***Original Research Article***

**Effect of *Moringa oleifera* leaf powder (MOLP) supplementation on haematological profile in transition Osmanabadi goats**

**ABSTRACT**

**Aims**: The present study aimed at investigating the effect of feeding *Moringa oleifera* leaf powder (MOLP) on different haematological parameters during pregnancy in Osmanabadi goats at COVAS, Udgir, dist. Latur (Maharashtra state).

**Study design**: A total of 16 pregnant goats were randomly divide into two groups, comprising 6 animals each. Control (concentrate mixture without MOLP) and 20% MOLP supplemented group (concentrate mixture + 20% MOLP) /animal/day.

**Place and Duration of Study**: Experimental animals were selected and fed on standard ration and supplements with MOLP at Livestock Farm Complex, College of Veterinary and Animal Sciences, Udgir. Dept of Veterinary Biochemistry, from July- October, 2024.

**Methodology**: The experiment started after confirmation of pregnancy (1 month) till 2 weeks post parturition. Haematological parameters (haemoglobin, PCV, TEC, TLC, DLC, MCV and MCH) were measured and recorded individually at beginning of the experiment, on 60th day and postpartum 7th day.

**Results**: The results of study revealed that haemoglobin, PCV and TEC showed no significant difference in all experimental groups. The MOLP supplementation resulted into significant (P<0.05) improvement in TLC values on 60th day in contrast to the control group. The DLC (granulocytes, lymphocytes) values were found highly significant (P<0.05) in MOLP supplemented group on 60th day and postpartum 7th day, however, the monocytes values did not differ significantly among the experimental groups. The values of MCV showed no significance difference in all experimental groups. The MCH concentration showed no significance, but the values were higher than the normal range in all experimental groups.

**Conclusion**: The significant increase in granulocytes and lymphocyte counts could be attributed to enhanced immune response during pregnancy and 7th day partum stage in animals. The significant increase in total leucocyte count during pregnancy might be associated with enhanced phagocytosis against infectious diseases. Feeding of MOLP did not affect blood profile in pregnant Osmanbadi goats.

 **Keywords**: Moringa oleifera leaves, pregnancy, Osmanabadi goats, haematological parameters and

 transition stage

1. **INTRODUCTION**

Livestock play an important role in the economy, both at the farm and national levels. 12 percent of the world's population depends solely on livestock for its livelihood.

Amongst the indigenous breeds of caprines, the Osmanabadi breed is recognized as one of the most significant indigenous goat varieties, deriving its nomenclature from its geographical habitat and primarily distributed across the Ahmednagar, Solapur, and Osmanabad districts within the state of Maharashtra (Motghare *et al*., 2005 [27] ; Deokar *et al*., 2006) [9], where it exists in its purest form. The breed is predominantly concentrated in the Latur, Parbhani, Ahmadnagar, and Solapur districts of Maharashtra, in addition to Osmanabad district. It has been observed that animals thrive across a diverse array of agro-climatic conditions in the regions of Vidharbha, Marathwada, Western Maharashtra, as well as neighbouring areas of Karnataka and Andhra Pradesh. Deokar *et al*. (2006) [9] conducted a characterization study on Osmanabadi goats and noted that a majority of exhibited a black coat colour, complemented by grey-white skin, a black muzzle, black eyelids, and black hooves, with grey, straight, and posteriorly oriented horns averaging (13.01 cm in length), pendulous ears measuring (4.83±0.08 cm in length), a convex head conformation, and the absence of both wattles and a beard, along with a curved, slender, and medium-length tail. The Osmanabadi breed is classified as medium-sized, characterized by a relatively elongated body and long legs. Koratkar *et al*. (1998) [21] investigated the reproductive performance of this breed and determined breeding efficiency rate of 92 percent.

Pregnancy in goats is a complex physiological process that begins with successful fertilization of the ovum, usually occurring in the oviduct shortly after mating or artificial insemination. The fertilized embryo travels to the uterus and implants into the uterine wall, where it develops into a foetus. Nutritional requirements are high during this period due to accelerated digestion rate, tissue mobilization for mammary development, and foetus growth (Berchieri-Ronchi *et al*., 2015) [8]. Certain botanical species possess therapeutic properties and hold nutritional significance that can improve the health status and reproductive efficacy of caprine species. The incorporation of these plants into a foundational diet may alleviate nutrition-associated challenges encountered in goat husbandry (Patra *et al*., 2019) [29].

Moringa (*M. oleifera*), often called the "miracle tree," is a fast-growing, drought-resistant plant native to India and parts of Africa and Asia, valued for its exceptional nutritional and medicinal properties (Leone *et al*., 2015) [23]. It is rich in vitamins A, C, and E, as well as calcium, potassium, and protein, moringa leaves also offer strong antioxidant and anti-inflammatory benefits (Gopalakrishnan *et al*., 2016) [15]. It supports immune function, heart health, blood sugar regulation, digestion, and promotes healthy skin and hair (Mahmood *et al*., 2010) [24]. All parts of the tree leaves including pods, seeds, and root are used in traditional medicine and cooking, with this the dried leaves commonly processed into powders, teas, and supplements (Fahey, 2005) [12]. Its ability to thrive in arid conditions also makes it an important crop for sustainable agriculture and food security.

As very meagre research have been conducted concern to the effect of feeding MOLP to pregnant goats as per the available literatures, the present study was undertaken to determine the effect of *M. oleifera l*eaf powder (MOLP) as a nutritional supplements on haematological parameters during pregnancy and post-partum transition Osmanabadi goats.

1. **MATERIALS AND METHODS**

The present study was carried out at Livestock Farm Complex (LFC), College of Veterinary and Animal Sciences, Udgir. The Udgir city is situated at 18.40ºN latitude and 77.11ºE longitude above 640.13 MSL (mean sea level) in the Marathwada division of the Maharashtra state, including Balaghat mountain range. It has a tropical wet and dry or savanna climate having average rainfall of 821 mm.

Total 16 female Osmanabadi goats weighing about 30 kg, above 3 years of age were selected from LFC (Livestock Farm Complex), COVAS, Udgir, after diagnosis for pregnancy by utilizing a diagnostic technique well known as ultrasonography. Animals were segregated into two groups, control group and MOLP supplemented group comprising 8 animals each. Animals were provided with feed [T1 (control group):100 g concentrate mixture without MOLP per animal per day and T2 (MOLP supplemented group):100 g concentrate mixture with 20 g (20%) MOLP per animal per day] as per NRC (2007) [28] standards via the method of stall feeding from 8:00 to 9:00 am during the entire duration of pregnancy. The concentrate mixture consisting of maize, cotton seed cake, udit chunni, wheat bran, soyabean DOC, mineral mixture and salt was formulated to fulfil the nutrient requirements of the goats as shown in Table 1. The feeding levels were adjusted to previous studies conducted on goats (Afzal *et al*., 2021) [2]. As per the routine schedule, the animals were permitted to graze in the open yard from 9:00 am until 4:00 pm. The animals had also access to ad-lib drinking water. Additionally, these animals underwent routine deworming. Experimental period was of four months and blood samples (4 ml) were collected on the 0th day prior to the initiation of the experiment (one month after confirmation of pregnancy), 2 months post pregnancy, and 7th day (postpartum transition state of animals). Blood samples were collected from 16 animals via jugular venepuncture in sterile test tubes containing sodium fluoride as an anticoagulant and were immediately processed for the analysis of haematological parameters. Blood samples were collected without anticoagulant for the serum. Serum was separated by centrifugation at 2500 rpm for 20 min and stored at -20ºC until analysis.

**Table 1. Formulation of concentrate mixture for experimental animals**

|  |  |  |
| --- | --- | --- |
| **Sr. No.** | **Feed ingredients** | **Quantity (Kg)** |
| 1. | Maize | 35 |
| 2. | Cotton seed cake | 15 |
| 3. | Udit chunni | 20 |
| 4. | Wheat bran | 17 |
| 5. | Soyabean DOC | 10 |
| 6. | Mineral mixture | 2 |
| 7. | Salt | 1 |
|  | Total | 100 |

**2.1 Haematological parameters**

The haematological parameters were measured by using hemoanalyzer machine (model no. MEK-6420P) of Nihon Kohden (India). Hemoglobin (Hb), Packed cell volume (PCV), Total erythrocyte count (TEC), Total leucocyte count (TLC), Differential leucocyte count (DLC), Mean corpuscular volume (MCV) and Mean corpuscular hemoglobin (MCH).

**2.2 Statistical Analysis**

The statistical analysis of data was done by using Microsoft excel software for windows (version 2013). T-Test: two-sample assuming unequal variances was applied to analyse the variance about mean values for haematological parameters between two groups.

1. **RESULTS AND DISCUSSION**

**3.1 Haemoglobin**

The estimated haemoglobin values were 7.91±0.14, 7.93±0.15 g/dL prior to initiation of the experiment, on 60th day were 7.94±0.18, 7.98±0.08 g/dL and on 7th day (PP-transition state) were 7.90±0.34, 7.93±0.32 g/dL in T1 and T2 groups, respectively as shown in Table 2. No significant difference was observed in haemoglobin values among the experimental groups.

**3.2 Packed cell volume (PCV)**

 The estimated PCV values were 19.50±0.59, 19.81±0.69 % prior to initiation of the experiment, on 60th day were 20.04±0.40, 20.01±0.51 % and on 7th day (PP-transition state) were 19.85±0.39, 19.74±0.45 % in T1 and T2 groups, respectively. No significant difference was observed in PCV values among the experimental groups.

**3.3 Total erythrocyte count (TEC)**

 The estimated TEC values were 4.82±0.28, 4.72±0.31 × 106/µL prior to initiation of the experiment, on 60th day were 4.55±0.29, 4.61±0.15 × 106/µL and on 7th day (PP-transition state) were 4.45±0.21, 4.53±0.21 × 106/µL in T1 and T2 groups, respectively. No significant difference was observed in TEC values among the experimental groups.

 In the present experiment, PCV, TEC and Hb concentration were found non-significant between treatment and control groups, Yusuf *et al*. (2018) [33] reported similar results of PCV, TEC and Hb concentration in *M. oleifera* leaf meal supplemented group in West African Dwarf goats as compared to control. Our findings of Hb and PCV were in collaboration with (Jadhav, 2017 [17] ; Ali *et al*., 2018 [4]) who observed no significant difference in Moringa fed group as compared to control. Our findings are collinear with Haridas, (2018) [16], who reported that haemoglobin levels were found statistically non-significant in Moringa fed sheep and goat as compared to control diet that could be due to the presence of tolerable level of anti-nutrients in moringa which did not negatively affect the blood profile (Sánchez-Machado *et al*.,2010) [31].

 In the present results, numerically similar values within the normal physiological range were obtained in healthy goats, which implies that the *M. oleifera* could safely be included in diet of pregnant and post-partum transition goats (Jiwuba et al., 2017 [18]).

 However, the present results of RBC, Hb and PCV were found within normal physiological range which are in agreement with Toviesi *et al*. (2024) [32].

 Contrary to present results, RBC count was increased significantly (P<0.05), Hb and PCV were improved by the supplementation of *M. oleifera* leaves in Sirohi goat kids (Meel *et al*. 2018 [26] and Zaher *et al*. 2020 [34]), these findings may be due to favourable effect of *M. oleifera* supplementation on blood parameters. Divya *et al*. (2023) [10], showed that all haematological parameters were non-significant except PCV which was found significantly higher in MOLM (*M. oleifera* leaf meal) supplemented group. Fadiyimu *et al*. (2016) [11] also reported significantly higher levels of PCV in Moringa fed sheep.

**3.4 Total leucocyte count (TLC)**

 The estimated TLC values were 8.08±0.33, 8.01±0.39 × 103/µL prior to initiation of the experiment, on 60th day were 12.94±0.48, 13.97±0.27 × 103/µL and on 7th day (PP-transition state) were 12.29±0.57, 13.25±0.43 × 103/µL in T1 and T2 groups, respectively shown in Table 2. Significantly higher (P<0.05) values of TLC were observed in group T2 as compared to T1 (control) group on 60th day, however no significant difference was observed in TLC values among the experimental groups on 0th day and PP-transition state 7th day.

 In the present research, TLC count was found significantly higher (P<0.05) in *M. oleifera* fed group on 60th day as compared to control group. These results were in agreement with (Babeker & Abdalbagi, 2015 [7]; Jiwuba *et al*. 2017 [18] & Ali, 2017 [3]), who reported that the WBC count was increased significantly (P<0.05) in group B offered (20%) *M. oleifera* leaves in Sudan Nubian goats, which implies that defence mechanism of animal has been improved in *M. oleifera* supplemented groups (Konlan *et al*. 2012 [20]). (Ghattas & Hassan, 2019 [14]) also, recorded significantly higher counts of WBCs in Moringa fed groups on 5th and 7th week of experiment in Barki ewers. Al-Mufarji *et al*. (2022) [5], who also reported significant (P<0.05) increase in WBCs during the transition period of ewes supplemented with *M. oleifera*. In line with the present results, Salih *et al*. (2025) [30], who investigated the effect with different proportions of moringa seed powder supplementation on physiological traits in ewes and lambs. They reported significant (P<0.05) increase in leucocytes and lymphocytes level in moringa oleifera fed groups.

 In contrary to the present results, WBC count was higher in control than Moringa fed group (Adegun *et al*., 2011) [1], Meel *et al*., (2018) [26] also found that WBC counts were significantly lower in Moringa fed Sirohi goat kids. Fadiyimu *et al*., (2017) [11] reported significantly lower values of WBCs in West African dwarf sheep of Moringa supplemented group.

 In contrary to the present results, (Kumar *et al*., 2020) [22], who reported normal haematological profile in *M. oleifera* fed growing female Black Bengal goats viz. TLC, neutrophils, eosinophils, lymphocytes and monocytes. Kekana *et al*., (2020) [19] observed non-significant results of haematological parameters viz. WBC, monocytes (%), neutrophils (%), basophils (%) and eosinophils (%) in Moringa fed treatment groups.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sr. No.** | **Parameters** | **0th day (prior to initiation of experiment)** | **60th day** | **7th day (Postpartum transition stage)** |
| **T1** | **T2**  | **T1** | **T2**  | **T1** | **T2**  |
| 1. | Haemoglobin (g/dL) | 7.91±0.14 | 7.93±0.15 | 7.94±0.18 | 7.98±0.08 | 7.90±0.34 | 7.93±0.32 |
| **P-value** | 0.33 | 0.42 | 0.48 |
| **Level of significance** | NS | NS | NS |
| 2. | PCV (%) | 19.50±0.59 | 19.81±0.69 | 20.04±0.40 | 20.01±0.51 | 19.85±0.39 | 19.74±0.45 |
| **P-value** | 0.37 | 0.49 | 0.43 |
| **Level of significance** | NS | NS | NS |
| 3. | TEC (106/µL) | 4.82±0.28 | 4.72±0.31 | 4.55±0.29 | 4.61±0.15 | 4.45±0.21 | 4.53±0.21 |
| **P-value** | 0.41 | 0.43 | 0.40 |
| **Level of significance** | NS | NS | NS |
| 4. | TLC (103/µL) | 8.08±0.33 | 8.01±0.39 | 12.94b ± 0.48 | 13.97a ± 0.27 | 12.29±0.57 | 13.25±0.43 |
| **P-value** | 0.44 | 0.04 | 0.10 |
| **Level of significance** | NS | S\* | NS |
| 5. | MCV (fL) | 30.45±0.84 | 30.24±0.83 | 30.71±0.83 | 30.91±0.79 | 31.18±0.93 | 31.39±0.99 |
| **P-value** | 0.43 | 0.43 | 0.44 |
| **Level of significance** | NS | NS | NS |
| 6. | MCH (pg) | 16.89±0.50 | 16.95±0.75 | 17.46±0.45 | 17.40±0.51 | 16.99±0.44 | 17.40±0.43 |
| **P-value** | 0.47 | 0.47 | 0.26 |
| **Level of significance** | NS | NS | NS |

**Table 2. Haematological profile (Mean ± SE) in Osmanabadi goats (n=16)**

Superscripts a and b: Means with no common superscripts are significantly different (P<0.05) between T1 and T2 groups on different days.

Superscripts \*: Means with \*superscripts are significantly different (P<0.05) between T1 and T2 groups on different days.

NS : Non - significant difference between T1 and T2 groups on different days.

**3.5 Mean corpuscular volume (MCV)**

The (Mean ± SE) estimated MCV values were 30.45±0.84, 30.24±0.83 fL prior to initiation of the experiment, on 60th day were 30.71±0.83, 30.91±0.79 fL and on 7th day (PP-transition state) were 31.18±0.93, 31.39±0.99 fL in T1 and T2 groups, respectively as shown in Table 2. No significant difference was observed in MCV values among the experimental groups.

 In the present result, the values of MCV were did not differ significantly in Moringa supplemented group as compared to control in Osmanabadi goats. Divya *et al*., (2023) [10], carried out the study on the effect of *M. oleifera* leaf meal in Nellore lambs. They reported that there was no significant difference about MCV values in Moringa fed animals as compared to control which are in agreement with present results. Similar findings also reported by Ali, (2017) [3], who found that there was no significant difference in Moringa fed goats.

 Contrary to the present results, (Manikrao, 2020) [25], who reported that significantly higher values of MCV in sheep with Moringa supplemented group. Babeker & Abdalbagi, (2015) [7], also observed that MCV was significantly increased in Moringa fed goats.

 However, in contrast to the present results, Farrag (2024) [13], who reported significant increase in Hb concentration, RBC, PCV and MCV counts in *M. oleifera* leaves (MOL) fed Baladi goats. They concluded that the increase in Hb may be attributed to increase in carrying capacity of blood which support the health of animals and preventing them from becoming anaemic. The rise in mean value of Hb, RBC and PCV and MCV might be due to supply of moringa in the diet of goats which is rich in content of essential amino acids, vitamins iron.

**3.6 Mean corpuscular hemoglobin (MCH)**

 The estimated MCH values were 16.89±0.50, 16.95±0.75 pg prior to initiation of the experiment, on 60th day were 17.46±0.45, 17.40±0.51 pg and on 7th day (PP-transition state) were 16.99±0.44, 17.40±0.43 pg in T1 and T2 groups, respectively as shown in Table 2. No significant difference was observed in MCH values among the experimental groups, but numerically higher values were observed in all experimental groups.

 In the present result, there was no significant difference about MCH in treatment (MOLP) as compared to control, but numerically higher values of MCH was observed in all experimental groups. In line with present findings, Divya *et al*., (2023) [10], who reported no significant difference in MCH values amongst the experimental groups. The present findings are in agreement with Fadiyimu *et al*., (2016) [11], who reported no significant difference in MCH values in sheep; Manikrao *et al*., (2020) [25], who also reported that MCH value did not differ significantly in Moringa supplemented group in growing Deccani lambs.

 Contrary to the present results, Adegun *et al*., (2011) [1], who reported significantly higher levels of MCH in sheep fed on Moringa based multi-nutrient blocks. Moreover, Farrag (2024) [13], observed similar results, who reported no significance differences in MCH between *M. oleifera* leaves fed and control group in Baladi goats.

**3.7 Differential leucocyte count (DLC)**

The estimated DLC values (granulocytes) were 33.80±1.13, 35.80±1.65 % prior to initiation of the experiment, on 60th day were 36.16±0.95, 39.61±1.20 % and on 7th day (PP-transition state) were 36.65±1.06, 40.18±1.24 % in T1 and T2 groups, respectively. The (Mean ± SE) estimated DLC values (lymphocytes) were 54.96±1.06, 54.94±1.19 % prior to initiation of the experiment, on 60th day were 57.41±0.68, 60.76±1.06 % and on 7th day (PP-transition state) were 54.15±1.20, 58.16±1.20 % in T1 and T2 groups, respectively. The (Mean ± SE) estimated DLC values (monocytes) were 4.34±0.20, 4.4±0.18 % prior to initiation of the experiment, on 60th day were 4.24±0.19, 4.44±0.16 % and on 7th day (PP-transition state) were 4.43±0.16, 4.3±0.18 % in T1 and T2 groups, respectively. Significantly higher (P<0.05) values of granulocytes and lymphocytes were observed in group T2 as compared to T1 (control) group on 60th and PP-transition state 7th day, respectively. However, no significant difference was observed in monocytes values among the experimental groups.

In the present study, the levels of granulocytes (neutrophil, basophil and eosinophil) and a granulocytes (lymphocytes and monocytes) were found significantly higher (P<0.05) in Moringa supplemented group on 60th day of pregnancy in Osmanabadi goats. The present results were corroborated by (Ghattas & Hassan, 2019) [14], who evaluated effect of *M. oleifera* tree leaves supplementation on the reproductive performance in Barki ewes of Egypt. They found that WBC, lymphocytes, monocytes and neutrophils were differed significantly (P<0.05) in supplemented group as compared to control. Toviesi *et al*. (2024) [32], also reported significant difference about blood cells including eosinophils, basophils, neutrophils and lymphocytes in all Moringa leaf meal inclusion levels, which are in agreement with present findings. Similar results were reported by Salih *et al*. (2025) [30], who found that lymphocytes were significantly (P<0.05) increased in moringa seed powder supplemented ewes and lambs.

[Anyanwu](https://pubmed.ncbi.nlm.nih.gov/?term=Anyanwu+GA&cauthor_id=33438136) *et al*. (2021) [6], who evaluated the effect with different inclusion levels (0, 50, 100, and 150 g/kg DM) of *Leucaena leucocephala* pasture leaf-meal on growth, haematology and physiological performance of growing pigs. They reported that there was no significant effect on haematological parameters as compared to control.

**Table 3. Haematological profile for DLC (Mean ± SE) in Osmanabadi goats (n=16)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sr. No.** | **Types of WBC’s** | **0th day (prior to initiation of experiment)** | **60th day** | **7th day (Postpartum transition stage)** |
| **T1(Control)** | **T2 (MOLP)** | **T1(Control)** | **T2 (MOLP)** | **T1(Control)** | **T2 (MOLP)** |
| 1. | Granulocytes (%) | 33.80±1.13 | 35.80±1.65 | 36.16b±0.95 | 39.61a ±1.20 | 36.65b±1.06 | 40.18a±1.24 |
| **P-value** | 0.17 | 0.02 | 0.02 |
| **Level of significance** | NS | S\* | S\* |
| 2. | Lymphocytes (%) | 54.96±1.06 | 54.94±1.19 | 57.41b±0.68 | 60.76a±1.06 | 54.15b±1.20 | 58.16a±1.20 |
| **P-value** | 0.5 | 0.01 | 0.02 |
| **Level of significance** | NS | S\* | S\* |
| 3. | Monocytes (%) | 4.34±0.20 | 4.4±0.18 | 4.24±0.19 | 4.44±0.16 | 4.43±0.16 | 4.3±0.18 |
| **P-value** | 0.41 | 0.22 | 0.31 |
| **Level of significance** | NS | NS | NS |

Superscripts a and b: Means with no common superscripts are significantly different (P<0.05) between T1 and T2 groups on different days.

Superscripts \*: Means with \*superscripts are significantly different (P<0.05) between T1 and T2 groups on different days.

NS : Non - significant difference between T1 and T2 groups on different day

**CONCLUSION**

 The increase in granulocytes and lymphocytes count could be attributed to the increased immune response during pregnancy and 7th day partum stage in MOLP fed animals. The significant increase in total leucocyte count during pregnancy might be attributed to enhanced phagocytosis against infectious diseases. The most of the haematological parameters were found in normal range that may implies that the feeding of moringa did not impose adverse effect in pregnant Osmanbadi goats.

**ETHICAL APPROVAL**

 In this study, the experimental measures using Osmanabadi goats have been conducted after approval from the Institutional Animal Ethical Committee (IAEC) of the College of Veterinary and Animal Sciences, Udgir (Maharashtra Animal and Fishery Sciences University, Nagpur) (Approved No. XII/24). All the research investigations with Osmanabadi goats were carried out according to the IAEC guidelines.

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