. All kids were managed under standard caring, feeding and management practices. The kids were allowed 10 days of adjustment period prior to experimental feeding. All the Experimental kids were dewormed at the beginning of experiment by using Albendazole as an anthelmintic and were examined periodically for parasitic infestation. Kids did not show any symptoms of clinical ailment or external injury and were looked quite healthy during whole experimental period. Methi straw (*Trigonella foenum-graecum*) were used as a roughage, commercially available readymade feed were used as a concentrate feed and *Moringa oleifera* dry leaves were used as a experimental feed for feeding of sirohi goat kids. *Moringa oleifera* leaves were harvested from the moringa plots of the Livestock Research Station, Bojunda, Chittorgarh. The collected moringa leaves were sun dried on thick plastic sheets and used for feeding. The group T_1 offered roughage and commercially available readymade concentrate feed in ratio of 60:40 and groups T_2, T_3, T_4 and T_5, the readymade concentrate feed were replaced by *Moringa oleifera* leaves at 25%, 50%, 75% and 100% levels, respectively. Feeding trials of Twenty six weeks were conducted for all the treatment groups. Various haemato-biochemical parameters *viz.*, WBC count, RBC count, Hemoglobin, PCV, Serum glucose, Serum Protein, Serum Albumin, Serum Globulin were determined as per Feldman *et al*. [38]. Blood sample were collected through jugular vein in an aseptic manner before feeding and watering from the experimental goat kids at beginning (0 day), at mid (3rd month) and at end of experiment (6th month). Hematological studies *viz.*, WBC count, RBC count, Hemoglobin, PCV was performed soon after collection of blood with the help of auto hematology analyzer (Model no. BC-2800Vet, Mindray). For blood biochemical study, blood was collected in tube without anticoagulant and kept in slanting position for separation of serum. These tubes were incubated for 1 hour at 37^0 C. Tubes were centrifuged at 2500 rpm for 30 minutes. The separated serum was pipetted out in small pyrex tubes and stored in deep freezed at -20^0 C for further analysis. The blood biochemical parameters were analyzed using commercial kits (CPC Diagnostic Pvt. Ltd.) in auto analyzer (Turbochem 100, chemistry analyzer, model 4601). The chemical composition of feed ingredients and experimental diet were analyzed according to standard procedure of the AOAC [27].

3. Statistical analysis

The data were statistically analyzed using Analysis of variance as per Snedecor and Cochran [28] for interpretation of the results. The differences in the means will be compared by Least Significant Differences (LSD) at 5 per cent level ($P<0.05$).

4. Results and Discussion

4.1 Chemical composition of feed ingredients

The percent chemical composition of methi straw, readymade concentrate and *Moringa oleifera* dried leaves on dry matter basis has been presented in Table 1.

Table 1: Percent chemical composition of experimental diet

Nutrients	Feed ingredients		
	Methi straw	Readymade concentrate	*Moringa oleifera* dried leaves
DM	93.88	89.00	85.69
OM	90.79	91.84	90.24
CP	09.68	20.00	23.31
EE	01.80	04.00	04.70
CF	38.26	10.00	09.26
NFE	41.05	57.84	52.97
TA	09.21	08.16	09.76

The dry matter, organic matter, crude protein, ether extract, crude fibre, nitrogen free extract and total ash in the methi straw were 93.88, 90.79, 9.68, 1.80, 38.26, 41.05 and 9.21 percent, respectively, in the readymade concentrate were 89, 91.84, 20, 4, 10, 57.84 and 8.16 percent, respectively and in the *Moringa oleifera* leaves were 85.69, 90.24, 23.31, 4.7, 9.26, 52.97 and 9.76 percent, respectively. The crude protein content of *Moringa oleifera* leaves used in the study was comparable with the values 25.95, 22.6, 29.7, 23.24, 29.14 and 26.3% obtained by Manh *et al.* [29], Sánchez *et al.* [30], Fadiyimu *et al.* [31], Jiwuba *et al*. [32], Oyedele *et al.* [33] and Damor *et al.* [34], respectively, but higher than the values 19.3, 19.5, 18.26 and 20.56% reported by Aregheore [35], Kakengi *et al*. [36], Sultana *et al*. [23 and Ali S. B. [37], respectively. The variations in nutritive value of *Moringa oleifera* could be due to the age of harvest, soil type and fertility, proportion of leaf and stem and agroecological zone where trees are growing.

4.2 Chemical composition of experimental diet

The percent chemical composition of experimental diets of different groups on dry matter basis has been presented in Table 2.

Table 2: Chemical composition of experimental diet (%DM basis)

Nutrients	T_1	T_2	T_3	T_4	T_5
DM	91.928	91.597	91.266	90.935	90.604
OM	91.21	91.05	90.89	90.73	90.57
CP	13.808	14.139	14.542	14.873	15.204
EE	02.68	02.75	02.82	02.89	02.96
CF	26.956	26.882	26.808	26.734	26.66
NFE	47.766	47.279	46.792	46.305	45.818
TA	08.79	08.95	09.11	09.27	09.43

The dry matter, organic matter, crude protein, ether extract, crude fibre, nitrogen free extract and total ash were 91.928, 91.21, 13.808, 2.68, 26.956, 47.766 and 8.79%, respectively in group T1 diet, 91.597, 91.05, 14.139, 2.75, 26.882, 47.279 and 8.95%, respectively in group T2 diet, 91.266, 90.89, 14.542, 2.82, 26.808, 46.792 and 9.11%, respectively in group T3 diet, 90.935, 90.73, 14.873, 2.89, 26.734, 46.305 and 9.27%, respectively in group T4 diet and 90.604, 90.57, 15.204, 2.96, 26.66, 45.818 and 9.43%, respectively in group T5 diet. The chemical composition of experimental diet for all groups was nearly similar in term of protein contents.

4.3 Hematological profile

4.3.1 White Blood Cell count (WBC)

Blood examination of WBC values was recorded at 0 day, 3rd month and 6th month of the study by using auto hematology analyzer. The findings of WBC values in the groups are presented in Table 3 and analysis of variance is presented in Table 4.

Table 3: Average White Blood Cell count ($\times 10^9$/L) in experimental goat kids

Period	Treatment Groups					Significance
	T1	T2	T3	T4	T5	
0 Day	10.06±0.27	10.24±0.57	10.25±0.28	10.59±0.39	10.21±0.44	NS
3 Month	11.01±0.49	10.95±0.37	10.89±0.28	10.78±0.55	10.05±0.49	NS
6 Month	11.99±0.33	11.60±0.32	11.48±0.31	11.29±0.50	10.93±0.30	NS
Mean±SE	11.02±0.16	10.93±0.33	10.87±0.16	10.88±0.22	10.57±0.25	NS

NS Non-significant difference ($p<0.05$)

Table 4: Analysis of variance of overall White Blood Cell (WBC) Count

Source of variance	Df	SS	MSS	F – value
Treatment	4	2.8125	0.703125	0.4967
Error	115	162.8054	1.415699	

The overall mean of WBC values were 11.02±0.16, 10.93±0.33, 10.87±0.16, 10.88±0.22 and 10.57±0.25 ($\times 10^9$/L) in treatment groups T_1, T_2, T_3, T_4 and T_5, respectively which was statistically non-significant ($p<0.05$). Highest average WBC count was found in goat kids fed with T_1 diet while the lowest was found in goat kids fed with T_5 diet. In present study, WBC values ranged between 10.06 and 11.99 ($\times 10^9$/L) and fell within the normal physiological range reported by Feldman *et al.* [38] for goats. The normal values of WBC obtained in this study suggested well developed immune system of the goats in different dietary groups with the lowest and highest values obtained in diet T1 and T5, respectively.

The results obtained in present findings are in agreement with Adegun *et al.* [36], who reported higher WBC values in control group than experimental group fed moringa. However, the present findings are in disagreement with the observations made by Babekar and Bdalbagi [40], Jiwuba *et al.* [32] and Ali S. B. [37] who reported significant increase in WBC values in goats fed Moringa leaves in goat ration.

4.3.2 Red Blood Cell count (RBC)

Blood examination of RBC values was recorded at 0 day, 3rd month and 6th month of the study by using auto hematology analyzer. The findings of RBC values in the groups are presented in Table 5 and analysis of variance is presented in Table 6.

Table 5: Average Red Blood Cell count ($\times 10^{12}$/L) in experimental goat kids

Period	Treatment groups					Significance
	T1	T2	T3	T4	T5	
0 Day	12.00±0.64	12.23±0.61	12.51±0.80	12.18±0.62	12.04±0.54	NS
3 Month	12.33±0.61	13.65±0.69	13.86±0.75	14.78±0.46	14.88±0.59	*
6 Month	13.41±0.61	14.78±0.54	15.35±0.72	15.58±0.52	16.11±0.51	*
Mean±SE	12.58±0.37^a	13.55±0.35^a	13.91±0.46^b	14.18±0.36^b	14.35±0.31^b	*

* Significant difference ($p<0.05$) NS Non-significant difference

Table 6: Analysis of variance of overall Red Blood Cell (RBC) Count

Source of variance	Df	SS	MSS	F – value
Treatment	4	47.19408	11.79852	2.648485
Error	115	512.3042	4.454819	

The overall mean of RBC count were 12.58±0.37, 13.55±0.35, 13.91±0.46, 14.18±0.36 and 14.35±0.31 ($\times 10^{12}$/L) in treatment groups T_1, T_2, T_3, T_4 and T_5, respectively. Highest average RBC was found in goat kids fed with T_5 diet while the lowest was found in goat kids fed with T_1 diet. The statistical analysis of data as shown in table 5 revealed significant ($p<0.05$) effect of treatments. The Group T_5 was shown statistically significant ($p<0.05$) difference with T_1 whereas the difference between T_5, T_4, T_3 and T_2 were non-significant and difference between T_1, T_2, T_3 and T_4 were also non-significant. In present study, RBC values ranged between 12.00 to 16.11 ($\times 10^{12}$/L) and fell within the normal physiological range reported by Feldman *et al.* [38] for goats. The normal values of RBC obtained in this study suggested that the diets supported good health status of the goats and hence the goats were not anaemic.

The results obtained in present findings are in agreement with Adegun *et al*. [39]), Babekar and Bdalbagi [40] and Jiwuba *et al.* [32] who reported significantly increase in RBC values in goat fed moringa leaves by replacing concentrate mixture. However, the present findings are in disagreement with the observations made by Ali S. B. [37] who reported non-significant difference in RBC values in goats fed Moringa leaves in goat ration.

4.3.3 Hemoglobin (Hb)

Blood examination of hemoglobin concentration was recorded at 1st day, 3rd month and 6th month of the study by using auto hematology analyzer. The findings of hemoglobin concentration in the groups are presented in Table 7 and analysis of variance is presented in Table 8.

Table 7: Average Hemoglobin Concentration (g/dl) in experimental goat kids

Period	Treatment Groups					Significance
	T1	T2	T3	T4	T5	
0 Day	9.53±0.65	9.4±0.33	09.8±0.42	10±0.34	10.01±0.36	NS
3 month	9.64±0.88	10.13±0.48	10.2±0.42	10.38±0.31	10.39±0.34	NS
6 Month	9.89±0.39	10.65±0.33	10.84±0.25	11.09±0.23	10.99±0.21	*
Mean±SE	9.68±0.37	10.06±0.35	10.28±0.46	10.45±0.36	10.58±0.31	NS

* Significant difference (p<0.05) NS Non-significant difference

Table 8: Analysis of variance of overall Hemoglobin Concentration

Source of variance	Df	SS	MSS	F – value
Treatment	4	8.429167	2.107292	0.77544
Error	115	312.5175	2.717543	

The overall mean of Hemoglobin were 9.68±0.37, 10.06±0.35, 10.28±0.46, 10.45±0.36 and 10.58±0.31% in treatment groups T_1, T_2, T_3, T_4 and T_5, respectively which was statistically non-significant (p<0.05). Highest average Hb was found in goat kids fed with T_5 diet while the lowest was found in goat kids fed with T_1 diet. The statistical analysis of data as shown in table 7 revealed non-significant (p<0.05) effect of treatments in 0 day and 3 month whereas significant in 6 month. The Hb values tended to increase with the increasing levels of the test ingredient. The values obtained, were also within the normal physiological range reported by Feldman *et al*. [38] for goats. This is an advantage as these diets seemed to be capable of supporting high oxygen carrying capacity of blood in these animals.

The results obtained in present findings are in agreement with Jiwuba *et al.* [32] and Ali S. B. [37] who reported non-significant difference in Hb values in goat fed moringa leaves by replacing concentrate mixture. However, the present findings are in disagreement with the observations made by Babekar and Bdalbagi [40]) who reported significant difference in Hb values in goats fed Moringa leaves in goat ration.

4.3.4 Packed Cell Volume (PCV)

Blood examination of PCV was recorded at 0 day, 3rd month and 6th month of the study by using auto hematology analyzer. The findings of PCV values in the groups are presented in Table 9 and analysis of variance is presented in Table 10.

Table 9: Average Packed Cell Volume (%) in experimental goat kids

Period	Treatment groups					Significance
	T1	T2	T3	T4	T5	
0 Day	27.25±0.78	27.35±0.62	28.08±0.86	28.1±0.75	28.03±0.94	NS
3 Month	29.23±0.94	29.51±0.83	30.05±0.58	30.13±0.81	30.19±0.94	NS
6 Month	30.09±0.93	30.66±0.61	31.11±0.62	31.4±0.70	31.54±0.98	NS
Mean±SE	28.85±0.45	29.18±0.36	29.75±0.50	29.88±0.44	29.92±0.55	NS

NS Non-significant difference (p<0.05)

Table 10: Analysis of variance of overall Packed Cell Volume

Source of variance	Df	SS	MSS	F – value
Treatment	4	21.51617	5.379042	0.8184
Error	115	755.8225	6.57237	

The overall mean of PCV were 28.85±0.45, 29.18±0.36, 29.75±0.50, 29.88±0.44 and 29.92±0.55% in treatment groups T_1, T_2, T_3, T_4 and T_5, respectively which was statistically non-significant (p<0.05). Highest average PCV was found in goat kids fed with T_5 diet while the lowest was found in goat kids fed with T_1 diet. The statistical analysis of data as shown in table 9 revealed non-significant (p<0.05) effect of treatments. In present study, PCV values ranged between 27.25 to 31.54% and fell within the physiological range 22 to 38% reported by Krammer [41] for goats. Normal PCV values obtained in this study suggested that the treatment diets were nourished, non-toxic and influenced adequate blood supply.

The results obtained in present findings are in agreement with Ali S. B. [37] who reported non-significantly difference in PCV values in goat fed moringa leaves by replacing concentrate mixture. However, the present findings are in disagreement with the observations made by Asaulo *et al*. [22], Babekar and Bdalbagi [40] and Jiwuba *et al.* [32] who reported significant difference in PCV values in goats fed Moringa leaves in goat ration.

4.4 Biochemical profile

4.4.1 Serum Glucose

Serum glucose was recorded at 0 day, 3rd month and 6th month of the study by using auto analyzer. The findings of Serum glucose values in the groups are presented in Table 11 and analysis of variance is presented in Table 12.

Table 11: Average serum glucose (mg/dl) in experimental goat kids

Period	Treatment Groups					Significance
	T1	T2	T3	T4	T5	
0 Day	56.78±1.63	57.62±1.38	57.32±1.22	57.16±1.96	58.07±1.83	NS
3 Month	59.28±1.55	59.22±1.93	59.02±2.86	58.75±2.57	58.32±1.01	NS
6 Month	61.19±1.97	60.78±2.24	59.78±1.01	58.88±1.29	58.43±0.89	NS
Mean±SE	59.08±0.94	59.21±0.80	58.71±0.70	58.26±1.13	58.27±1.06	NS

=* Significant difference (p<0.05) NS Non-significant difference

Table 12: Analysis of variance of overall serum glucose

Source of variance	Df	SS	MSS	F – value
Treatment	4	18.58645	4.646613	0.1894
Error	115	2821.695	24.53647	

The overall mean of serum glucose values were 59.08±0.94, 59.21±0.80, 58.71±0.70, 58.26±1.13 and 58.27±1.06 mg/dl under treatment groups T_1, T_2, T_3, T_4 and T_5 respectively which was statistically non-significant (p<0.05). The average serum glucose values in all the groups were in normal range (50-75mg/dl) of goats, which reported by Kaneko *et al.*[43] The low glucose level observed indicates that it is suitable for human diabetic consumption, as the presence of flavonoid also correlates with the reports of Farooq *et al.* [42] who stated that the *M. oleifera* plant is one of the highly potential antidiabetic plants, probably because of the presence of the ability of its compounds and some flavonoids to inhibit a-amlylase activity to regulate the amount of glucose in the blood.

The results obtained in present study are in agreement with Damor *et al.* [34], Ali S. B. [37] who reported non-significant difference in serum glucose values in goat fed moringa leaves by replacing concentrate mixture. However, the present findings are in disagreement with the observations made by Babekar and Bdalbagi [40] who reported significant decrease in serum glucose values in goats fed Moringa leaves at 20% in goat ration.

4.4.2 Serum Total Protein

Serum total protein was recorded at 0 day, 3rd month and 6th month of the study by using auto analyzer. The findings of Serum total protein values in the groups are presented in Table 13 and analysis of variance is presented in Table 14.

Table 13: Average serum total protein (g/dl) in experimental goat kids

Period	Treatments Groups					Significance
	T1	T2	T3	T4	T5	
0 Day	6.11±0.14	6.16±0.08	6.18±0.13	6.13±0.07	6.15±0.11	NS
3 Month	6.24±0.25	6.41±0.77	6.64±0.23	6.79±0.11	6.93±0.11	*
6 Month	6.64±0.19	6.83±0.23	7.09±0.18	7.20±0.14	7.44±0.13	*
Mean±SE	6.33±0.08^{a}	6.47±0.05^{ab}	6.63±0.08^{ab}	6.70±0.04^{ab}	6.84±0.06^{b}	*

* Significant difference (p<0.05) NS Non-significant difference

Table 14: Analysis of variance of overall serum total protein

Source of variance	Df	SS	MSS	F – value
Treatment	4	3.797417	0.949354	2.9035
Error	115	37.60156	0.32697	

The overall mean of serum total protein values were 6.33±0.08, 6.47±0.05, 6.63±0.08, 6.70±0.04 and 6.84±0.06 g/dl under treatment groups T_1, T_2, T_3, T_4 and T_5 respectively. The statistical analysis of data as shown in Table 13 revealed significant (p<0.05) effect of treatments. The Group T_5 was shown statistically significant (p<0.05) difference with T_1 whereas the difference between T_5, T_4, T_3 and T_2 were non-significant and difference between T_1, T_2, T_3 and T_4 were also non-significant. The highest level of serum total protein was observed in T_5 and lowest in T_1. The higher serum protein levels observed in the present study may be due to higher protein content of Moringa leaves than the concentrate feed. The serum total protein values in all the groups were in normal range of goats, which reported by Kaneko *et al.* [43]. The high level of total protein is safe, beneficial and not detrimental. Moringa leaves are good protein source that is a convenient substitute of some meals (soybean and rapeseed) for ruminants

The results obtained in present study are in agreement with Babekar and Bdalbagi [40] and Damor *et al.* [34], who reported significant difference in serum total protein values in goat fed moringa leaves by replacing concentrate mixture. However, the present findings are in disagreement with the observations made by Ali S. B. [37] who reported non-significant difference in serum total protein values in goats fed Moringa leaves.

4.4.3 Serum Albumin

Serum albumin was recorded at 0 day, 3rd month and 6th month of the study by using auto analyzer. The findings of Serum albumin values in the groups are presented in Table 15 and analysis of variance is presented in Table 16.

Table 15: Average serum albumin (g/dl) in experimental goat kids

Period	Treatment Groups					Significance
	T1	T2	T3	T4	T5	
0 Day	2.48±0.07	2.55±0.13	2.53±0.11	2.46±0.08	2.49±0.12	NS
3 Month	2.56±0.08	2.74±0.14	2.85±0.12	2.99±0.06	3.03±0.08	*
6 Month	2.86±0.09	3.00±0.14	3.11±0.10	3.26±0.12	3.43±0.08	*
Mean±SE	2.73±0.04^{a}	2.85±0.08^{ab}	2.92±0.06^{ab}	2.94±0.05^{ab}	3.03±0.07^{b}	*

* Significant difference (p<0.05) NS Non-significant difference

Table 16: Analysis of variance of overall serum albumin

Source of variance	Df	SS	MSS	F – value
Treatment	4	1.695333	0.423833	2.6478
Error	115	18.40833	0.160072	

The overall mean of serum albumin values were 2.73±0.04, 2.85±0.08, 2.92±0.06, 2.94±0.05 and 3.03±0.07 g/dl under treatment groups T_1, T_2, T_3, T_4 and T_5 respectively. The serum albumin values in all the groups were in normal range of goats, which reported by Kaneko *et al.* [43] The statistical analysis of data as shown in table 15 revealed significant ($p<0.05$) effect of treatments. The Group T_5 was shown statistically significant ($p<0.05$) difference with T_1 whereas the difference between T_5, T_4, T_3 and T_2 were non-significant and difference between T_1, T_2, T_3 and T_4 were also non-significant. The highest level of serum albumin was observed in T_5 and lowest in T_1. The higher serum albumin levels observed in the present study may be due to higher albumin content of Moringa leaves than the concentrate feed. The high level of serum albumin is safe, beneficial and not detrimental. The results obtained in present study are in agreement with Babekar and Bdalbagi [40], Damor *et al.* [34], who reported significant difference in serum albumin values in goat fed moringa leaves by replacing concentrate mixture. However, the present findings are in disagreement with the observations made by Ali S. B. [34] who reported non-significant difference in serum albumin values in goats fed Moringa leaves.

4.4.4 Serum Globulin

Serum globulin was recorded at 0 day, 3rd month and 6th month of the study by using auto analyzer. The findings of Serum globulin values in the groups are presented in Table 17 and analysis of variance is presented in Table 18.

Table 17: Average serum globulin (g/dl) in experimental goat kids

Period	Treatment Groups					Significance
	T1	T2	T3	T4	T5	
0 Day	3.64±0.19	3.61±0.15	3.65±0.13	3.66±0.14	3.66±0.15	NS
3 Month	3.68±0.30	3.68±0.14	3.79±0.25	3.8±0.13	3.9±0.12	NS
6 Month	3.78±0.14	3.83±0.23	3.98±0.24	3.94±0.19	4.01±0.16	NS
Mean±SE	3.69±0.11	3.70±0.09	3.80±0.07	3.80±0.08	3.86±0.09	NS

* Significant difference ($p<0.05$) NS Non-significant difference

Table 18: Analysis of variance of overall serum globulin

Source of variance	Df	SS	MSS	F – value
Treatment	4	0.464583	0.116146	0.4424
Error	115	30.1899	0.262521	

The overall mean of serum globulin values were 3.69±0.11, 3.70±0.09, 3.80±0.07, 3.80±0.08 and 3.86±0.09 g/dl under treatment groups T_1, T_2, T_3, T_4 and T_5 respectively which was statistically non-significant ($p<0.05$). The highest level of serum albumin was observed in T_5 and lowest in T_1. The average serum globulin values in all the groups were in normal range of goats, which reported by Kaneko *et al.* [43].
The results obtained in present study are in agreement with Ali S. B. [37] who reported non-significant difference in serum globulin values in goat fed moringa leaves by replacing concentrate mixture.

5. Conclusion

From the present study, it can be concluded that hematology and biochemical profile showed improvement when concentrate feed was replaced with 100% *Moringa oleifera* leaves in diet of sirohi goat kids. Replacing the concentrate feed with *Moringa oleifera* leaves in diet of growing Sirohi goat kids increased RBC, Hemoglobin, PCV, serum total protein, albumin and globulin level while decreased serum glucose level. The study revealed that the *Moringa oleifera* leaves could be used to improve livestock system of small ruminant without any adverse effect on hemato-biochemical profile.

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7. References

1. Indian Livestock Census. 19th Livestock Census, 2012. www.dahd.nic.in. 2012.
2. NBAGR: National Bureau of Animal Genetic Resources, 2016. www.nbagr.res.in
3. Gorti RK, Suresh KP, Sampath KT, Giridhar K, Anandan S. Modeling and forecasting livestock and fish feed resources: Requirement and availability in India. National Institute of Animal Nutrition and Physiology, Bangalore, 2012.
4. Jain AK. Evaluation of herbal products as feed additives on nutrient utilization efficiency in Marwari goat. M.V.Sc. Thesis submitted to RAJUVAS, Bikaner, Rajasthan, 2013.
5. Singh B, Makkar HPS. The potential of mulberry tree foliage as an animal feed supplement in India, 2014. https://www.researchgate.net/Publication/237519606.
6. Sultana N, Alimon AR, Haque KS, Sazili AQ, Yaakub H, Hossain SM. The effect of cutting interval on yield and nutrient composition of different plant fraction of *Moringa oleifera* tree. Journal of Food Agricultural Environment. 2014; 12(2):599-604.
7. Gebregiorgis F, Negesse T, Nurfeta A. Feed intake and utilization in sheep fed graded levels of dried moringa (*Moringa stenopetala*) leaf as a supplement to Rhodes grass hay. Tropical Animal Health Production. 2012; 44(3):511-17.
8. Tona GO, Ogunbosoye DO, bakare BA. Growth performance and nutrient digestibility of west African dwarf goats fed graded levels of *Moringa oleifera* leaf meal. International Journal of Current Microbiol Applied Science. 2014; 3(8):99-106.

9. Moyo B, Patrick JM, Muchenje V. Effect of supplementing crossbred Xhosa lop-eared goat castrates with *Moringa oleifera* leaves on growth performance, carcass and non-carcass characteristics. Tropical Animal Health Production. 2012; 44:801-809.
10. Fuglie LJ. The Moringa trees a local solution to malnutrition. Dakar, Senegal, 2003.
11. Amaglo N. Moringa and other highly nutritious plant resources: Strategies, standard and markets for a better impact on nutrition in Africa. Accra, Ghana, 2006.
12. Yisehak K, Solomon M, Tadelle M. Contribution of Moringa (Moringa stenopetala, Bac.) a Highly Nutritious Vegetable Tree, for Food Security in South Ethiopia: A Review. Asian Journal of Applied Sciences. 2011; 4:477-488.
13. Ashfaq M, Basra SMA, Ashfaq U Moringa. A miracle plant of agroforestry. Journal of Agriculture and Social Science. 2012; 8:115-122.
14. Yameogo CW, Bengaly MD, Savadogo A, Nikiema PA, Traore SA. Determination of chemical composition and nutritional values *Moringa oleifera* leaves. Pakistan Journal of Nutrition. 2011; 10:264-268.
15. Rockwood JL, Anderson BG, Casamatta DA. Potential uses of *Moringa oleifera* and an examination of antibiotic efficacy conferred by *Moringa oleifera* seed and leaf extracts using crude extraction techniques available to underserved indigenous populations. International Journal of Phytothearpy Research. 2013; 3:61-71.
16. Mbikay M. Therapeutic potential of *Moringa oleifera* leaves in chronic hyperglycemia and dyslipidemia: a review, Front. Pharmacol. 2012; 3:1-12.
17. Fuglie LJ. The Moringa tree: A local solution to malnutrition; Church World Service in Senegal, 2005.
18. Ijarotimi OS, Adeoti O, Ariyo O. Comparative study on nutrient composition, phytochemical and functional characteristics of raw, germinated and fermented *Moringa oleifera* seed flour. Food Sci Nutr. 2013; 1:452-463.
19. Choudhary MK, Bodakhe SH, Gupta SK. Assessment of the antiulcer potential of *Moringa oleifera* root-bark extract in rats. Journal of Acupuncture Meridian Studied. 2013; 6:214-220
20. Jung IL. Soluble extract from *Moringa oleifera* leaves with a new anticancer activity. PLOS ONE. 2014; 9:1-10.
21. Sarwatt SV, Milangha MS, Lekule FP, Madalla N. *Moringa oleifera* and cottonseed cake as supplements for smallholder dairy cows fed Napier grass. Livestock Research for Rural Development. 2004; 16(6).
22. Asaolu VO, Binuomote R, Akinlade J, Aderinola O, Oyelami O. Intake and growth performance of West African Dwarf goats fed *Moringa oleifera*, *Gliricidia sepium* and *Leucaena leucocephala* dried leaves as supplements to Cassava Peels. Journal of Biology, Agriculture and Health Care. 2012; 2(10):76-88.
23. Sultana N, Alimon AR, Huque KS, Sazili AQ, Yaakub H, Hossain J et al. The feeding value of Moringa (*Moringa oleifera*) foliage as replacement to conventional concentrate diet in Bengal goats. Advance Animal and Veterinary Sciences. 2015b; 3(3):164-173.
24. Khalel MS, Shwerab AM, Hassan AA, Yacout MH, El-Badawi AY, Zaki MS. Nutritional evaluation of *Moringa oleifera* fodder in comparison with *Trifolium alexandrinum* (Berseem) and impact of feeding on lactation performance of cows. Life Science Journal. 2014; 11(10):1040-1054.
25. Kholif AE, Gouda GA, Moray TA, Salem AZM, Lopez S, Kholif AM. *Moringa oleifera* leaf meal as a protein source in lactating goat's diets: Feed intake, digestibility, ruminal fermentation, milk yield and composition and its fatty acids profile. Small Ruminant Research, 2015; DOI: http://dx.doi.org/10.1016/ j.smallrumres, 2015.05.007.
26. Azzaz HH, Eman SA, Morsy TA, Aziz HA, Fatma IH, Abd-Alla MS. *Moringa oleifera* and *Echinacea purpurea* as supplements for Rhamani lactating ewe's diets and their effect on rumen characteristics, nutrients digestibility, blood parameters, milk production, composition and its fatty acid profile. Asian Journal of Animal and Veterinary Advances. 2016; 11(11):684-692.
27. AOAC. Official methods of analysis 15th ed., Association of Analytical Chemista, Washington, D.C, 2005.
28. Snedecor GW, Cochran WC. Statistical methods, 8th edn.; The Lowa State University Press, Ames, Lowa, USA, 1994.
29. Manh LH, Dung NNX, Ngoi TP. Introduction and evaluation of *Moringa oleifera* for biomass production and as feed for goats in the Mekong Delta. Livestock Research for Rural Development. 2005; 17(9). Retrieved from http://www.lrrd.org/ lrrd17/9/manh17104.htm.
30. Sànchez RN, Spörndly E, Ledin I. Effect of feeding different levels of foliage of *Moringa oleifera* to creole dairy cows on intake, digestibility, milk production and composition. Livestock Science. 2006; 101(1-3):24-31.
31. Fadiyimu AA, Julias AA, Fajemisin AN. Digestibility, nitrogen balance and haematological profile of West African Dwarf sheep fed dietary levels of *Moringa oleifera* as supplement to Panicum maximum. Journal of Animal Science. 2010; 6(10):634-643.
32. Jiwuba PDC, ahamefule FO, Okechukwu OS, ikwunze K. Feed intake, body weight changes and haematology of west African dwarf goats fed dietary levels of *Moringa oleifera* leaf meal. Agricultura. 2016; 13(1, 2):71-77. DOI: 10.1515/agricultura-2017-0009.
33. Oyedele OJ, Asalou VO, Odeyinka SM. Nutrient digestibility and growth performance of west African dwarf (WAD) goats fed foliage combinations of *Moringa oleifera* and gliricidia sepium with equal proportions of a low – cost concentrate. Journal of Natural Sciences Research. 2016, 18. ISSN 2224-3186 (Paper). ISSN 2225-0921 (online).
34. Damor SV, Pawar MM, Ankuya KJ, Gami YM, Srivastava AK, Chauhan HD *et al*. Effect of replacing concentrate mixture with Moringa (*Moringa oleifera*) leaves on blood biochemical and mineral profile of mehsana goat kids. Life Science Leaflets. 2017; 89:28-35. Print : ISNN 2277-4297, 0976-1098.
35. Aregheore EM. Intake and digestibility of *Moringa oleifera*–batiki grass mixtures by growing goats. Small Ruminant Research. 2002; 46:23-28.
36. Kakengi AMV, Shem MN, Sarwatt SV, Fujihara T. Can *Moringa oleifera* be used as a protein supplement for ruminants. Asian-Australian Journal of Animal Science. 2005; 18(1):42-47.
37. Ali SB. Growth performance of goats fed *Moringa oleifera* leaf meal incorporated in concentrate mixture. MVSC thesis submitted to Maharashtra Animal and Fishery Sciences University, Nagpur, 2017.
38. Feldman BF, Zinki JG, Jain NC. Schalm's veterinary hematology. Philadelphia. 2000, 1344-1348.

39. Adegun MK, Aye PA, Dairo FAS. Evaluation of *Moringa oleifera*, Gliricidia sepium and Leucaena leucocephala based multinutrient blocks as feed supplements for sheep in South Western Nigeria, Agriculture and Biology Journal of North America. 2011; 2(11):1395-1401.
40. Babeker EA, Bdalbagl YMA. Effect of feeding different levels of *Moringa oleifera* leaves on performance, hematological, biochemical and some physiological parameters of Sudan Nubian goats. Online Journal of Animal and Feed Research. 2015; 5(2):50-61.
41. Kramer JW. Normal hematology of cattle, sheep and goat. In Schlam's veterinary hematology. Ed 5th, Philadephia, Williams and Wilkins, 2000.
42. Farooq A, Sajid L, Muhammad A, Anwarul-Hassan G. *Moringa oleifera*: A food plant with multiple medicinal uses. Phytotherapy Research. 2007; 21:17-25.
43. Kaneko JJ, Harvey JW, Bruss ML. Clinical Biochemistry of Domestic Animals. 5th Ed., Harcourt Brace and Company Asia Pvt. Ltd., Academic press, USA. 1997, 890-893.