EFFECT OF FEEDING MORINGA (*Moringa oleifera*) LEAF MEAL BASED DIETS ON PRODUCTIVE PERFORMANCE OF GROWING DECCANI SHEEP IN DIFFERENT FARMING SYSTEMS

BY

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DECEMBER, 2019

CERTIFICATE

This is to certify that Mr. **BHOKRE SAINATH MANIKRAO (RVD/2016-17)** has satisfactorily prosecuted the course of research and that the thesis entitled **"EFFECT OF FEEDING MORINGA (*Moringa oleifera*) LEAF MEAL BASED DIETS ON PRODUCTIVE PERFORMANCE OF GROWING DECCANI SHEEP IN DIFFERENT FARMING SYSTEMS"** submitted is the result of original work done and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part there of has not been previously submitted by him for a degree of any University.

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Place: Hyderabad

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DECLARATION

I, Mr. **BHOKRE SAINATH MANIKRAO (RVD/2016-17)** hereby declare that the thesis entitled "**EFFECT OF FEEDING MORINGA (*Moringa oleifera*) LEAF MEAL BASED DIETS ON PRODUCTIVE PERFORMANCE OF GROWING DECCANI SHEEP IN DIFFERENT FARMING SYSTEMS**" submitted to **P.V.NARSIMHA RAO TELANGANA VETERINARY UNIVERSITY, RAJENDRANAGAR, HYDERABAD** for the degree of **DOCTOR OF PHILOSOPHY** in Livestock Production Management is result of original research work done by me. I also further declare that th thesis or any part thereof has not been published earlier elsewhere in ar manner.

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No part of the thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All the assistance and help received during the course of the investigation has been duly acknowledged by the author of the thesis.

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LIST OF ABBREVIATIONS

%	:	Percentage
ACU	:	Adult Cattle Unit
ADG	:	Average daily gain
ADF	:	Acid Detergent fibre
AOAC	:	Association of Analytical Chemist
ANOVA	:	Analysis of Variance
BAM	:	Bamboo
BL	:	Body Length
BW	:	Body Weight
CB	:	Cannon Bone
CD	:	Chest depth
CF	:	Crude fibre
cm	:	Centimeter
cm^2	:	Centi meter Square
cμ	:	Cubic micron
CP	:	Crude protein
CPL	:	Cassava peels
CRIDA	:	Central Research Institute for Dryland Agriculture.
CSC	:	Cotton seed cake
CSR	:	Corn starch residue
CW	:	Chest Width
cumm	:	cubic milli metre
DCP	:	Digestible crude protein
DGNC	:	Deoiled Ground nut cake
dl	:	Decilitre
DM	:	Dry matter
DMI	:	Dry matter intake
DMB	:	Dry matter basis
DMOL	:	Dried Moringa leaves
DORB	:	Deoiled Rice bran
DP	:	Dressing Percentage
et al	:	Co-workers
etc.	:	and so on
EDTA	:	Ethylene Diamine Tetra acetic acid
EE	:	Ether extract
ELW	:	Empty live weight
FCE	:	Feed conversion efficiency
FCR	:	Feed conversion ratio
Fig	:	Figure
g	:	Gram
GE	:	Gross energy
GH	:	Gross hay
GMNB	:	Glyricidia Moringa multi-nutrient block
GNC	:	Groundnut cake
GNH	:	Ground nut hay

HAW	:	Height at Withers
Hb	:	Hemoglobin
HG	:	Heart Girth
HW	:	Hip width
IU	:	International units
ICAR	:	Indian Council of Agriculture Research
IVDMD	:	In vitro dry matter digestibility
K cal	:	Kilo calories
Kg	:	Kilogram
Kg W0.75	:	Kilogram metabolic body weight
LFC	:	Livestock Farm Complex
LL	:	*Leucaena leucocephala*
LMNB	:	Leucaena multi-nutrient block
MCH	:	Mean corpuscular haemoglobin
MCHC	:	Mean corpuscular haemoglobin concentration
MCV	:	Mean corpuscular volume
ME	:	Metabolizable energy
mEq/L	:	Milli equivalent per liter
mg	:	Milligram
MJ	:	Mega Joules
MLM	:	Moringa leaf meal
MMNB	:	Moringa multi-nutrient block
m ha	:	Million hectares
N	:	Number animals per group
NDF	:	Nitrogen Detergent Fibre
NFE	:	Nitrogen free extract
NRC	:	National Research Council
OM	:	Organic matter
OMD	:	Organic matter digestibility
PCV	:	Packed cell volume
RBC	:	Red blood corpuscles
SC	:	Seasame cake
SGOT	:	Serum glutamic oxaloacetic transaminase
SGPT	:	Serum glutamic pyruvic transaminase
TDN	:	Total digestible nutrients
TMNB	:	Tithnia multi-nutrient block
Viz.,	:	Namely
WAD	:	West African Dwarf
WBC	:	White blood corpuscles

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ABSTRACT

Two studies were conducted to assess the effect of feeding Moringa (*Moringa oleifera*) leaf meal-based diets on growth performance, dry matter intake, biometry, body condition score, hematobiochemical parameters, feeding behaviour, faecal consistency score, carcass traits and cost economics in growing Deccani sheep under both intensive and semi-intensive systems. Three experimental diets were prepared using 100 percent groundnut cake (T1), 75% groundnut cake+ 25% *Moringa oliefera* leaf meal (T2) and 50% groundnut cake+ 50% *M. oliefera* leaf meal (T3) as protein source in the concentrate mixture and offered @ 1% of body weight along with *ad libitum* green fodder. In experiment 1, eighteen growing Deccani sheep of uniform body weight (14.22 ±1.5 kg) were selected and randomly allotted to three treatment groups with six lambs in each group (6 x 3) and reared under intensive farming system at LFC, Rajendranagar for 90 days. Similarly, in experiment 2, eighteen growing Deccani lambs of uniform body weight (18.83 ± 0.97 kg) were selected from Animal Experiment Farm of ICAR-CRIDA and randomly allotted to three treatment groups with six lambs in each group (6 x 3) and reared under semi-intensive farming system at Animal experimental farm, CRIDA campus, Hayathnagar, Hyderabad for 90 days.

No significant difference was observed in the fortnightly body weights of the lambs from 1st to 6th fortnights in both intensive and semi-intensive systems. However, total body weight gain and average daily gain were significantly ($P<0.01$) higher in T2 group lambs fed with 25% *Moringa oliefera* leaf meal-based diet compared to that of T1 and T3 groups under intensive system whereas it was non-significant in semi-intensive system. The dry matter intake per day and per 100 kg body weight was higher in T2 group than T1 and T3 group animals under both intensive and semi-intensive farming systems. The FCR was non-significantly higher (lower value) in test diets (T2 and T3) than control (T1) under both the systems.

In intensive farming system, the fortnightly biometric measurement indicated that the mean fortnight body length, face length and hip width of growing Deccani lambs increased linearly throughout the experimental period and had significant

difference (P<0.05) among the treatments. However, the height at wither, chest girth and tail length showed non-significant difference among the groups. A similar trend was observed in growing Deccani lambs under semi-intensive system.

The body condition score of lambs was significantly (P<0.05) affected by the feeding of *Moringa oliefera* leaf meal during 3rd to 6th fortnights, whereas no significant difference was observed during 1st and 2nd fortnight among the treatment group animals in both the farming systems. Significantly (P<0.01) higher BCS was observed in T2 and T3 group lambs when compared to T1.

Pulse rate was significantly (P<0.01) affected in all fortnights except in the first fortnight in intensive system while it was significantly (P<0.01, 0.05) different during the experimental period in all fortnights under the semi-intensive farming system. The pulse rate was significantly higher in T2 and T3 than T1 group lambs, however it was in within the physiological limits. Feeding Moringa based diets had no significant effect on rectal temperature and respiratory rate and were within the normal physiological limits in lambs reared under both intensive and semi-intensive farming systems.

WBC, RBC values were significantly (P<0.05) higher in T2 group in both systems, whereas difference in haemoglobin levels among experimental diets was non-significant in intensive system but it was significant (P<0.01) among the treatment groups in semi-intensive system. PCV value was found to be significant (P<0.01) in intensive system, while it was non-significant in semi-intensive system. A significant effect (P<0.05) on MCV (cμ) and higher MCV (cμ) values were observed in T2 group than T1 and T3 groups in both the systems of farming. No significant differences were noticed in MCH (pg) and MCHC (%) among the experimental animals fed with different diets under both the systems. A similar trend was noticed in leucocyte indices in both systems except for lymphocytes which was significantly higher in T2 group under intensive farming system.

The blood biochemical profile showed significantly higher serum total protein levels in T2 group lambs under intensive system (P<0.01) and semi-intensive system (P<0.05). Albumin and Glucose levels were non-significant in both systems of farming. The mean values for SGOT and SGPT were non-significantly higher in T2 and T3 than T1 group animals. This indicated that there was no harmful effect of *Moringa oliefera* leaf meal on liver function.

The digestibility coefficients (%) of DM, OM, CP, CF, EE were non-significantly higher in *Moringa oliefera* leaf meal supplemented group animals compared to the control under both the farming systems. However, NFE digestibility coefficient (%) was significantly (P<0.05) higher in lambs reared under intensive system. Significantly (P<0.05) higher ADF and NDF digestibility coefficients (%)were observed with *Moringa oliefera* leaf meal supplementation in lambs reared under semi-intensive farming system, whereas both were non-significant in lambs reared under intensive farming system.

No significance difference was observed in feeding behaviour among lambs fed with different experimental diets and more time was spent in eating in T2 group indicated that the Moringa based diet (25%) was relatively more palatable than the other two groups under intensive farming system. Faecal consistency score value was significantly (P<0.01) higher for Moringa based groups (T2 and T3) than control (T1) group under intensive and semi-intensive farming systems.

Pre slaughter weight, empty body weight, hot carcass weights and dressing percent on pre slaughter weight and empty body weight were comparable among the three groups. Similarly, a non-significant difference was noticed among treatment groups for edible and non-edible offal under both the farming systems. The cost of feed per kg body weight gain in growing Deccani lambs fed with replacement of 25 % ground nut cake protein with *Moringa* leaf meal (T2 group) was found to be more economical than 0% replacement in T1group and 50% replacement in T3 under both the farming systems.

Results of the present study indicated that replacement of 25% ground nut cake with *Moringa oleifera* leaf meal in concentrate mixture proved to be superior and improved the growth performance, digestibility of nutrients and carcass traits without any adverse effects on experimental lambs. Based on the present study, it is recommended to feed *Moringa oleifera* leaf meal in place of GNC as a protein source to reduce the cost of feeding in sheep rearing.

CHAPTER I

INTRODUCTION

Sheep is one of the important species of livestock contributing to the livelihood of resource poor farmers in rural areas especially where crop and dairy farming are not economical in arid and semi- arid regions and largely in marginal and sub – marginal holdings. It contributes to the farm households not only by acting as a source of livelihood and nutritional security, but also as a moving asset, which can be liquidated at times of crisis within short time. Sheep with its peculiar habit of lower grazing and higher utilization of crude fibre, can reach to the remotest areas and utilize the vegetation on the lands which are otherwise uncultivable.

The sheep are favoured because of low investments, easy to raise and manage, low feed requirement compared to cattle, ability to thrive on different flora, high disease resistance, and superior market potential. The anticipated rise in demand for sheep and goat meat and meat products with the growing economy in the near future, will provide an avenue for resource-poor farmers to increase production, improve their livelihood, reduce malnutrition and thereby, contribute to the goal of overall poverty alleviation in rural areas.

As per 20th Livestock Census (2019-20) the sheep population in India is 74.26 million and contributes 13.87 % of the total livestock population. India ranks third in world sheep population with 6.8% of the world population and contributing to 4.9% of total meat production in the country. The sheep sector is growing at anuual rate of 3.9% and producing 556.44 (in 000 Tons) of mutton in the country (BAHS, 2016-17).

Telangana state is known for its diversified livestock resources. According to 20th livestock census Telangana ranked first in sheep population with 19.1 million and contributing 25.72% of total sheep population in India. (DAH, GOI., 2019). Small ruminant farming is the livelihood for nearly 5.32 lakh families in the state. Telangana is the home tract of Deccani breed of sheep which is well-known for its taste.

Sheep are mostly reared for meat and wool. Sheep skins and manure constitute 0Indian sheep is lower than those of agriculturally more advance countries. The major reason for low productivity is inadequate grazing resources, diseases causing high

mortality, morbidity and consequent reduced production and serious lack of organised effort for bringing genetic improvement.

India's huge small ruminant (sheep and goat) population still sustain to larger extent on the grazing resources, grazing based animal husbandry plays a significant role in rural economy of an agrarian country like India. The grazing activity depends on the availability of the grazing resources from pasture and other grazing lands, viz. forest, miscellaneous tree crops and groves, cultivable waste lands and fallow lands. The requirement for fodder is mainly governed by the population and species of livestock, management level and climate condition. As per estimates of IGFRI (2013) the availability of green fodder from cultivated areas and pastures is 826.0 MT against the demand of 1012.7 MT in the country by 2050. Similarly, in case of dry fodder, estimated total availability will be 547.7 MT (from dry residues and by-products of grain, commercial crops and dry grass from grazing lands and forests) against the requirement of 631.0 MT. The total area under cultivated fodder is only 8.4 m ha on individual crop basis which is static since last two decades. The scope for further increase in area under forages seems meagre due to pressure of food crops for human population.

Furthermore, overgrazing on limited area has made goat and sheep to be a major cause of deforestation, range land destruction and soil erosion. For such reason extensive management system in India is gradually replaced by semi-intensive and intensive system which has restructured the livestock management system. Recent introduction of intensive rearing of livestock in India has restructured the livestock management systems. Hence, it is necessary to look for cheaper, non-conventional feed sources. The non-conventional feeds could partly fill the gap in the feed supply, decrease competition for food between humans and animals, reduce feed cost and contribute to self-sufficiency in nutrients.

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.,* 2012a). In recent years, there has been increased research on alternative protein sources from forage trees and shrubs that can be fed to sheep. In recent years, attention has been given to the use of moringa leaf meal (MLM) as a protein source and feed component in animal production especially in goats (Sarwatt *et al.,* 2002; Asaolu *et*

al., 2010, and Moyo *et al.,* 2012b) and also for other ruminants (Sarwatt *et al.,* 2000) and Gerbregiorgis and Negesse, 2011). There are many advantages of using moringa foliage as protein source including the fact that it is a perennial plant that can be harvested several times in one growing season. The leaves can be fed fresh or dried with little effect on intake. Dried moringa leaf can be stored for longer periods without deterioration in nutritive value.

Moringa (*Moringa oleifera*) is a leaf fodder that has been tried in the livestock ration and observed to increase animal performance in many parts of the world. Moringa (*Moringa oleifera*) commonly called "Drumstick tree" or "Miracle tree" as a protein source for livestock (Makker and Becker, 1997; Sarwatt *et al*., 2002). Moringa belongs to the genus *Moringa* of *Moringaceae* family and is locally popular as drumstick tree. India is the largest producer of Moringa (Radovich and Elevitch 2011) with an annual production of 1.1 to 1.3 million tons of fruit pods (Sagbo, 2006). Moringa foliage dried meal, contains 214.80 to 216.20 g CP kg-1 DM, 268.30 to 310.29 g ADF kg-1 DM and 347.1 to 381.8 g NDF kg-1 DM (Sultana *et al.,* 2014). *Moringa oleifera* leaves have negligible content of tannins and no trypsin and amylase inhibitors and cyanogenic glucosides (Makkar and Becker, 1997). The advantages of using moringa as a protein source are numerous and include the fact that it is a perennial plant that can be harvested several times in one growing season and also has the potential to reduce feed cost of livestock ration. Moringa can easily be established in field, has good copping ability, as well as good potential for forage production. It can reach 12 m height at maturity and yielding up to120 tonnes/ha/year, when it is planted very densely for use as forage (Makkar and Becker, 1997). Additionally, it is not affected by any serious diseases in its native or introduced ranges (Parrotta, 2013).

Further, among the Indian states, Andhra Pradesh leads in both cultivation area and production of *Moringa oleifera* followed by Karnataka and Tamil Nadu. Moringa foliage being rich available sources of protein and cell wall materials may be one of the alternatives to conventionally mixed concentrates used for feeding sheep. The studies on the utility of Moringa leaf meal as sheep feed are limited. In view of this, the present study was planned to replace GNC with dried *Moringa oleifera* leaf meal in the concentrate mixture of sheep reared under different farming system with the following objectives.

1. To study the effect of feeding *Moringa oleifera* leaf meal–based diets on performance and nutrient digestibility in growing Deccani sheep reared in different farming systems.
2. To study the effect of feeding *Moringa oleifera* leaf meal-based diets on biometry, body condition scores and physiological parameters in growing Deccani sheep in different farming systems.
3. To evaluate the effect of feeding *Moringa oleifera* leaf meal-based diets on haemato- biochemical and carcass characteristics in growing Deccani sheep in different farming systems.
4. To work out the cost economics of feeding of *Moringa oleifera leaf* meal-based diets in growing Deccani sheep in different farming systems.

CHAPTER II

REVIEW OF LITERATURE

Moringa oleifera leaf meal (MLM) is a kind of non-conventional feed stuff which can be used as a high protein feed for ruminant feeding. Results from various trials with different classes of animal indicate that MLM can be satisfactorily fed. However, the scientific literature on inclusion of *Moringa oleifera* leaf meal as source of protein on growth performance of sheep is very scanty. In view of this research conducted on broiler chicken and fish was also reviewed to envisage the effect of MLM as a protein supplement on growth performance. In this chapter various aspects of animal diets containing *Moringa oleifera* have been reviewed with the available literature related to the present study under the following headings.

2.1 COMPOSITION OF *MORINGA OLEIFERA* LEAF MEAL (MLM)

Makkar and Becker (1996) investigated nutritional value of whole and ethanol extracted *Moringa oleifera* leaves. They found that crude protein contents of the extracted and unextracted leaves were 43.5 and 25.1%, respectively while the true protein contents of these leaves were 93.8% and 81.3% of the total crude protein and non protein nitrogen contents of 2.7 and 4.7% in extracted and unextracted leaves, respectively.

Richter *et al.* (2003) reported that CP, EE, ash, NDF, and ADF contents of *Moringa oleifera* leaf meal as 25.0, 10.6, 8.4, 15.9 and 12.6 percent, respectively.

Kakengi *et al*. (2005) found that crude protein content ranged from 265-308 g/kg DM in *Moringa oleifera leaves* (MOL) and seed cake (MOC) respectively. *Leucaena leucocephala* and *Moringa oleifera* soft twigs and leaves (MOLSTL) had CP content of 236 and 195 g/kg DM, while *Moringa oleifera* soft twigs alone (MOST) and *Moringa oleifera* bucks (MOB) had 160, 114 and 69.3 g/kg DM, respectively. It was concluded from this study that the high crude protein content in MOL and MOLST could be well utilized by ruminant animals.

Sanchez *et al.* (2005) reported DM 164 g/kg, CP 176 g/kg DM, NDF 506 g/kg DM, ADF 376 g/kg DM and ash 107.6 g/kg DM in *Moringa oleifera* foliage.

Asaolu *et al.* (2010) studied the chemical composition of Moringa leaves and found the DM 25% and CP 22.2%, EE 6.68%, NFE 41.3%, Ash 13.2%, NDF 28.0%, ADF 28.9%, K 1.26%, Na 0.28%, Ca 1.97% and P 0.13%, on DM basis.

Asaolu *et al.* (2011) reported the chemical composition of *Moringa oleifera* fodder (MO) DM 95.57%, CP 26.74%, EE 8.06%, CF 11.03%, NDF 26.35%, ADF 40.40%, OM 89.83%, NFE 39.53%, calcium 1.10 g/100g, phosphorus 0.43 g/100g, sodium 0.20 g/100g, potassium 0.20 g/100g, magnesium 0.20 g/100g, iron 281.00 mg/kg, manganese 80.0 mg/kg, copper 7.0 mg/kg and zinc 29.0 mg/kg.

Nouman *et al.* (2012) in a study of proximate composition of Moringa oliefera reported that Moringa leaves contained appreciable amount of crude protein (23.5%), crude fiber (7.5%), DM (8.6%), EE (3.0%), ash (13.5%), NDF (21.0%) and ADF (16.0%).

Divya *et al.* (2014) evaluated the proximate composition of *Moringa oleifera* and reported that Moringa leaves contained appreciable amounts of crude protein (24.01%), crude fiber (9.15%), ash (14.11%), crude fat (2.3%), calcium (1.97%) and phosphorus (0.65%).

Teixeira *et al.* (2014) in their study revealed that whole leaf flour of Moringa contained 28.7% crude protein, 7.1% fat, 10.9% ash, 44.4% carbohydrate and 3.0 mg/100g calcium and 103.1mg/100g iron. The protein profile revealed 3.1% albumin, 0.3% globulins, 2.2% prolamin, 3.5% glutelin and 70.1% insoluble proteins.

Tona *et al.* (2014) in a study of growth performance and nutrient digestibility of West African Dwarf goats fed graded levels of *Moringa oleifera* leaf meal observed the, DM 90.46%, CP 18.38%, CF 14.04%, EE 14.58%, Ash 8.38%, OM 91.62%, NFE 44.71%, NDF 25.68%, ADF 14.78%, ADL 7.11%, hemicelluloses 10.90% and cellulose 6.67%.

Babeker and Bdalbagi (2015) evaluated the proximate composition of *Moringa oliefera* and found 20.9% crude protein, 18.5% crude fiber, DM 42.7%, EE 3.8%, ash 10.5%, NDF 28.5% and ADF 18.1 % in Moringa leaves.

Damor *et al.* (2017a) found 77.4% DM, 26.3% crude protein, 14.1% ash, 5.7% ether extract and 8.8% crude fiber in Moringa leaves.

Choudary *et al.* (2018) reported that the Moringa leaves contained 21.37% crude protein, ether extract 6.06%, total ash 12.3%, dry matter 87.13% and crude fiber 4.82%.

2.2. GROWTH PERFORMANCE

2.2.1. Body Weight Gain

Krishna Mohan and Charyulu (1983) reported the average daily gain of 54 g in 60:40 (group I) and 50:50 (group II), respectively with a feed efficiency of 9.13 and 9.46 in both the groups, respectively in Nellore weaner lambs when fed free choice under intensive feeding.

Mangan (1988) studied the nutritional effects of Tannins in animal feeds and reported that condensed tannins protect labile plant proteins in the rumen and may increase the supply of high-quality proteins entering the duodenum and body weight.

Arora and Karim (1995) reported that Malpura and mutton synthetic lambs achieved finishing weight of 20.3 and 20.2 kg with average daily gain (ADG) of 137 and 151 g in 50 and 45 days of intensive feeding, respectively. Total feed intake was higher in Malpura (38.8 kg) compared to mutton synthetic lambs (34.8 kg) and feed conversion efficiency was also better in mutton synthetic (19.1%) than in mature Malpura lambs (17.9%). They have concluded that under intensive feeding mutton synthetic lambs had better growth response and feed conversion efficiency compared to Malpura lambs.

Reed (1995) reported that condensed and hydrolysable tannins present in forage legumes have both positive and negative effects, respectively. The widely accepted explanation for positive effects of condensed tannins on protein digestion and metabolism is that Proanthocyanidins (condensed tannins) -protein complexes escape ruminal degradation and the protein is available in the lower tract and helps in gain in body weight.

Agnigothri and Raj Kumar (2001) reported that average daily gain, feed efficiency and body weight were improved as protein and energy levels in the diet were increased. With increase in protein levels in the diet, feed intake increased but decreased with increasing energy levels under semi-intensive system. The performance of animals under same system shall deeply vary from breed to breed

Reddy and Reddy (2001) reported in an experiment using twelve each of Nellore brown lambs and non-descript kids (12-14 Kgs) were fed diet containing urea treated sorghum straw and cowpea fodder at 70:30 ratio (on DMB) in a 150 days growth trail under intensive system of feeding. The ADG (g), DM required per KG gain (Kg) and cost of feed per kg gain (Rs) were 6.2, 9.0 and 16.20 in sheep and 5.7, 9.8 and 17.6 in goats respectively

Aregheore (2002) found that goats fed on *Moringa oleifera* at 20% (M20%) and 50% (M50%) diets exhibited higher live weight gain as compared to other groups indicating that *Moringa oleifera* at 20% and 50% level of total forage allowance could be used as a cheap protein supplement in batiki grass hay based diet for goats in a study of intake and digestibility of *Moringa oleifera*–batiki grass mixtures by growing goats.

Sarwatt *et al.* (2002) in the study of substitution of sunflower seed-cake (SSC) with *Moringa oleifera* leaves as a supplemental feed in Tanzania, observed that incorporation of different levels of *Moringa oleifera* leaves (MOOL) did not significantly affect the goats' body weight gain.

Kabir *et al.* (2004) reported that significantly increased growth performance of sheep under grazing with concentrate supplementation and inferred that growth performance of Bharat Merino lambs during 3-6 months was better under intensive feeding than grazing with supplementation.

Mahgoub *et al.* (2005) carried out a feeding trial to study the feedlot performance of Omani Batina and Dhofari goats fed diets containing low, medium and high metabolizable energy (ME) levels. They found a significant increase in body weight gain pattern with increasing ME density. Batina and Dhofari goats on highest ME gained more daily weight (96 and 53 g/d) thus reaching higher BW (27.7 and 21.7 kg) at week 20 of experiment than goats on medium (80 and 53 g/d; 25 g and 21.6 kg) and lower (50 and 46 g/d; 21.4 and 20.7 kg) ME diets, respectively.

Porwal *et al.* (2006) reported an average daily gain of 72.6 ±5.40, 160.9 ±10.52 and 135.9 ±7.50 g in Kheri male weaners under extensive, semi-intensive and intensive system of feeding management, respectively.

Asaulo *et al.* (2012b) found that mean weight gains for animals on Moringa-based Multinutrient Blocks (MMNB) supplementations (38.10g day^{-1}) was significantly ($P<0.05$) higher than those of the animals on the reference supplements, which showed no statistical difference.

Bharambe and Burte (2012) in a study of comparative growth performance of Deccani lambs under different rearing systems viz., T1 (Grazing), T2 (Semi stall fed) and T3 (Stallfed) found the dry matter intake, average daily gain in body weight, body length, body height, chest girth and total greasy fleece yield was significantly higher ($P< 0.01$) in stall fed system than grazing and semi stall fed systems. The higher intake of dry matter in T3 (Stallfed) lambs was observed than the lambs reared under the other two systems.

Moyo *et al.* (2012a) reported that, there was significant increase in average daily weight gain ($P<0.05$) in animals fed with *Moringa oleifera* leaves (MOL) and sunflower cake (SC) as compared to animals fed on grass hay (GH). The growth performance of SC and MOL goats were not different. Feeding MOL or SC improved the growth performance of goats in an almost similar way, which indicates that *Moringa oleifera* could be used as an alternative protein supplement in goats.

Mahamoud (2013) conducted an experiment in which twenty-seven of Rahamni lambs fed with three different diets viz., control group lambs were fed R1 contained Clover hay (CH) (1% from live body weight (LBW) plus concentrate feed mixture CFM (3% from LBW), while the experimental lambs were fed CH plus 25 % *Moringa oleifera* stems from CFM (R2) and 25% *Moringa oleifera* stems from CH plus CFM (R3). He found that highest ($P<0.05$) nutrients digestibility and nutritive values were recorded for control ration (R1), while R2 showed the lowest values and R3 had intermediated values. The average daily and total body weight gains for lambs fed R1, R2 and R3 were 205.13, 223.8 and 211.77 g and 18.46, 20.14 and 19.05 kg, respectively with insignificant differences among groups. Rations contained *Moringa oleifera* stems (R2 and R3) had achieved higher feed efficiency than control rations with highly significant different.

Rao *et al.* (2013) conducted a long-term experiment to assess the performance of stocker ram lambs utilizing stockpiled foliage and forage from established Leucaena leucocephala-based silvopastoral system vis-à-vis natural pasture. The study showed that the total forage production, nutrient contents and lambs average daily gain (ADG) was significantly ($P<0.01$) higher in silvipasture than natural pasture.

Divya *et al.* (2014) revealed that the performance parameters in terms of body weight gain at any level of Moringa leaves resulted in decreased gain in body weight during 21 to 42 days of age, although the decrease in body weight was not significant. There was no significant change in BW gain.

Tona *et al.* (2014) studied the growth performance and nutrient digestibility of West African Dwarf goats fed graded levels of *Moringa oleifera* leaf meal and reported that better daily weight gain for goat on diets containing *Moringa oleifera* leaf meal 0% (D1) and *Moringa oleifera* leaf meal 15% (D4) than that obtained in *Moringa oleifera* leaf meal at 5% (D2) and *Moringa oleifera* leaf meal at 10% (D3) in the concentrate mixture.

Babeker and Bdalbagi (2015) found significant ($P<0.05$) improvement in body weight at the end of experiment in group B offered 20 % than another group A (0 %) and C (50%) levels of *Moringa oleifera* leave. Total gain and ADG increased significantly ($P<0.05$) in group B as compare to group A and C.

Sultana *et al.* (2015) revealed that final live weight of goats fed T5 was significantly lower ($P<0.05$) than goats on T1, T2, T3 and T4 as well as daily live weight gain was significantly ($P<0.05$) higher in goats on diets T1, T2, T3 and T4 than

those on diet T5. The average live weight gain in goats fed on T1, T2, T3 and T4 diet was significantly (P<0.01) higher than in goats fed on T5 diet.

Syed Ali (2017) studied the replacement of CSC to the extent of 50% with dried *Moringa oleifera* leaf meal in the concentrate mixture under intensive system of goat rearing and reported that the average initial and final body weights were found to be 14.79 and 14.89 kg in T0 and T1 (50%) groups, respectively which did not differ significantly between both group. Average daily gain over the period was found to be marginally higher in T1 group than control group. However, the difference was statistically non-significant.

Bhalerao (2018) studied the effect of supplementation of *Moringa oleifera* leaf meal on the performance of the growing sheep in which the cotton seed cake was in the concentrate mixture replaced with 10 % and 20 % *Moringa oleifera* leaf meal and concluded that treatment groups had high body weight gain than control but it was statistically non significant.

2.2.2. Dry Matter Intake

Krishna Mohan and Charyulu (1983) reported that the voluntary intake of dry matter was 3.83 and 3.72 kg per 100 kg body weight in 60:40 (group I) and 50:50 (groupII) concentrate to roughage groups, respectively in Nellore weaner lambs when fed free choice under intensive feeding.

A study was conducted by Aregheore (2002) to assess intake and digestibility of *Moringa oleifera*–batiki grass mixtures by growing goats. The DMI of the goats on Batiki grass alone (M0) control group, *Moringa oleifera* leaves at 20 % (M20), *Moringa oleifera* at 50 % (M50) and at 80 % (M80) diets were observed to be 50.6, 50.9, 51.0 and 46.8g/($W^{0.75}$kg), respectively. They observed that DMI was significantly lower (P <0.05) in the goats on M80 diet.

Sarwatt *et al.* (2002) reported that goats provided with treatment diet containing 75% of Moringa + 25% Sunflower seed cake (T3) had significantly (P<0.01) higher DMI than the rest of the goats in the other treatments, followed by those provided with treatment T4 (Moringa 100%), T1 (Sole sunflower seed cake), and then T2 (Moringa 25% + 75% sunflower seed cake). However, the goats in the T1 and T2 treatment diets did not differ significantly (P < 0.05).

Murro *et al.* (2003) found that the dry matter intake and digestibility were higher when Moringa leaves replace cotton seed cake in Black head Persian male sheep.

Manh *et al.* (2005) observed lower dry matter intake in goats offered *Moringa oleifera* (MO) as compared to *Leucaena leucocephala* (LL) irrespective of feeding

method. The results inferred that MO when used as sole fodder needed adoption time as compared to LL and there was no health problem during the experimental period either MO or LL feeding.

Sanchez *et al.* (2005) evaluated the effect of different levels of foliage of *Moringa oleifera* to creole dairy cows on intake, digestibility, milk production and consumption. The animals were fed with *Brechiara brizantha* hay *adlibitum* with or without supplementation of *Moringa oleifera* Lam. *Moringa oleifera* Lam is given @ 2-3 kg to the cows. The total dry matter intake of cows supplemented with 2 kg DM and 3 kg DM of Moringa to *B. brizantha* hay-based diet had significantly ($P<0.05$) higher than the intake of the un supplemented cows.

Asaolu *et al.* (2010) found that there was no significant difference in total DM intake values which ranged from 291 to 315 and 316g DM/animal/day, corresponding to 54.6, 59.6 and 59.6 g/kg $^{0.75}$ for the animals on 100 GNH (Ground nut hay), 50 Bamboo: 50 Ground nut hay (50BAM:50GNH) and 50 Moringa:50 Ground nut hay (50MOR:50GNH), respectively.

Fadiyimu *et al.* (2010) studied the effect of different level of inclusion of Moringa leaves in five rations and found the DM intake was significantly ($P<0.05$) lowered at high inclusion (>50%) level in West African Dwarf sheep.

Asaolu *et al.* (2011) studied the utilization of *Moringa oleifera* fodder (MO) in combination with *Leucaena leucocephala* (LEU) and *Gliricidia sepium* (GLI) fodders in West African Dwarf goats (WAD) by feeding three experimental diets viz., 50MO:50LEU, 50MO:50GLI and 100MO. Their study revealed that there was no significant difference in DM intake between different treatment feeds.

Adegun and Aye (2011) found the dry matter intake was 38.4, 40.6, 42.8 and 42.3 in control (Panicum+ Cassava peels), Moringa multi nutrient block (MMNB), Gliciridia-based multi nutrient blocks, (GMNB) and Leucaena Leucocephala multi nutrient blocks (LMNB), respectively in WAD sheep.

Asaulo *et al.* (2012b) evaluated performance of grazing West African Dwarf goats on moringa multi nutrient block supplementation and found a significant difference ($P<0.05$) in supplement intakes, viz., 11.08, 23.61 and 34.53 g^{-1} $kg^{0.75}$ in MMNB, CPL (Cassava peels) and CSR (Corn starch residues), respectively.

Moyo *et al.* (2012a) reported that, there was significant increase in feed intake ($P<0.05$) in animals fed with *Moringa oleifera* leaves (MOL) and sunflower cake (SC) as compared to animals fed on grass hay (GH).

In study Adegun and Aye (2013) observed the dry matter intake was increased with increasing level of replacement of cotton seed cake with *Moringa oleifera* (0 to 100%) in a concentrate mixture fed to the West African Dwarf sheep

Tona *et al.* (2014) studied the growth performance and nutrient digestibility of West African Dwarf goats fed graded levels of *Moringa oleifera* leaf and found that the DMI increased in the order 5% (D2) < 10% (D3) < 15% (D4) levels.

Babeker and Bdalbagi (2015) studied the effect of feeding *Moringa oleifera* leaves on performance, hematological, biochemical, and some physiological parameters of Sudan Nubian goats at three different levels viz., 0%, 20%, and 50% of *Moringa oleifera* in groups A, B and C, respectively. They found significant ($P<0.05$) increase in feed intake in group B than group A and C.

Kholif *et al.* (2015) studied Moringa oleifera leaf meal as a protein source in lactating goat's diets in order to determine the feed intake, digestibility, ruminal fermentation, milk yield and composition in sixteen lactating Anglo-Nubian goats (36.2 ± 0.7 kg BW). Goats fed on M15 and M20 diets showed increased feed intake ($P<0.05$). They concluded that inclusion rate of 15% MLM (replacing 75% of sesame meal) in the diet was the most suitable level for lactating goats.

Sultana *et al.* (2015) found that the dry matter intake (DMI) of the goats in T2 and T3 was significantly ($P<0.01$) higher than that of T1, T4 and T5 diets. DMI as percent live weight was significantly ($P<0.01$) higher in goats fed on T2 and T3 diets than that of T1, T4 and T5 diets. The range of DMI as percent live weight varied from 3.94 for the animals of T5 to 4.92% for those of T3. Total DMI per unit metabolic body weight was significantly ($P<0.01$) higher in goats of T2 and T3 than in those of T1, T4 and T5 diets.

Jiwuba *et al.* (2016) in study of feeding different level of Moringa leaves to WAD does found that average dry matter intake was significantly ($P<0.05$) higher with goats fed 15% Moringa leaves.

Kholif *et al.* (2016) observed significant ($P<0.05$) intakes of DM, OM, CP, NSC, NDF, ADF and cellulose in goats fed silage and fresh *Moringa oleifera* biomass as compared to those fed on control diet (Sesame meal as sole diet).

Zinder *et al.* (2016) studied the effect of feeding lactating cows with ensiled mixture of *Moringa oleifera,* wheat hay and molasses on digestibility and milk production. The experimental study revealed that voluntary DM intake of cows, fed control TMR, tended to be 1.22% higher than that of the MO-TMR fed cows ($P = 0.09$).

Ahmad *et al.* (2017) conducted a study to evaluate the effect of feeding different levels of dried Moringa oleifera leaves on nutrient digestibility, some blood constituents and performance of calves and found that the DMI was increased with increased level of DMOL in the ration up to 15 percent.

Syed Ali (2017) observed no significant difference in overall daily dry matter intake between ration M0 (Basal diets with GNC) as control and M 50 (GNC replaced with 50% Moringa) treatment group in goats.

Damor *et al*. (2017) conducted an experiment in kids by allotting three experimental treatments viz., T_1 (100% concentrate mixture), T_2 (50% concentrate mixture + 50 % Moringa leaves) and T_3 (100% Moringa leaves). Kids were allowed 6 hours daily grazing. In addition to grazing, kids were supplemented with experimental diets at the 1% of live body weight. Results shown that the dry matter intakes of the kids in all the groups were similar without any significant changes. It was concluded that feeding of dried Moringa (*Moringa oleifera*) leaves replacing conventional concentrate mixture does not affect feed intake.

Jagritisrivastav (2019) conducted a study to investigate the effect of supplementation of *Moringa oleifera* leaves on nutrient utilization and growth performance in goats and observed a non-significant difference in DMI and digestibility of dry matter and crude protein when experimental goat kids supplemented with *Moringa oleifera* leaves at the level of 15% of complete feed.

2.3. BIOMETRIC MEASUREMENTS AND CORRELATION CO-EFICIENT

The biometric measurements indicate the skeletal growth of the animals. Body length and height at withers are the measures of bony growth while chest girth is a measure of development of muscles, bones and fat and it had close relationship with live weight. (Pomeroy, 1955).

Singh and Mishra (2004) reported the co-efficient of determination (γ^2) was maximum for gain in heart girth when compared to gain in height at withers and body length.

Dass (2007) found higher gain in body length for the stall feed pugal sheep in its home tract.

Rahman (2007) conducted a study to predict carcass weight from the body characteristics of Black Bengal goats and suggested that body measurements like live weight, wither height, heart girth, body length can be used as selection criteria to select

goats for meat production. Rib-saddle joint length is more reliable in predicting live weight than hip width in Black Bengal goats.

Alex *et al*. (2010) collected data on body weight and body measurements of Malabari goat and found that the correlation between body weight and body measurements at different ages was positive and strongly correlated in most cases.

Jimmy *et al*. (2010) conducted a study on East African goat breeds and concluded that all linear body measurements and live body weight were highly ($P<0.001$) and positively correlated for all ages except for the group with two pairs of permanent incisors.

Chaturvedi *et al*. (2010) reported the body weights of lambs at 15, 30, 45, 60, 75 and 90 days of age and body weight gain and average daily gain (g) of lambs at 90 days of age were also higher in G1 (Grazing + Pelleted concentrate mixture) than that in G2 (Sole grazing) but the differences were non-significant. The concentrate supplementation at the rate of 400 g/ewe/day during these critical stages enhanced the production performance and birth weight of lambs.

Adegun and Aye (2011) studied the evaluation of *Moringa oleifera, Gliricidia sepium* and *Leucaena leucocephala* - based multi-nutrient blocks as feed supplements for sheep in South Western Nigeria and observed the body length, heart girth, height at withers, scrotal circumference and tail length gains were least in the control whereas GMNB(Glyricidia Multri-nutient Block) had the highest body length and tail length gain, respectively.

Fahim *et al*. (2013) worked on Rohilkhand goats to record the morphometric traits to establish a relationship between live weight and found a positive and significant ($P<0.01$) correlation between mature body weight and chest girth, body length, height at withers, neck length and pelvic width and it was found to be 0.615, 0.319, 0.439, 0.430 and 0.614, respectively.

Iqbal *et al.* (2013) observed significant and positive correlation coefficients between live weight and other body characteristics: body length, height at withers, heart girth, rump and forehead (0.805, 0.766, 0.767, 0.088 and 0.229), respectively.

Mahammad *et al.* (2014) found significantly positive correlation coefficient between body weight gain and the biometrical measures, where in the co-efficient of determination (R^2) was significantly higher between the body weights to heart girth followed by height at withers and body length.

Padma Meel (2018) studied the effect of feeding drumstick (*Moringa oleifera*) leaves on growth performance in Sirohi kids and reported that the overall body weight

changes, average daily body weight gain, body height, length and heart girth increased in kids.

Jagritisrivastav (2019) conducted the study to investigate the effect of supplementation of *Moringa oleifera* leaves on nutrient utilization and growth performance in goats and observed non- significant difference in the values of body measurement (Body height, heart girth and body length) at 15 % level of Moringa in complete feed.

2.4. BODY CONDITION SCORE

Body condition score is a simple, non-invasive, time saving and beneficial technique to rank sheep according to their body reserve by sight and touch. It is also an important management tool for feeding of animals based on their requirements. The influence of feeding varying levels of concentrate on body condition score and also its effects on the productive performance of lambs is reviewed under.

Russel *et al.* (1969) reported that body condition scores can provide an acceptable and useful estimate of the proportion of fat in the live animal and that the level of prediction is superior to that afforded by live weight. Body condition score is a good indicator of changes in body weights of sheep and will assist sheep breeders with regard to the feeding program to be applied particularly before the breeding system.

Southam *et al*. (1971) stated that ewe hoggets which scored extremely low body condition score were poorest in breeding performance.

Busani Moyo *et al.* (2013) studied the effects of supplementing cross-bred Xhosa lop eared goats with *Moringa oleifera* Lam on helminth load and corresponding body condition score, packed cell volume and observed that the mean BCS and packed cell volume (PCV) in the *Moringa oleifera* (MOL) and Sunflower seed cake (SC) groups started to increase after day 14, until the end of the experiment and concluded that supplementing goats with *Moringa oleifera* improved the BCS**,** PCV values and suppressed coccidian-oocysts and helminth load.

2.5. **PHYSIOLOGICAL PARAMETERS**

Srikandakumar *et al.* (2003) studied the effect of heat stress on respiratory rate, rectal temperature and blood chemistry in Omani and Australian Merino sheep and reported that the body temperature is good measure of heat tolerance in animals. Body temperature represents the resultant of all heat gain and heat loss processes of the body. Rectal temperature is considered as a good index of body temperature even though there is a considerable variation in different parts of the body core at different times.

Marai *et al.* (2007) reported in a review of physiological traits as affected by the heat stress in sheep concluded that exposure of sheep to elevated ambient temperature negatively affect the biological functions which are reflected in the impairment of their production and reproduction.

Venkata Raju *et al.* (2015) studied the physiological responses to intensification in Deccani sheep and found that, the animals kept under intensive system of rearing could achieve superior body weight as compared to extensive and semi-intensive system of rearing. All the physiological values under three different system of management was within physiological limits and there was no significant difference between the groups. However, the animals kept under intensive system of rearing showed least fluctuations in the rectal temperature as compared to those kept under extensive and semi-intensive system of rearing.

Babeker and Abdalbagi (2015) studied the effect of feeding different levels of *Moringa oleifera* leaves on performance, physiological parameters of Sudan Nubian goats. Sudan Nubian goats divided into three groups and fed on three different levels of *Moringa oleifera* in Group A (MOL0%) as control, group B and C animals fed with 20% and fed 50% of *Moringa oleifera* leaves, respectively. Forage was fed at the rate of 1% of the live body weight and reported the mean respiratory values were significantly different from each other in groups. The mean pulse rates were significantly ($P<0.05$) different from each other in group A, C and B. The highest values of these physiological parameters were only noted in group B, this could be attributed to that *M. oleifera* is of high and better nutritional value as a sign of health and more productive animals.

Hassan *et al.* (2015) studied the effect of feeding some forage shrubs on goats' performance and rumen fermentation in dry season. The result indicated that the *Moringa oleifera* and *Lucenea leucocephala* fodder had higher in crude protein digestibility than those fed with *Acacia saligna* and also improved dry matter intake and concluded that the *Moringa oleifera* and *Lucenea leucocephala* fodder are suitable for feeding goats without any adverse effect on their growth performance.

2.6. HAEMATO-BIOCHEMICALS PARAMETERS

Garg *et al.* (1992) studied feeding of bypass protein to cross bred cows in India on straw-based ration and reported that feeding of bypass protein to lactating animals have been suggested by many research scientists as a way to increase the nutrient supply at the intestinal level thereby enhance animal production in ruminant animals.

Karim and Verma (2000) reported a glucose concentration of 50.2 mg /dl in Malpura lambs and blood total protein, albumin and globulin concentrations ranged

from 9.0-10.08, 4.2-4.8 and 4.2-6.1 percent, respectively and it was within the normal range under both intensive and semi-intensive system of management.

The influence of various factors such as age, season, growth performance, reproductive status and farming systems upon blood parameters are necessary to understand in the evaluation of blood parameters to determine the nutritional status of animals for undertaking the prophylactic measures to counter the health disorders and to increase productivity (Antunovic *et al*., 2002).

Ramesh Kumar *et al.* (2003) reported albumin and globulin level ranged in between 2.50 and 3.98 g /dl and 1.83 to 3.26g/dl in Mecheri Sheep. They have reported SGOT ranged between 28.50 to 59.0 IU/L while SGPT level ranged from 2.00 to 7.50 IU/L in Mecheri Sheep.

Porwal *et al*. (2005) reported the total protein, albumin, globulin and Albumin: Globulin ratio (A/G ratio) similar in grazing with supplementation, intensive and extensive range feeding management in lambs.

Daramola *et al.* (2005) in a study of haematological and biochemical parameters of West African Dwarf (WAD) goats indicated haematological and serum biochemical values and could serve as a baseline information for comparison in conditions of nutrient deficiency, physiological and health status of WAD goats kept under native husbandry system in Southern Guinea Savannah of Nigeria.

Fadiyimu *et al*. (2010) found that packed cell volume (PCV), hemoglobin (Hb), red blood cell count (RBC) and white blood cell count (WBC) for animals on browse supplementation were within normal physiological range for healthy sheep, in contrast to those without supplementation which were below the range. The blood profile was best for animals on 25% Moringa inclusion in West African Dwarf goats.

Adegun and Aye (2011) reported the values for PCV, Hb, RBC, MCV, MCH and MCHC were significantly higher in 30% Moringa supplemented groups than control in WAD goats.

Konlan *et al.* (2012) studied the effect of feeding mixture of 625 g/kg DM rice straw and 375 g/kg DM groundnut haulms (T1), T1 + concentrate feed containing 115 g/kg DM shea nut cake (T2) and T1 + concentrate feed containing 230 g/kg DM shea nut cake (T3) and found that Supplementation did not affect the haematological and serum biochemical indices of the rams except total protein and albumin, which two values were significantly high on T3.

Asaulo *et al.* (2012b) in an experiment of feeding Moringa Multi- Nutrient Blocks (MMNB), cassava peels (CPL) and corn starch residue (CSR) reported that

MMNB supplementation were resulted in a significant (P<0.05) increases in PCV at the end of the study although all values fells within the range considered normal for clinically- healthy WAD goats. Each of the 3 supplements resulted in significant (P<0.05) increase in hemoglobin and RBC, although the magnitudes of the increases where most pronounced with MMNB. Animals on CSR maintained relatively comparable level of WBC at both the commencement and end of the study. However, CPL supplementation result in higher (P<0.05) WBC values at the end of the study where as MMNB supplementation resulted in corresponding lower (P<0.05) values. Hence, adoption of the MMNB feeding technology by small ruminant keeper could be a panacea to the nutritional and health hardship faced by the animals during the usually long dry season.

Babeker and Bdalbagi (2015) found significant variations in erythrocytes indices among the groups except Mean Corpuscular Hemoglobin Concentration (MCHC) in 20% Moringa group, which recorded significantly (P<0.05) high in all indices of erythrocytes when compared with the other two groups. The leukocytes indices have similar observations for all parameters except total white blood cells count (WBC) which increased significantly (P<0.05) in 20% Moringa group (6.21 ± 0.14) than 50% Moringa group (4.77 ± 0.34) and 0% Moringa group (4.21 ± 0.09). Glucose decreased a significantly (P<0.05) in 20% Moringa group when compared to other two groups, while total protein (7.71 ± 0.03) and albumin (2.86 ± 0.10) were highly significant (P<0.05) in 20% Moringa group when compared with other two groups. Therefore, the study revealed that the *Moringa oleifera* leaf meal could be used to improve livestock system of small ruminants without any adverse effect on the productive performance and blood indices at the 20% diet inclusion level.

Kholif *et al.* (2015) observed no significant effect of Moringa supplementation on total protein, albumin, glucose and SGOT and SGPT concentrations were increased with 20 % Moringa diet when compared to control diet in Anglo-Nubian lactating goats.

Azzaz *et al.* (2016) reported that there was no significant difference in blood albumin, ALT, AST but the ewes fed *Morina oleifera* dried leaves had significantly higher plasma protein and glucose values than control groups in Rahmani lactating ewes.

Kholif *et al.* (2016) in an experiment with feeding processed *Moringa oleifera* meal in lactating Anglo-Nubian goats reported that the serum cholesterol was decreased while glucose levels were increased compared with control.

There were significantly (P<0.05) higher protein and albumin in lambs fed with Moringa meal while significant decrease in serum glucose compared to control diets (Suliman *et al.,* 2016).

Jiwuba *et al.* (2016) studied the effect of feeding different levels of feeding Moringa leaf meal in goats and concluded that PCV, RBC, MCV and WBC differed significantly (P<0.05) among the treatment groups and recommended that supplementation of *Moringa oleifera* at 15% was optimum in West African Dwarf goats.

Ahmad *et al.* (2017) found that there was insignificant difference in blood total protein, globulin, creatine and ALT among experimental rations. They inferred that replacing up to 15% calf starter by DMOL improved growth performance in growing calves compared to 20% replacement and control groups.

Syed Ali (2017) opined that supplementation of 50% Moringa meal had no effect on serum total protein, albumin, globulin, glucose, SGOT and SGPT similarly, non-significant effect on erythrocyte and leucocyte indices in growing goats. They concluded that no beneficial and adverse effect on growing goats with replacement of cotton seed cake with 50 percent Moringa leaf meal in concentrate mixture.

Damor *et al.* (2017b) reported serum total protein, albumin and SGOT levels were found to be significantly (P<0.05) higher in moringa fed group as compared to control group. They concluded that moringa (*Moringa oleifera*) leaves are rich in protein and minerals and replacing the concentrate mixture with Moringa leaves in diet of growing Mehsana goat kids increased concentrations of blood total protein, albumin, SGOT and calcium while decreased level of blood cholesterol.

Yosuf *et al.* (2018) opined that supplementation of *Moringa oleifera* leaf meal (MLOM) up to 100g/Kg DM didn't have any effect on RBC, Hb, PCV and total protein in goats.

Manmohan Kumar *et al.* (2018) studied the effect of feeding *Moringa oleifera* leaf powder on growth performance of growing female Black Bengal goat and found good improvement in hematological and biochemical profile without affecting health status under intensive and semi-intensive systems of management.

Padma Meel (2018) in an experiment of feeding drumstick (*Moringa oleifera*) leaves on growth performance of Sirohi kids reported that WBC values, hemoglobin and PCV values were non-significant among groups but improved by increasing levels of *Moringa oleifera* leaves in diet. The serum total protein and serum albumin levels were significantly increase (P<0.05) in 100% MLOM group whereas serum globulin

level improved while serum glucose level decreased by increasing levels of *Moringa oleifera* leaves in diet.

Jagritisrivastav (2019) conducted a study to investigate the effect of supplementation of *Moringa oleifera* leaves on nutrient utilization and growth performance in goats and observed a non- significant difference in the values of total serum protein and glucose when experimental goat kids fed Moringa leaves at 15% of complete feed.

2.7. NUTRIENT DIGESTIBILITY

Murro *et al.* (2003) reported that dry matter intake and dry matter digestibility were higher in blackhead Persian sheep when *Moringa oleifera* leaf meal replaced with cotton seed cake in the concentrate mixture.

Manh *et al.* (2005) studied the digestibility of dry matter, protein, NDF, ADF and nitrogen retention in goats fed Moringa and observed the same were not different from those fed *Leucaena*. The study showed that Moringa leaves can be used as a sole feed for goat.

Sanchez *et al* (2005) observed that supplementation of different levels of Moringa significantly increased ($P<0.05$) the dry matter intake in dairy cows.

Naula *et al.* (2006) revealed that when *Moringa oleifera* replaced concentrate in the supplement by 25 % (C75) or by 50% (C50), there was no significant difference in gas production (GP) and In Vitro Digestibility (IVTD) after 24 hours fermentation between these supplements and *Moringa oleifera* alone at 10% and 20% level of supplementation.

Akinyemi *et al.* (2010) they were used five treatments 1-5 with 0, 25, 50, 75 and 100 % *Moringa oleifera* inclusion levels, respectively. The best DM, organic matter (OM), CP and Nitrogen-free extract (NFE) digestibility were obtained at 100 % Moringa inclusion while CF and ether extract (EE) digestibility were highest at 25 % inclusion level which also gave similar DM and CP digestibility with 100 % inclusion.

Tona *et al.* (2013) found that the percentage of Organic Matter digestibity (OMD) was highest ($P<0.05$) in D1 (61.42%) and lowest in both D2 (46.22%) and D5 (46.81C) which did not differ ($P>0.05$) in a study the ruminants in Nigeria were fed with 0% (D1) MOL, 5% (D2) MOL, 10% (D3) MOL, 15% (D4) and 100% (D5) MOL. This study demonstrated that MOL when fed in combination with conventional concentrate ingredients could enhance its utilization as feed for goats.

Mahmoud (2013) studied the effect of feeding Moringa oleifera stems (MS) on growth performance of growing lambs by feeding R1 contained clover hay (CH) (1%

from live body weight (LBW) plus concentrate feed mixture CFM (3% from LBW), while the experimental lambs were fed CH plus 25 % Moringa oleifera stems from CFM (R2) and 25% Moringa oleifera stems from CH plus CFM (R3). They found that digestion coefficients were insignificant among three tested rations for EE and cellulose, while the highest digestibility for other nutrients (DM, OM, CP, CF, NFE, NDF, ADF and hemicellulose) with R1 followed by R3 with significant differences between treatments. However, ration two led to significantly decrease all nutrients digestibility.

Kholif *et al.* (2015) opined that goats fed on diet containing 15% Moringa (M15) showed increased ($P<0.05$) ruminal pH, volatile fatty acids and propionate concentrations compared to the control diet. The inclusion at the rate of 15% MLM (replacing 75% of sesame meal) in the diet was the most suitable level for lactating goats.

Soby *et al.* (2015) observed that digestibility of all nutrients was non-significant except EE when different levels of Moringa leaves fed to the fattening lambs.

Sultana *et al.* (2015) in a study to evaluate the feed intake, nutrient digestibility and live weight gains of Black Bengal goats fed napier grass mixed with different levels of Moringa foliage in the diets found the dry matter intake and digestibility was increased with the increasing level of Moringa foliage. The digetibilty of other nutrients did not vary significantly among the diets. Nitrogen retension was significantly higher in goats fed with T1 (100% Moringa foliage), T2 (75% Moringa foliage+ 25% Napier grass) or T3 (50% Moringa foliage+ 50% Napier grass) diets than those fed with T4 (25% Moringa foliage+ 75% Napier grass) or T5 (100% Napier grass) diets. The study concluded that Moringa foliage can be replaced in the goat diet upto 75% of napier garss based diet.

Aye (2016) reported that the amount of nitrogen retained in the animal body was significantly higher than the control (*Panicum maximum* and *cassava peels*) when fed *Gmelina arborea* multi-nutrient blocks (GMNB), *Moringa oleifera* multi-nutrient blocks (MMNB) and Tithania diversifola multi-nutrient blocks (TMNB) based multi-nutrient blocks. The study revealed that WAD sheep fed multi-nutrient blocks performed better than those fed control diet of *Panicum maximum-cassava peels* only. Of the entire multi-nutrient blocks *Moringa oleifera* – based multi-nutrient blocks had the best performance, thus providing a better nutrients balance to WAD sheep.

Fadiyimu *et al.* (2016) reported that inclusion of *Moringa oleifera* as supplement to *Panicum maximum* in the diet of WAD sheep significantly lowered ($P<0.05$) DMI specialy at higher (>50%) inclusion rates. The OM, EE and NFE digestibilities were

highest at 25% inclusion level which also gave similar DM and CP digestibility with 100% inclusion.

Oyedele *et al.* (2016) found that DM digestibility was non- significant among the groups viz., 100% Gliricidia (G100 M0), 100 % Moringa (M100), 75% Gliricidia and 25% Moringa (G75M25), 50% Gliricidia and 50% Moringa (G50M50) and 25% Gliricidia and 75% Moringa (G25M75). The CP, EE and NFE digestibility were high in animal fed concentrate in combination with Moringa as sole roughage source. Crude fiber digestibility was least ($P<0.05$) when either of the two forage was fed single along with the concentrate. The observed digestibility of DM, CP, CF, EE and NFE was 66.40, 86.00, 29.50, 78.80 and 69.20, respectively in group where in *Gliricidia sepium* was 100 per cent replaced by *Moringa oleifera.*

Zinder *et al.* (2016) conducted an experiment to study the effect of feeding lactating cows with an ensiled mixture of *Moringa oleifera*, wheat hay and molasses on digestibility and efficiency of milk production and found that invivo digestibility of dry matter, cellulose, NDF and hemicellulose were higher in control cows compared with Moringa fed group.

Ahmad *et al*. (2017) found that nutrient digestability, nutrient values, weight gain, feed conversion and economic efficiency of tested ration were significantly increased with increasing levels of dried Moringa leaves (DMOL) in the ration up to 15% of calf starter in suckling buffalo calves.

Syed Ali (2017) in an experiment of growth performance of goat fed with *Moringa oleifera* leaf meal incorporated in concentrate mixture and found that DM, CP, CF and EE digestibilities were non-significantly increased in Molringa leaf meal based (MLM) diets compared to control, further he concluded that NFE digestibility was significantly ($P<0.01$) increased in MLM group compared to control group.

2.8. FEEDING BEHAVIOR

Abijaoude *et al*. (2000) reported the number of secondary meals decreased with the increase of forage content. Intake during secondary meals was 0.84, 0.88, 0.83 and 0.70 kg DM/day, respectively, on CR (Forage30:70 Concentrate and rapidly degradable starch), CS (Forage30:70 Concentrate and slowly degradable starch), FR (Forage55:45Concentrate and rapidly degradable starch) and (Forage55:45 Concentrate and slowly degradable starch). Chewing during eating and rumination depended on the type of diet (less than 740 min/day on C (Forage 30:70 Concentrate) and more than 820 min/day on F (Forage 55:45 Concentrate). Percent of total time spent for eating,

ruminating, drinking, standing, playing, resting and others were 26.6, 16.6, 2.7, 21.8, 4.6, 23.9 and 3.8, respectively.

Nasrullah *et al*. (2013) compared the voluntary intake and digestibility of sheep and goats fed Janter (*Coriandrum sativum*), Guar (*Cyamopsis tetragonoloba*), and Cowpea (*Vigna sinesis*). Results showed that eating time was significantly higher in goats than sheep. Ruminating time was statistically ($P<0.05$) different between sheep and goats. Sheep and goats showed different eating pattern on offered fodders. Drinking time was lower while playing, resting and others activities were higher in goats than sheep.

2.9. FAECAL CONSISTENCY SCORE

A trial was conducted by Perry and Stallings (1993) in lactating Holstein cows to study the relationships of dietary fibre and protein percentage and source to faecal consistency. TMR were formulated to contain 17 or 25 % ADF and CP of 15 or 22% with soyabean supplementation or 22% with combination of corn gluten and soyabean meal. Two forage combinations were corn silage with and without alfalfa and concluded that lower dietary fibre reduced faecal pH, score, NDF and ADF but increased DM and starch. A higher percentage of soyabean meal lowered faecal DM and faecal score. Forage source affected faecal DM, NDF, ADF and starch but not pH or score.

Sweeny *et al*. (2012) conducted a trial to estimate the impact of naturally acquired protozoa and nematode infections on growth and faecal attributes in lambs and found that mixed internal parasite infections have greater impact on FCS and BCS than single infections. A higher number of internal parasites detected per lamb was associated with lower BCS and more loose faeces.

Bhavana Aharwal (2018) studied the effect of *Moringa oleifera* leaf meal on feed intake and growth performance of Murrah buffalo calves and observed that the fecal consistency score was significantly ($P<0.05$) higher in (control) group compared to rations conatining 5% (T2) and 15 % (T2) Moringa leaf meal.

2.10. CARCASS TRAITS OF GROWING DECCANI SHEEP IN DIFFERENT FARMING SYSTEMS.

Singh and Sahu (1987) reported that dressing percentage was superior under intensive system, the bone and lean percent was higher under semi intensive and fat under intensive system in lambs.

Shinde *et al.* (1995b) reported a meat yield of 13.19 ±0.51 and 10.16 ±0.49 kg under intensive system and semi-intensive system, respectively whereas dressing yield

on liveweight (%) was 45.10 ±1.70 and 44.5 ± 2.20 under intensive and semi intensive system, respectively.

Pal *et al.* (1997a) reported that the carcass weight in the intensive and semi intensive systems were 15.08 and 11.71 kg, respectively in Muzaffarnagari breed. The per cent improvement in slaughter weight, carcass weight was 24.35 and 24.01 in intensive system and 4.95 and 7.62 in semi-intensive system in Muzaffarnagari lambs.

Pal *et al.* (1997b) reported a slaughter weight of 20.48 kg, carcass weight of 9.11kg and carcass yield of 44.51 per cent under semi intensive system in Muzaffarnagari lambs.

Agnigothri and Raj Kumar (2001) reported that lambs maintained under intensive system had higher carcass weight and carcass yield, however proportion of meat and bone components declined significantly while the fat increased substantially in the carcass compared to semi intensively managed lambs. Among the non-carcass components, skin, head and cannon weights were significantly higher in the intensive group in comparison to semi intensive group.

Karim *et al.* (2004) reported that the pre slaughter weight, empty live weight, hot carcass weight, dressing yield in terms of pre slaughter weight and empty slaughter weight were 24.3 ±0.74, 20.3 ±0.58 kg, 10.6 ±0.46 kg, 43.7 ±1.11 %, 52.3 ±1.13 % under intensive system and 22.1 ±0.01 kg, 19.1 ±0.83 kg, 9.5 ±0.42 kg, 42.9 ±0.50 % and 49.5± 0.56 %, respectively in grazing with supplementation group.

Suresh Kumar and Karim (2009) reported that the Pre-slaughter weight, empty live weight and hot carcass weight were similar in Chokla and Avikalin yearling males. The dressing yield in terms of pre slaughter weight and empty live weight were however, higher ($P<0.01$) in Avikalin than Chokla. In the variety meat, liver weight was higher ($P<0.01$) in Chokla (1.8 % of PSW) than Avikalin (1.6 % of PSW) whereas the kidney, heart, testicle, spleen weights were similar in the 2 breeds averaging to 0.28, 0.41, 0.79 and 0.16 %, respectively. The skin weight was significantly ($P<0.05$) higher in Chokla (9.45 % of PSW) whereas percentages of the head and lungs with trachea were higher ($P<0.05$) in Avikalin.

Busani Moyo *et al.* (2013) studied to determine the effect of supplementing *Moringa oleifera* leaves (MOL) on growth performance, carcass and non-carcass characteristics of crossbred Xhosa lop-eared goats and found that carcass characteristics of SC (sesame cake) and MOL goats were not different. Feeding MOL or SC improved the growth performance and carcass characteristics of goats in an almost similar way,

which indicates that *Moringa oleifera* could be used as an alternative protein supplement in goats.

Malisetty (2013) studied the comparative effect of sole grazing and grazing with concentrate supplementation in lambs and found that, the carcass weight ($P<0.01$) and dressing percentage on slaughter weight basis ($P<0.05$) were also significantly higher in grazing ram lambs supplemented with concentrate than those maintained on grazing only.

Kochewad *et al.* (2018) reported that the T1 (intensive) group had higher pre-slaughter weight, hot carcass weight, meat %, fat% and meat: bone ratio than T2 (Semi-intensive) and T3 (Extensive). The dressing yields were comparable. The weights of other offals (heart, kidney, spleen, testicles, blood, head and lung and trachea) were comparable. The findings of this study indicated that the intensive and semi-intensive system of rearing could be useful for mutton production.

2.11. ECONOMICS OF FEEDING MORINGA BASED DIETS.

Nagpal *et al.* (1995) reported that weaning kids at 3-4 months age and feeding intensively was most expensive (Rs 28.92 to 32.84 / Kg gain) compared to weaning at 2 months of age and rearing under a semi intensive system (Rs 6.29 to 7.25 /Kg gain).

Shinde *et al.* (1995b) reported that based on inputs and scale of produce the lambs in the two-feeding system provided net return of Rs 124.54 and 153.36 with cost benefit ratio of 1.22 and 1.38, respectively in intensive and semi- intensive system of management.

Mehta *et al.* (2000) reported that the net returns from Sirohi, Kutchi and Marwari kids slaughtered at the age of 9 months were Rs 52.15, 67.88 and 110.10, respectively being highest from Marwari due to fastest growth rate during 3-6 months of age.

Porwal *et al.* (2006) reported that disposal of the finisher by slaughter provided 225, 266 and 303 percent higher income under extensive, semi intensive and intensive than sale of live animals.

Karim and Verma (2004) reported that under intensive feeding 70 kg complete feed was consumed at a cost of Rs 274/ head, while grazing with supplementation consumed 27 kg concentrate costing Rs 162/ head. Accordingly, the cost of feeding/ gain in live weight was Rs 31 in intensive system and Rs 23 in grazing with supplementation.

Patel *et al*. (2004) reported that the average total feed cost (Rs /head) for rearing lambs was Rs 291.06 and 190.35 under conventional and non-conventional

treatment groups, respectively. The total feed cost was significantly reduced to the tune of 47.84 percent under non-conventional group over conventional group due to higher cost of conventional concentrate ingredients. The feed cost per Kg gain and per kg dressed weight was 30.01 ± 2.58 and 32.79 ± 1.40 and 23.04 ± 1.07 and 23.95 ± 0.57 under conventional treatment group and non-conventional treatment groups, respectively.

Adegun and Aye (2013) reported cost per metabolic weight gain was observed to be significantly low in diets with graded levels of replacement of CSC by *Moringa oleifera* leaf meal as compared to group 1 which was maintained as control. They also observed significant reduction in cost per kg live metabolic body weight with increasing level of supplementation. They concluded that MLM can completely replace CSC as protein source in a concentrate mix fed to WAD sheep as supplement to basal *Panicum maximum* diet.

Soby *et al.* (2015) reported economical evaluation was in favour of the 15% and 30% level supplementation regarding relative percentage of net revenue and relative percentage of cost of feed consumed. In conclusion, moringa leaves could be used economically and successfully for feeding lambs.

Syed Ali (2017) observed that the average cost of feeding in *Moringa oliefera* leaf meal was incorporated at 0% and 50% in the concentrate mixture was found to be Rs 875.56 and 790.21, respectively and the feeding cost per kg weight gain was Rs 195.87 and 173.67 in *Moringa oliefera* leaf meal incorporated at 0% and 50% in the concentrate mixture, respectively. The feed cost per kg weight gain was lower in MLM 50% group compared to MLM 0% group. Lower feeding cost in treatment group also fetched higher profit of Rs 25.05 per kg body weight gain. They concluded that replacement of cotton seed cake with 50% Moringa leaf meal reduced the cost of production and per kg weight gain.

Haridas (2018) found that feed cost/kg weight gain was Rs 131.96, 131.77 and 126.93 when lambs were fed with M0 (Sole cotton seed cake) M10 (Cotton seed cake replaced with 10% Moringa) and M20 (Cotton seed cake replaced with 20% Moringa) rations, respectively.

Yosuf *et al.* (2018) opined that MLOM based supplementation had significantly lowered the cost per kg weight gain and higher profit per kg weight gain in WAD goats.

2.12. SHEEP REARING SYSTEMS

Parthasarathy *et al*. (1984) reported that kids maintained under semi intensive system attained maximum body weight and reached target live weight of 25 Kg earlier than those under intensive or extensive systems and required less feed for Kg of weight gain than those under intensive feeding.

Prasad *et al.* (1991) reported an ADG of 91.33 g and a weight gain of 8.22 kg with feed efficiency of 14.60 in a 90 days growth trial in Nellore weaner under intensive system of feeding and management.

Shinde *et al.* (1995b) reported that Avivastra weaner lambs had achieved higher finishing weight in intensively (33.5 Kg) fed lambs compared to semi- intensively (27.38 kg) fed lambs. They have also an ADG of 138.9 ± 0.97 g and weight gain of 14.3 ± 0.89 kg in intensively managed Avivastra lambs is comparison to ADG of 98.6 ± 5.64 g and weight gain of 8.9 ± 0.51 kg in semi intensively managed lambs. The DMI (g/day/animal), DMI (g/kg/BW), DMI (g/kg 0.75) and feed conversion ratio reported as 944.7 ± 36.6, 36.5± 1.22, 83.4 ± 1.22 and 8.9 ± 0.51 in intensively management system, where as 743.9 ±48.65, 32.3 ± 2.17, 70.7 ± 4.50 and 12.95±1.03 in semi intensively management system in Avivastra lambs.

Shinde and Singh (1995a) reported that sheep grazed on pasture are able to attain 27.3 kg finisher body weight at 6 months of age under free grazing and concentrate supplementation at 15 g/ kg of age under free grazing and concentrate supplementation at15 g/ kg of body weight.

Maurya *et al.* (1997) in a field study found that the body weight of Awassi x Malpura crossbred lambs were significantly higher than the respective male and female lambs of native Malpura breed under identical semi intensive management systems.

Pal *et al*. (1997b) reported that lambs reared under intensive system were superior to semi intensive system with respect to mutton production.

Reddy and Reddy (1998) studied the performance of sheep and goats under intensive rearing in their experiments with native male kids of Telangana region of Andhra Pradesh and observed an ADG of 37.1 g and FCR (Feed /Gain) of 14.7 .

Zervas *et al*. (1999) reported that body weight gain feed conversion ratio was superior in lambs fattened indoors than those allowed for grazing.

Karim and Verma (2001) reported that the average daily gain of 95 + 4.4 g in grazing with supplementation group and 79 ± 4.4 g in intensively feeding group and concluded that growth response was better under grazing with 300 g concentrate supplementation compared to intensive feeding. They have also reported that in spite of

lower DMI, DCP and TDN intake the growth rate was higher under grazing with supplementation than that in intensive feeding in Malpura weaners.

Meenakshi Sundaram *et al*. (2002) reported that in fifth to twelfth month of age, the intensively reared lambs (slatted and mud floor groups) maintained their superiority in growth rate than those reared under semi intensive system of management and the average daily gain for period of 3 to 12 months were significantly higher for lambs of intensive system than those under semi intensive system.

Singh *et al*. (2003) reported that lambs maintained under intensive and semi intensive system for a period of 90 days achieved 22.3 and 22.7 kg weight at 5 and 6 months of age respectively .The total post weaning gains were 10.0 and 10.2 kg with 111gand 113 g of ADG in the two systems and concluded that dressing yield in terms of empty live weight was higher in grazing with supplementation than intensive feeding.

Porwal *et al.* (2006) reported an average daily gain of 72.6 ± 5.40, 160.9 ±10.52 and 135.9 ± 7.50 g under extensive, semi-intensive and intensive system of feeding management, respectively when a study was taken up on farmers adopted Kheri male weaners for comparing the extensive, semi intensive and intensive management systems.

Bharambe and Burte (2012) studied the performance of Deccani lambs under different rearing systems viz., T1 (Grazing), T2 (Semi stall fed), T3 (Stall fed). The dry matter intake, average daily gain in body weight, body length, body height, chest girth and total greasy fleece yield was significantly higher ($P< 0.01$) in stall fed system than grazing and semi stall fed systems. The higher intake of dry matter in T3 (Stall fed) lambs was observed than the lambs reared under the other two systems.

CHAPTER III

MATERIALS AND METHODS

A study was conducted to evaluate the effect of feeding Moringa (*Moringa oleifera*) leaf meal-based diets on productive performance of growing Deccani sheep in two experiments i.e intensive and semi-intensive farming system.

3.1 GROWTH STUDY

3.1.1 Experiment Location

The experiment on feeding Moringa (*Moringa oleifera*) leaf meal-based diets on productive performance of growing Deccani sheep under intensive system was conducted at Livestock Farm Complex (ILFC), College of Veterinary Science, Rajendranagar, Hyderabad whereas the semi-intensive feeding trial was conducted at Animal Experimental Farm, ICAR- CRIDA campus, Hayathnagar, Rangareddy District.

The study was conducted for three months each in intensive and semi-intensive farming systems and following parameters were recorded and estimated.

1. Composition of *M. oliefera* leaves, green fodder (Para grass) and experimental diets
2. Dry matter intake**,** nutrient digestibility, body weight, body condition scores and biometry in different farming systems
3. Physiological parameters like rectal temperature, pulse rate and respiratory rate in farming systems
4. Biochemical constituent's like total protein, serum albumin, glucose, SGPT and SGOT and hematological constituents like RBC, WBC, DLC and Hb reared in different farming systems
5. Feeding behavior in intensive system and Fecal consistency score in different farming systems
6. Carcass characteristics like pre slaughter weight, dressing percentage, wholesale cuts.
7. Cost economics of rearing Deccani sheep in different farming systems.

3.1.2 Experimental animals

Eighteen growing Deccani sheep of uniform body weight (14.19 ± 1.5 kg) and age (4 to 8 months) were selected and randomly allotted to three treatment groups with six lambs in each group (6 x 3) and reared in intensive farming at LFC, Rajendranagar. Similarly, eighteen growing Deccani lambs of uniform body weight (18.77±0.97 kg) and age (6 to 10 months) were selected from Animal Experiment Farm of CRIDA and randomly allotted to three treatment groups with six lambs in each group (6 x 3) and

reared in semi-intensive farming at Animal experimental farm, CRIDA campus, Hayathnagar Hyderabad. Three experimental diets were prepared using 100 percent groundnut cake (T1), 75% groundnut cake+ 25% *Moringa oliefera* leaf meal (T2) and 50% groundnut cake+ 50% *Moringa oliefera* leaf meal (T3) as protein source in the concentrate mixture and offered @ 1% of body weight along with *ad libitum* green fodder. Distribution of experimental animals were shown in Table.1

3.1.3 Ingredient composition of experimental diets

The ingredient composition of experimental diets fed to lambs in different groups i.e., T1 (Control), T2 and T3 consisting of red gram chunni, deoiled rice bran, ground nut cake, cotton seed cake, moringa leaves, mineral mixture, salt and is given in Table 2.

3.1.4 Preparation of Moringa oleifera leaf meal (MLM)

For the purpose of experiment, the *Moringa oliefera* dried leaves was purchased from M/S Indian Agri farm, Karunkulam village, Kanyakumari Tamilnadu. The dried leaves were finely grounded to powder form and then bagged and stored for incorporation in the concentrate mixture.

3.1.5 Housing and management of experimental animals

All the lambs in the experiment were provided with a floor space of $1m^2$/ lamb in the covered shed with asbestos roof. The experimental lambs were ear tagged for proper recording of the data. All the lambs were dewormed with Albendazole @ 10 mg /kg body weight before start of the experiment and once in the middle of the trail in both systems of management. Proper feeding and watering arrangements were made hygienically.

3.1.6 Feeding and watering of experimental lambs

The three experimental diets were randomly allotted to three groups with six lambs in each group in completely randomised design (6 x 3) in both intensive and semi-intensive farming systems. Chaffed Paragrass was offered *adlibitum* in the morning and evening for a period of 90 days to meet the nutrient requirements of the lambs in intensive system. Leftover of feed and fodder, if any, was recorded next day morning at 24 hourly intervals to calculate total dry matter consumption per day. Same experimental diets were used to conduct the trial in semi-intensive system but the lambs were fed the experimental diets @ 1% of body weight + 4 hours of grazing and *adlibitum* quantity of green fodder for 90 days. Clean, wholesome and fresh drinking water was made available to each animal in water troughs throughout the experimental period. The feeding management schedule is presented in Table 3.

Table1. Distribution of sheep for growth studies

Intensive System			Semi -Intensive System		
No.	**Animal No.**	**Body Weight**	**No.**	**Animal No.**	**Body Weight**
T1			**T1**		
1	302	15.3	1	53	19.1
2	303	12.0	2	55	23.9
3	307	13.2	3	57	13.0
4	289	16.3	4	63	19.1
5	298	17.3	5	64	16.1
6	305	11.2	6	65	21.8
	Mean ±SE	**14.21±1.89**		Mean± SE	**18.83±1.59**
T2			**T2**		
1	291	20.0	1	51	19.2
2	304	9.1	2	52	23.2
3	309	10.5	3	56	15.4
4	287	20.0	4	61	19.5
5	295	11.5	5	62	20.5
6	299	14.0	6	68	15.2
	Mean± SE	**14.18±1.95**		Mean ±SE	**18.83±1.25**
T3			**T3**		
1	301	18.2	1	54	19.0
2	306	11.8	2	58	20.0
3	310	9.7	3	59	17.3
4	294	21.5	4	60	17.0
5	297	13.1	5	66	22.1
6	308	10.8	6	67	17.6
	Mean± SE	**14.18±0.97**		Mean ±SE	**18.83±0.80**

Table 2. Ingredient Composition of experimental diet (kg)

Ingredients	**Control T1**	**T2**	**T3**
De-oiled rice bran	29	26.7	24.5
Moringa Leaves	-	7.3*	14.5*
Ground nut cake (De-oiled)	20	15	10
Cotton seed cake	13	13	13
Red gram chunni	35	35	35
Salt	01	01	01
Min.Mix	02	02	02
Total Nutritive value (calculated %)	100	100	100
TDN	60.85	60.07	60.58
CP	19.28	19.00	18.72

*25% and 50% GNC Protein replaced with Moringa leaves in T2 and T3, respectively.

Fig 1. Housing system in intensive farming system

Fig 2. Intensive feeding

Table 3. Feeding Schedule of Experimental Animals in both the experiments.

Intensive System		Semi –Intensive System	
Group	**Feeding**	**Group**	**Feeding**
T1	Stall feeding with concentrate mixture (MLM 0%) @1 % of body weight and *ad-libitum* green fodder.	T1	Four hours grazing with concentrate mixture (MLM 0%) @ 1 % of body weight and *ad-libitum* green fodder.
T2	Stall feeding with concentrate mixture (MLM 25%) @1 % of body weight and *ad-libitum* green fodder.	T2	Four hours grazing with concentrate mixture (MLM 25%) @ 1 % of body weight and *ad-libitum* green fodder.
T3	Stall feeding with concentrate mixture (MLM 50 %) @1 % of body weight and *ad-libitum* green fodder.	T3	Four hours grazing with concentrate mixture (MLM 50%) @ 1 % of body weight and *ad-libitum* green fodder.

3.1.7 Live weight recording

The growth trial was conducted for ninety days in both the experiments. Lambs were weighed by using an electronic digital balance at fortnightly interval before offering feed and water in the morning throughout the experiment period in both farming system

Fig 3. Grazing of sheep in semi - intensive system

3.1.8 Average Daily Gain (ADG) and Feed Conversion Ratio (FCR)

The average daily gain (ADG) and feed conversion ratio (FCR) were calculated by using the following formulae.

$$ADG = \frac{\text{Final Weight (kg)} - \text{Initial Weight (kg)}}{\text{Number of days of growth trial}}$$

$$FCR = \frac{\text{Dry Matter intake (kg)}}{\text{Gain in body weight (kg)}}$$

3.1.9 Biometric measurements

Body measurements were recorded by using a standard measuring tape to the nearest 0.5 centimeter after the animals were allowed to stand squarely on an even ground. This was performed in the morning before the animals were let out for grazing in semi- intensive system.

The body measurements were recorded as per Narasimham *et al.* (2003) and Rajanna *et al.* (2013) as mentioned below.

Height at withers: Distance from the base of the hoof to the highest point of withers .

Chest girth: Body circumference around the chest, just behind the elbow joint.

Body length: Distance from point of shoulder to the point of tuber ischii.

Hip width: Distance from the tuberosity prominence of ilium bone of one side to the other, across the rump.

Face length: Distance from the base of the nose to the middle point of head.

Tail length: Distance from the base of the tail to the head of tail.

3.1.10 Body condition score (BCS)

Body Condition score is practical management tool to be used in conjunction with nutritional and other management strategies to optimize production of the flock. Body Condition score of the sheep in different farming systems were recorded at fortnightly intervals. The BCS was determined by visual appraisal and by palpation or

combination of the two in sheep. The body condition score was done based on 1 to 5 scale system with an interval range of 0.5 point as per the procedures suggested by Russel *et al.* (1969). The scores assigned were tallied with score of two colleague researchers and advisor of the research for correction and accuracy, the five BCS are as follows and related to the Fig.1

Table. 4. Body condition score

S.No.	Visual appraisal and by palpation	Body Condition score (BCS)
1	Emaciated	1
2	Thin	2
3	Average	3
4	Fat	4
5	Obese	5

Body Condition Score 1 (Emaciated)

Spinous processes are sharp and prominent. Loin eye muscle is shallow with no fat cover. Transverse processes are sharp; one can pass finger under ends. It is possible to feel between each process.

Body Condition Score 2 (Thin)

Spinous processes are sharp and prominent. Loin eye muscle have little fat. Transverse processes are smooth and slightly rounded. It is possible to pass finger under transverse processes with a little pressure.

Body Condition Score 3 (Average)

Spinous processes are smooth and rounded and one can feel individual process only with the pressure. Transverse processes are smooth and well covered, and firm pressure is needed to feel over ends. Loin eye muscle is full with some fat cover.

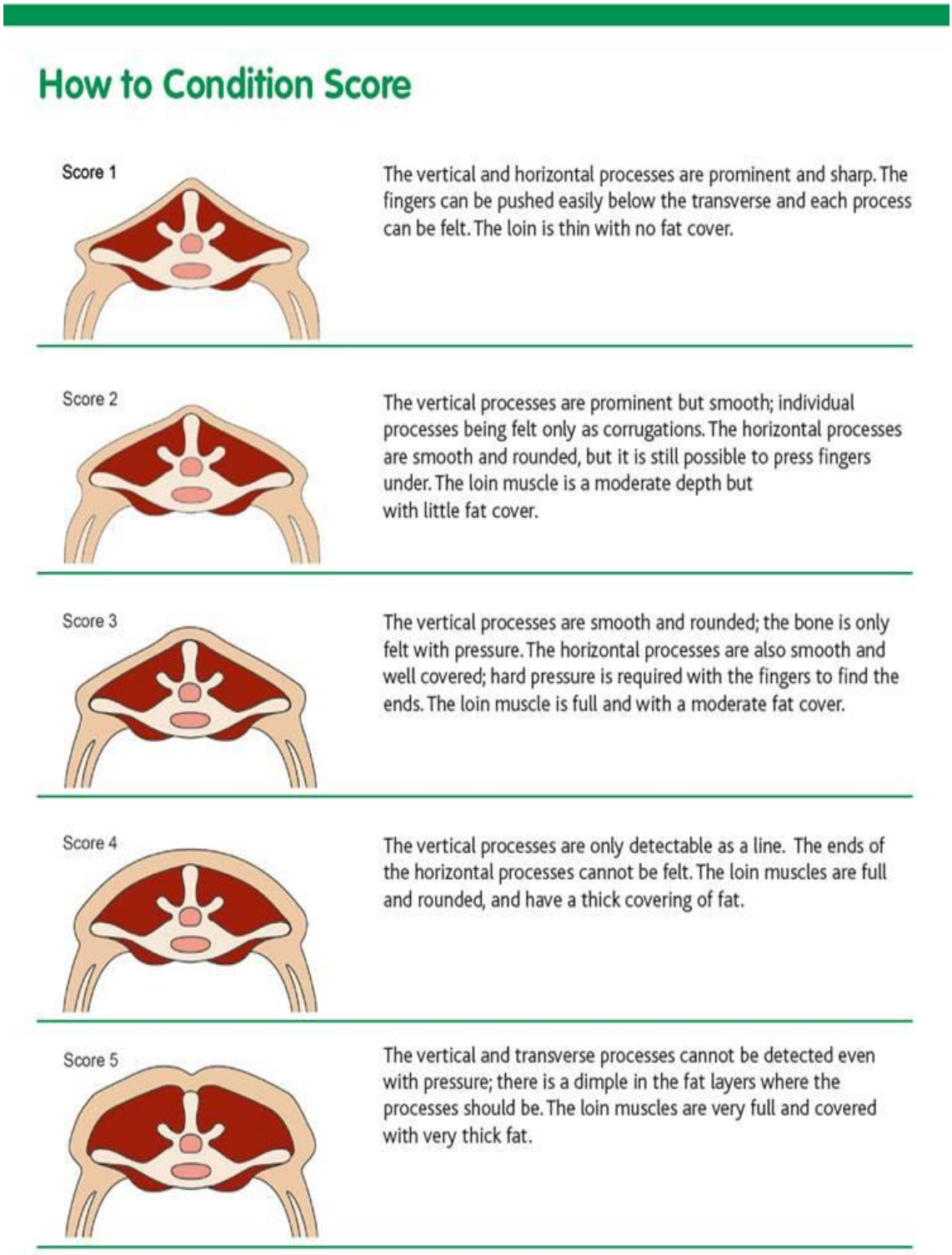
Body Condition Score 4 (Fat)

Spinous processes can be detected by only pressure as a hard line. Transverse processes cannot be felt. Loin eye muscle is full with thick fat cover.

Body Condition Score 5 (Obese)

Spinous processes can’t be detected. There is a depression between fat where spine would normally be felt. Transverse processes cannot be detected.

Fig 4. Body condition score



Source: www.farmhealthonline.com

3.2 PHYSIOLOGICAL PARAMETERS

Physiological parameters were recorded every fortnight twice in a day at 10.00 AM and 4.00 PM. in intensive system whereas the same was recorded twice in a day between 7.30 to 8.30 AM and 3.00 to 3.30 PM for every fortnight (before and after grazing) in semi intensive system.

3.2.1 Rectal temperature

The rectal temperature was recorded accurately by a clinical thermometer inserted into rectum, ensuring that the thermometer bulb was left in contact with the rectal mucosa for one minute. The observations were recorded in degree of Fahrenheit (^{0}F).

3.2.2 Respiration rate

The respiration rate was recorded by observing flank movement for one minute in which each inward and outward movement of the flank was counted as one complete respiration. The respiration rate was expressed as breaths per minute (bpm).

3.2.3 Pulse rate

Pulse rate of the animals was recorded by observing the pulsation of middle coccygeal artery at the base of the tail with the help of finger. The pulse rate was expressed as beats per minute.

3.3 HAEMATOLOGICAL PARAMETERS

The haematological parameters were carried out to study the effect of feeding Moringa (*Moringa oleifera*) leaf meal-based diets on haematological values of growing Deccani sheep in different farming systems.

3.3.1 Blood Collection

The whole blood sample (5ml) was collected by puncturing the jugular vein from all the experimental animals at every fortnight into a clean, dry, sterilized test tube with EDTA as anti coagulant under aseptic conditions. These test tubes were labelled and brought to the laboratory for further analysis.

The haematological study (i.e RBC, WBC, HB, Erythrocyte and leucocytes indices) was carried out with the help of haemoanalyser. (ABX-MICROS-60)

3.4 BIOCHEMICAL STUDIES

Whole blood (10 ml) was collected into test tube without adding the anticoagulant and serum was separated by centrifugation and then transferred into a sterilized plastic vial, labelled and stored at -20^{0}C till use for 72 hrs after collection of blood. Clean glassware and analytical grade chemicals were used in the study.

Blood serum metabolites like glucose, albumin, and total protein were analysed to find out the changes if any deviations from normal range due to feeding of Moringa leaf-based diets in different farming systems.The SGOT and SGPT levels were also analysed in the serum as part of liver function tests to find out the changes if any due to feeding of Moringa leaf-based diets in different farming systems. The biochemical constituents and liver function testswere estimated by using standard kits. The blood biochemical parameters were analyzed using commercial kits (Coral Clinical Systems) on auto analyzer (Model: Erba-chem 7, India) and spectrophotometer (Thermo) using following formula.

3.4.1 Glucose

The collected samples of serum from each group were examined for glucose by commercial test kit, Crest Bio systems (a division of Coral clinical) at 505 nm using spectrophotometer 106.

$$\text{Glucose (mg/dl)} = \frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times 100$$

3.4.2 Total protein

The collected samples of serum from each group were examined for total protein by using commercial test kit Crest Bio systems (a division of Coral clinical) at 550 nm wavelength using spectrophotometer 106.

$$\text{Total protein (mg/dl)} = \frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times 8$$

3.4.3 Albumin

The collected samples of serum from each group were examined for albumin protein by using commercial test kit, Crest Bio systems (a division of Coral clinical) at 630 nm wavelength using spectrophotometer 106.

$$\text{Albumin (mg/dl)} = \frac{\text{Absorbance of test}}{\text{Absorbance of standard}} \times 4$$

3.4.4 SGOT

The collected samples of serum from each group were examined for SGOT by commercial test kit Crest Bio systems (a division of Coral clinical) by Mod.IFCC method at 340 nm wavelength using spectrophotometer.

SGOT (IU/L) = Mean absorbance change/minute ×1746

3.4.5 SGPT

The collected samples of serum from each group were examined for SGPT by commercial test kit Crest Bio systems (a division of Coral clinical) by Mod. IFCC method at 340 nm wavelength using spectrophotometer.

SGPT (IU/L) = Mean absorbance change/minute × 952

3.5 NUTRIENT DIGESTIBILITY

At the end of the growth trial a seven-day digestibility trial was conducted on all lambs by keeping them in a Completely Randomized Design (CRD) to assess the nutrient utilization of experimental diets. The animals were kept in clean, well aired individual metabolic cages with feeding and watering arrangement.

During the collection period of seven days, daily feed consumption, left over feed as well as faeces voided were recorded. Faeces was collected using faecal bags harnessed to the lamb (Fig 6) dry matter intake and digestibility coefficients (%) for the nutrients were estimated as per the formula.

Fig 5. Digestibility trial

Fig 6. Sheep in semi intensive system with faecal collecting bags

$$\text{DM consumed (g/d)} = \frac{\text{DM in faeces (g)}}{\text{\% of indigestibilty of DM}} \times 100$$

$$\text{Digestibilty co-effient (\%)} = \frac{\text{Nutrient intake - Nutrient intake}}{\text{Nutrient intake}} \times 100$$

3.5.1 Collection of Samples

3.5.1.1 Feed and fodder

Representative samples of three experimental diets and green fodder were collected daily during the collection period before offering to animals and kept for dry matter estimation and pooled for seven days. The samples of all the experimental feeds and fodder were ground separately in air tight polythene bags for subsequent analysis. Similarly, representative sample of feed and fodder refusals were collected on daily basis throughout the test period for dry matter estimation.

The representive samples were collected by hand plucking method in semi-intensive system. In this method, the lambs were allowed to graze on the pasture. An operator in the pasture collected the samples, by simulating the actual forage consumed by the animals. On an average 40-50 bites per animal are collected for a period of 45 min for 2 days in the morning and 2 days in the evening. Samples are kept in paper bag and dried at 60-70^0 C for 24 h in an oven (Sahoo and Karim, 1996).

3.5.1.2 Faeces

Faeces from every animal was collected in separate containers.The total quantity of dung voided during each preceding 24 hours was weighed, mixed thoroughly and placed in a wide mouthed stoppard bottle before shifting to the laboratory for analysis. For dry matter determination, aliquots of 1/10th of daily faeces was taken from each animal in previously weighed petri dishes and dried overnight in hot air oven at 100±5˚C. The dried samples of 7 days were pooled and grounded in laboratory Willey mill and preserved in airtight containers for further analysis.

In grazing animals, animals were fitted with the faecal bags and harness 3 days before collection for adaption followed by 6 days collection period. Faeces were collected every 12 hours interval. The total faeces collected was thoroughly mixed and sub sample were taken for the estimation of dry matter and for further analysis.

3.5.2 Analytical Methods

The proximate analysis of feeds was performed as per the procedures described by AOAC (2005).

3.5.2.1 Dry matter (DM)

The DM content of feeds was determined by drying a weighed amount of the sample in a moisture cup overnight at 100 ± 2^{o}C to a constant weight. The weight of the dried sample expressed as percentage of the original air-dried sample represented the percent DM in the sample.

3.5.2.2 Crude protein (CP)

A known quantity of the ground samples (appropriate aliquots) were digested using Turbo therm (Gerhardt, Germany) with suitable quantity of concentrated H_2SO_4 in the presence of catalytic digestion mixture ($CuSO_4$ and K_2SO_4 in 1:10 ratio). An acid blank was also run along with the samples for correction of any nitrogen contribution by the acid itself. The nitrogen content of the sample was estimated by distilling in auto analyzer (Vapodest, Gerhardt, Germany). The nitrogen content multiplied by the factor 6.25 arrive the CP content of the sample, which was expressed as percentage on DMB.

3.5.2.3 Ether Extract (EE)

A known quantity of moisture free sample was extracted with petroleum ether (60-80^{0} C) for 8 h in a pre-weighed oil flask using Soxhlet extraction apparatus. The extracted crude fat in the oil flask was oven dried to a constant weight and expressed as EE percentage on DMB.

3.5.2.4 Total ash (TA) and Organic matter (OM)

Weighed and de carbonized samples were ashed in a muffle furnace at 550-600^{0}C for 3 hours. The weight of residue left was expressed as per cent total ash on DMB. Organic matter was obtained by deducting the per cent total ash on DMB from 100.

3.5.2.5 Crude fibre (CF)

Crude fibre was estimated by treating the sample with 1.25% H_2SO_4 and 1.25% NaOH and the residue left was ashed in muffle furnace at 550-600^{0}C. The loss due to ashing was considered as crude fibre.

3.5.2.6 Nitrogen free extract (NFE)

Nitrogen free extract was obtained by subtracting the sum of CP, EE, CF and total ash percentage from 100.

3.5.3 Fibre Fractions Analysis

Fibre fractions in feeds were analysed as per the method described by Van Soest *et al.* (1991).

3.5.3.1 Neutral Detergent Fibre (NDF)

Neutral detergent fibre was estimated by refluxing the sample with neutral detergent solution (pH 7.2) for 1 h to a constant volume and the residue left was dried in hot air oven at 100 ± 2^{0}C. The weight of the dried sample was expressed as neutral detergent fibre in percent.

3.5.3.2 Acid Detergent Fibre (ADF)

The ADF was estimated similar to NDF by refluxing the sample with acid detergent solution (pH 2.0) for 1 h to a constant volume.

3.6 FEEDING BEHAVIOUR

Behavioural recording was done by direct visual observation of lambs using a stopwatch for five days each for four hours from 8.00 AM-12.00 noon after refreshing of daily feed. The recorded activities were eating, ruminating, drinking, standing and sleeping as per the procedures of Fraser and Broom (1990).

Eating: The act of intake of feed by an animal.

Drinking: Act of taking water into mouth and swallowing.

Ruminating: Regurgitating, masticating and then swallowing the food which has been previously ingested into the rumen.

Standing: It is a term describing body position in relation to the ground.

Sleeping: Sleep is defined by brain changes and by loss of behavioural responses to many stimuli.

3.7 FAECAL SCORING

Faecal samples were collected in the morning and evening hours to observe the changes in faeces due to feeding of experimental diets. Faecal samples were scored using the method given by Greeffe and Karlson, (1997) which is shown in Table 05.

Table 5. Faecal scoring method (Greeffe and Karlson,1997)

Faecal score	Faecal consistency
1	Hard pellets- dry to touch, cracks readily under firm pressure between Fig and thumb
2	Soft pellets- moist to touch, less tendency to crack under firm pressure between Fig and thumb
3	Firm faecal mass- loss of pellet structure, firm paste, tube like appearance
4	Soft faecal mass- Pasty diarrhoea, soft paste
5	Fluid (Scouring)- Watery, liquid diarrhoea

3.8 CARCASS STUDIES

Three representative animals from each group were randomly selected and slaughtered after completion of the growth trial and various meat characteristics like dressing percentage, edible and non-edible organs were studied. Distribution of experimental animals is shown in Table 6.

3.8.1 Slaughter method

The representative animals were slaughtered by 'Halal' methodology after 18 hours of starving. The live weights before slaughter were recorded. Stripping, legging, dressing and evisceration were performed by adopting the standard procedures described by Gerrand (1964). The weight of hot carcasses, edible (liver, heart, testes, diaphragm, kidneys and spleen) and non-edible organs (blood, lungs, trachea, stomach and intestines) were recorded. The carcasses were then divided into five cuts - leg, loin, rack, shoulder and neck and fore shank and brisket as recommended by the National Livestock and Meat Board of United States of America (Brandly *et al*., 1968).

Fig 7. Hot carcass

Fig 8. Evisceration

Table 6. Distribution of experimental animals for slaughter studies in Intensive and Semi- Intensive farming system

Intensive System			Semi -intensive System		
No.	**Animal No.**	**Body Weight**	**Sr.No.**	**Animal No.**	**Body Weight**
T1			T1		
1	302	24.0	1	53	28.7
2	303	19.2	2	55	32.2
3	307	20.8	3	52	19.2
	Mean± SE	**21.3 ±7.41**		Mean± SE	**26.7±3.88**
T2			T2	51	29.0
1	291	28.9	1	52	30.0
2	309	20.5	2	56	24.0
3	304	17.5	3		
	Mean± SE	**22.3 ±3.41**		Mean± SE	**27.7±1.18**
T3			T3		
1	306	20.2	1	54	29.0
2	294	30.2	2	58	27.8
3	301	28.1	3	59	25.0
	Mean± SE	**26.1±7.41**		Mean± SE	**27.2±1.18**

3.8.2 Empty body weight (EBW)

Weight recorded after deducting blood and gut fill from pre slaughter weight was noted as EBW.

3.8.3 Organ weights

The weight of liver, heart, kidney, pluck (lung with trachea, liver and heart) and full and empty gastrointestinal tract (GIT) were expressed as percentages of pre slaughter weight.

3.8.4 Dressing weight

The weight of hot carcass was expressed as percentage of pre slaughter weight as well as Empty body weight to arrive at dressing percentage.

3.8.5 Cutting standards of various wholesale cuts

3.8.5.1 Leg

The leg was taken off from the carcass by cutting with a saw at right angle to back close to the hip bone.

3.8.5.2 Loin

The loin was removed from the carcass from the hip bone to the anterior part of the last rib.

3.8.5.3 Rack

The rack was obtained by cutting from the posterior part of the 12 th rib to the anterior part of the 5 th rib.

3.8.5.4 Shoulder and neck

This was carved out by cutting from the posterior part of the 4th rib to the neck (including the neck)**.**

3.8.5.5 Fore shank and brisket

Before cutting the shoulder and the rack, an incision was made with a knife 4″ above the costa-sternal joint and the part was removed with a saw. The weights of various wholesale cuts were recorded on individual basis.

3.8.5.6 Bone, separable muscle and brisket

The weights of fat, muscle and bone were recorded separately from the carcass.

3.8.5.7 The loin eye area

The loin eye area was marked on butter paper and measured by planimeter with standard procedure.

Fig 9. Carcass cuts

3.9 COST ECONOMICS

The cost of experimental diets was calculated on the source of prevailing market value of ingredients and process cost. The value per kg live weight gain was obtained by dividing the overall cost of diet consumed with total weight gain.

3.10 STATISTICAL ANALYSIS

Statistical analysis of the data was carried out in accordance with Snedecor and Cochran (1994). Analysis of variance was used to test the significance of variance and the treatment means tested for significance by Duncans new multiple range F test (Duncan,1995). Correlation among linear body measerments and body weight were estimated as per Pearsons method.

CHAPTER-IV

RESULTS

Experiment I

The results of feeding *Moringa Oleifera* based diets on the performance of growing Deccani lambs in intensive farming are tabulated, statistically analysed and presented in this chapter.

4.1 CHEMICAL COMPOSITION OF EXPERIMENTAL DIETS

The chemical composition of the feed ingredients used in experiment i.e DORB, Red gram chunni, DGNC, CSC, dried leaves of Moringa, Para grass is presented in Table 7.

The dry matter, crude protein, ether extract, crude fibre, total ash and acid insoluble of DORB, Red gram chunni, DGNC, CSC, dried leaves of Moringa and Para grass were 91.67, 92.26, 95.68, 92.42, 92.12 and 55.21; 13.54, 13.87, 34.03,24.4524.39 and 6.48; 0.76, 2.37, 0.78, 8.58, 6.67 and 1.58; 15.14, 31.89, 5.34, 26.83, 5.57 and 18.49; 12.88, 3.68, 12.78, 5.42, 12.66 and 6.67; 5.83, 0.23, 6.69, 0.40, 0.27 and 4.35 percent, respectively.The phosphorus, calcium, ADF and NDF were 1.92, 0.72, 0.75,0.98, 0.65 and 0.10; 0.20, 0.41, 0.60, 0.66, 2.07 and 0.35; 11.5, 15.17, 22.3, 20.2, 12.94 and 42.3; 24.1, 18.6, 26.28, 34.6, 38.84 and 68.7 percent, respectively for DORB, Red gram chunni, DGNC, CSC, dried leaves of Moringa and Para grass.

The Three experimental diets were analysed for proximate principles and cell wall constituents and the results are presented in Table 8. The experimental diets T1, T2, T3 contained (% DM basis) 91.68, 91.99 and 92.1 dry matter; 19.10, 19.0 and 18.50 crude protein; 3.53, 2.65 and 3.58 ether extract; 20.45, 17.58 and 19.47 crude fibre; 2.39,3.19 and 2.68 acid insoluble ash; 8.98, 10.08 and 10.07 total ash; 0.88, 0.93 and 0.78 phosphorus, 0.98, 1.76 and 1.58 calcium, respectively. The ADF and NDF contents were 39.44, 36.75 and 45.32 and 63.74, 62.25 and 69.98 % in T1, T2 and T3 diets, respectively on dry matter basis.

4.1.1 GROWTH PERFORMANCE

Growth trial was conducted for a period of 90 days to evaluate the effect of MLM at 25 and 50 percent on body weights, average daily gains and dry matter intake in growing Deccani sheep under intensive farming system.

4.1.1.1 Fortnightly Body Weights

The fortnightly body weight changes of growing Deccani lambs in intensive farming system is presented in Table 9 and graphically represented in Graph 1.

Table 7. Chemical Composition of feed ingredient and Moringa leaves (% DM Basis)

Constituent	De-oiled rice bran	Red gram chunni	Ground nut cake (De-oiled)	Cotton seed cake	Moringa Leaves	Para Grass
Dry matter	91.67	92.26	95.68	92.42	92.12	55.21
Crude Protein	13.54	13.87	34.03	24.45	24.39	6.48
Ether Extract	0.76	2.37	0.78	8.58	6.67	1.58
Crude Fiber	15.14	31.89	5.34	26.83	5.57	18.49
Total Ash	12.88	3.68	12.78	5.42	12.66	6.67
Acid Insoluble Ash	5.83	0.23	6.69	0.40	0.27	4.35
Total Phosphorus	1.92	0.72	0.75	0.98	0.65	0.10
Calcium	0.20	0.41	0.60	0.66	2.07	0.35
Neutral Detergent Fibre	24.10	18.60	26.28	34.60	38.84	68.70
Acid Detergent Fibre	11.50	15.17	22.3	20.20	12.94	42.3

Table 8. Chemical composition of concentrate mixture (% DM Basis)

Constituent	T1 (Control)	T2	T3
Dry matter	91.68	91.99	92.1
Crude Protein	19.10	19.00	18.50
Ether Extract	3.53	2.65	3.58
Crude Fiber	20.45	17.58	19.47
Acid insoluble ash	2.39	3.19	2.68
Total Ash	8.98	10.08	10.07
Total Phosphorus	0.88	0.93	0.78
Calcium	0.98	1.76	1.58
Acid Detergent Fibre	39.44	36.75	45.32
Neutral Detergent Fibre	63.74	62.25	69.98

T1: 0% MLM; T2: 25%MLM, T3: 50%MLM

The initial mean body weight (kg) of experimental lambs were 14.21 ±1.00, 14.18 ±1.95 and 14.18 ±1.89 and increased to 21.91 ±1.07, 23.31 ±1.98 and 22.85 ±2.06 at the end of the experiment in T1, T2 and T3 groups, respectively. The overall mean body weight of Deccani lambs in T1, T2 and T3 were 17.68 ±1.03, 18.65±1.25 and 18.45±1.20, respectively. Statistical analysis of the data revealed that there was no significant difference in the fortnightly body weights of the lambs from 1st to 6th fortnights among three dietary groups. However, there was a linear increase in body weights in all three treatment groups. Relatively higher body weight was observed in Moringa based diets (T2 and T3 groups) and lowest in control (T1 group) throughout the experiment.

4.1.1.2 Total Weight Gain

The total gain in body weight (kg) was 7.7 ±0.26, 9.13 ±0.24 and 8.67 ±0.25 in lambs fed with T1, T2 and T3 concentrate mixture, respectively in intensive farming system. Statistical analysis of the total weight gain revealed a significant difference (P <0.01) among the three experimental diets. Significantly (P<0.01) highest weight gain was observed in T2 group lambs than T1 lambs. However, there was no significant difference between T1 and T3 groups and T2 and T3 groups. (Table 9).

4.1.1.3 Average Daily Gain

The overall Average Daily Gain (ADG) observed in the lambs under intensive farming systems is presented in Table 9 and Graph 2.

The average daily gain (g) was 85.55±2.98, 101.50 ±3.01 and 96.29 ±2.83 g in T1, T2 and T3 groups, respectively. The T2 group lambs fed with 25% MLM based concentrate mixture had significantly (P<0.01) higher ADG than T1 group lambs. However, there was no significant difference between T2 and T3 groups.

4.1.1.4. Dry Matter Intake (DMI)

The Dry Matter Intake (DMI) by the growing Deccani lambs fed Moringa based diets in intensive farming system is presented in Table 10.

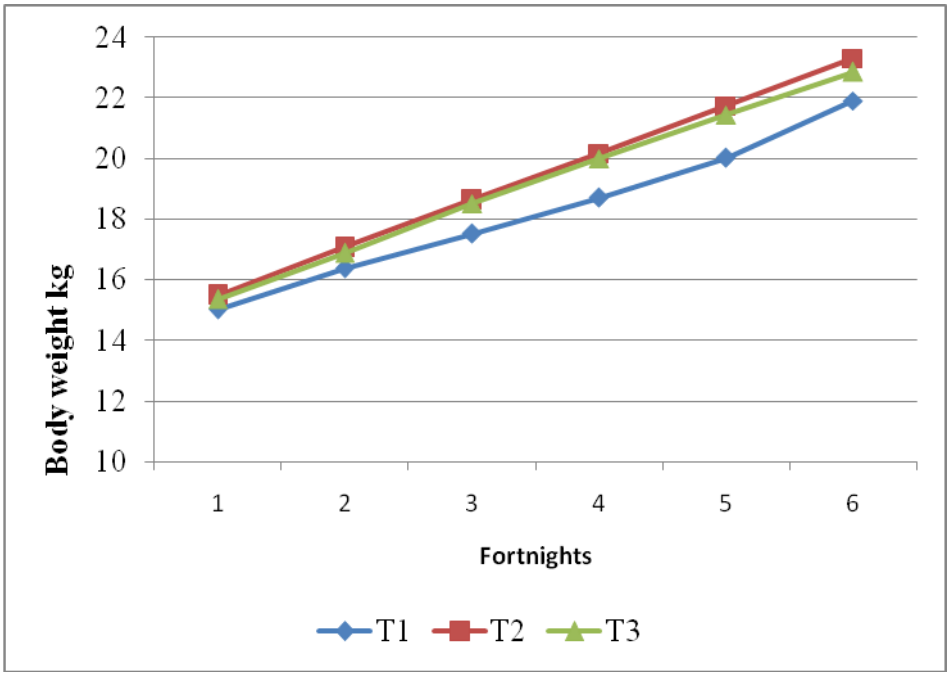
The average daily dry matter intake (kg/day) in Deccani growing lambs fed with experimental diets under intensive farming system were 0.82 ±0.04, 0.88 ±0.06 and 0.86 ±0.08 for T1, T2 and T3 diets, respectively (Table 10). The values recorded for average DMI per 100 kg body weight were 3.77±0.03, 3.82±0.04 and 3.80±0.07 kg, respectively for T1, T2 and T3 group lambs and the values were not significantly different. The daily average dry matter intake (DMI) per 100 kg body weight was comparatively higher in Deccani lambs fed with T2 and T3 diets.

Table 9. Effect of feeding Moringa based diets on body weight (kg) and ADG (g) of Deccani lambs under intensive farming system.

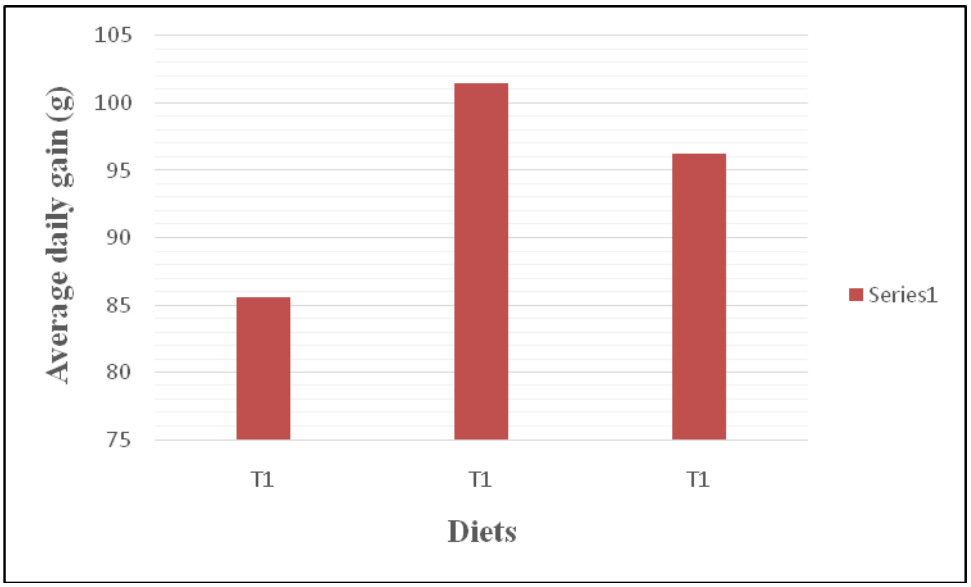
Experimental Diet	Initial BW (kg)	Fortnightly Body weight (kg)						Overall mean (kg)	Total Weight gain (kg)**	ADG (g) **
		1	2	3	4	5	6			
T1	14.21±1.00	15.01±0.97	16.38±1.13	17.51±1.07	18.71±0.99	20.01±0.99	21.91±1.07	17.68±1.03	7.70±0.26 [b]	85.55±2.98 [b]
T2	14.18±1.95	15.47±1.92	17.06±1.95	18.63±1.91	20.16±1.94	21.73±1.98	23.31±1.98	18.65±1.25	9.13±0.24[a]	101.50±3.01[a]
T3	14.18±1.89	15.35±1.99	16.88±2.04	18.51±2.09	20.00±2.06	21.43±2.07	22.85±2.06	18.45±1.20	8.67±0.25[ab]	96.29±2.83[a]
N	6	6	6	6	6	6	6	6	6	6
SEM	0.908	0.920	0.945	0.950	0.956	0.953	0.967	0.647	0.203	2.269
P-value	1.00	0.98	0.96	0.88	0.81	0.76	0.85	0.82	0.001	0.001

[ab] Means with different superscript in a column different significantly : ** P<0.01
P- value: Probability value; N: Number of animals; SEM: Standard Error Mean;
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Graph 1.Effect of feeding Moringa based diets on body weight (kg) of Deccani lambs under intensive system



Graph 2. Effect of feeding Moringa based diets on ADG (g) of Deccani lambs under intensive system



4.1.1.5 Feed Conversion Ratio

Effect of feeding Moringa based diets on FCR of Deccani lambs under intensive farming system is presented in Table 11 and Graph 3.

The FCR in T1, T2 and T3 diets were 9.58±0.55, 8.67±0.33 and 8.92±0.23, respectively. There was no significant difference in FCR among the lambs fed on three experimental diets. The highest FCR (lower value) was observed in T2 (25% ML) and lowest FCR (higher values) was observed in T1 (0% ML).

4.1.2 BIO METRIC MEASUREMENTS

4.1.2.1 Fortnightly Body Length (cm)

Effect of feeding Moringa based diets on fortnightly body length (cm) of Deccani lambs under intensive farming system is shown in Table 12 and graphically represented in Graph 4.

The initial mean body length was 47.50 ±1.43, 48.0 ±2.13 and 46.50 ±2.08 cm for dietary groups T1, T2 and T3, respectivelyand the final body length (6^{th} fortnight) was 58.66 ±1.09, 66.0 ±0.82 and 62.0 ±1.51 for T1, T2 and T3 treatment groups, respectively. Statistical analysis revealed a significant difference ($P<0.05$) among three treatment groups in final fortnight (6^{th} fortnight). T2 group lambs had significantly ($P<0.05$) higher body length than T1 group lambs. From 1^{st} to 5^{th} fortnights the mean body length was non-significantly higher in T2 group. The findings indicated that the mean fortnight body length of growing Deccani lambs increased linearly throughout the experimental period.

The overall mean of body length was 52.79 ±1.57, 55.95 ±2.57 and 53.57 ±2.18 and gain in body length was 11.16 ±1.74, 18.00 ±2.51 and 15.5 ±2.68 in T1, T2, T3 groups, respectively. The body length gain was higher in Moringa supplemented group lambs (T2 and T3) when compared to T1, however the differences were not significant.

4.1.2.2 Fortnightly Height at Withers (cm)

Effect of feeding Moringa based diets on fortnightly height at withers (cm) of Deccani lambs under intensive farming system is shown in Table 13 and graphically represented in Graph 5

The initial mean height at withers (cm) was 54.66 ±0.88, 53.66 ±2.66 and 54.66 ±2.38 and the final height at withers (cm) was 63.00 ±0.5, 65.16±1.57 and 63.50±1.35 for treatment groups T1, T2 and T3, respectively. There was no statistical difference among treatment groups for initial and final height at withers (cm). From 1^{st} to 5^{th} mean fortnightly body length of growing Deccani lambs increased linearly throughout the experimental period.

The overall mean of height at wither was 58.71 ±1.07, 59.28 ±1.38 and 58.69 ±1.35 cm and final gain in height at wither was 8.34 ±1.25, 11.50 ±1.97 and 9.34 ±2.09 cm in T1, T2, T3 groups, respectively. There was no significant difference in height at withers (HW) among the treatment group lambs, however HW was higher in Moringa supplemented group lambs (T2 and T3) when compared to T1.

Table 10. Effect of feeding Moringa based diets on Dry Matter Intake (DMI) of Deccani lambs under intensive farming system

Experimental Diet	BW(kg)	Dry Matter Intake (kg)		Total DMI (kg/Day)	DMI (Kg/100kg B.W)
		Fodder	Experimental Diet		
T1	21.91±1.07	0.588±0.04	0.28±0.001	0.82±0.04	3.77±0.03
T2	23.31±1.98	0.613±0.06	0.27±0.001	0.88±0.06	3.82±0.04
T3	22.85±2.06	0.585±0.082	0.27±0.002	0.86±0.08	3.80±0.07
N	6	6	6	6	6
SEM	0.968	0.001	0.002	0.012	0.031
P-value	0.16	1.03	0.76	7.13	0.78

P- value: Probability value; N: number of animals: SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

4.1.2.3 Fortnightly Face Length (cm)

Effect of feeding Moringa based diets on fortnightly face length (cm) of Deccani lambs under intensive farming system is shown in Table 14 and graphically represented in Graph 6

The initial mean face length (cm) was 16.83 ±0.30, 16.33 ±0.42 and 16.41 ±0.61 and the final mean face length (cm) was 19.33 ±0.24, 20.75±0.65 and 20.58±0.65 for treatment groups T1, T2 and T3, respectively. Statistical analysis of the data revealed no significant difference between treatment groups for initial and final mean face length (cm). From 1st to 5th fortnightly face length (cm) of growing Deccani lambs increased linearly throughout the experimental period. T2 group lambs had non-significantly higher face length (cm) than T3 and T1 group lambs.

Table 11. Effect of feeding Moringa based diets on overall performance of Deccani lambs under intensive farming system.

S.No.	Parameter	T1 (Control)	T2	T3
1.	Feed Intake (Kg/Day)	2.03 ± 0.09	2.05 ± 0.09	2.05 ± 0.09
2.	Dry Matter Intake (kg/Day)	0.82±0.04	0.88 ±0.06	0.86 ± 0.08
3.	Total Feed Intake (kg)	182.70 ± 4.58	184.5 ± 3.75	186.30 ± 3.78
4.	Total Dry Matter Intake (kg)	73.80 ± 1.07	79.2 ± 0.81	77.40 ± 0.99
5.	Weight gain (kg)	7.70 ± 0.26	9.13± 0.24	8.67± 0.25
6.	Average daily gain	85.60 ± 3.01	101.5± 2.87	96.20 ± 2.26
7.	Feed convertion ratio (FCR)	9.58 ± 0.55	8.67 ± 0.33	8.92 ± 0.23

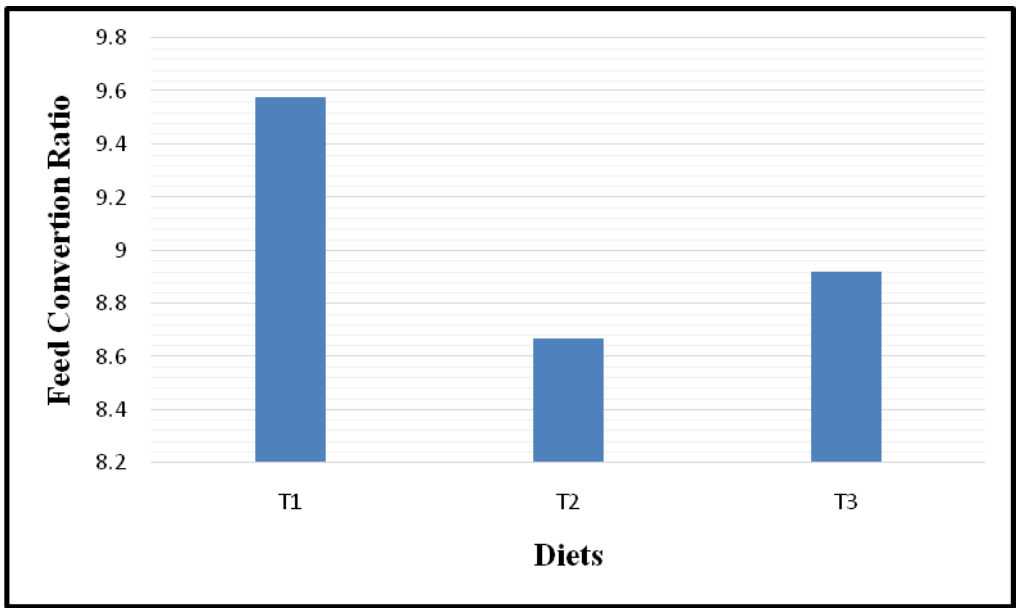
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table12. Effect of feeding Moringa based diets on fortnightly body length (cm) of Deccani lambs under intensive farming system

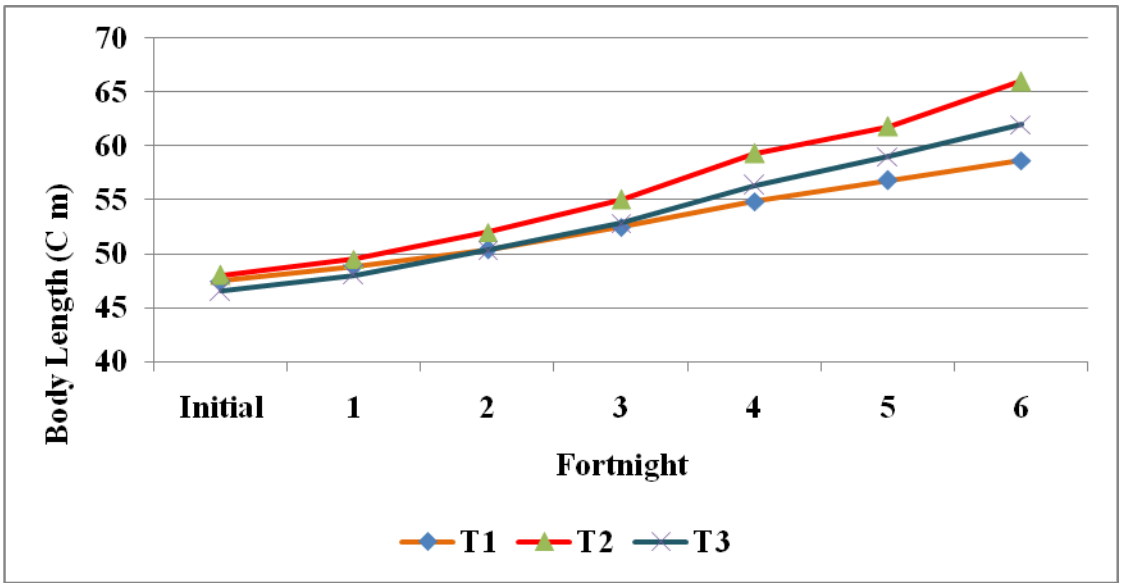
Experimental Diet	Initial body Length	Fortnightly body length (cm)						Overall mean (cm)	Gain in body length (cm)
		1	2	3	4	5	6*		
T1	47.50±1.43	48.83±1.62	50.41±1.46	52.50±1.18	54.83±1.14	56.83±1.22	58.66±1.09[b]	52.79±1.57	11.16±1.74
T2	48.00±2.13	49.50±2.46	52.00±2.25	55.00±1.67	59.33±1.36	61.83±0.98	66.0±0.82[a]	55.95±2.57	18.00±2.51
T3	46.50±2.08	48.00±1.69	50.33±1.38	52.83±1.19	56.33±1.56	59.00±1.84	62.00±1.51[ab]	53.57±2.18	15.50±2.68
N	6	6	6	6	6	06	6	6	6
SEM	1.106	1.074	0.963	0.788	0.867	0.905	0.965	1.205	1.445
P-value	0.86	0.86	0.75	0.39	0.91	0.06	0.02	0.56	0.14

[ab] Means with different superscript in a column different significantly: * P<0.05
P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Graph 3. Effect of feeding Moringa based diets on FCR of Deccani lambs under intensive farming system



Graph 4. Effect of feeding Moringa based diets on fortnightly body length (cm) of Deccani lambs under intensive farming system



The overall mean face length (cm) was 18.01 ±0.33, 18.53 ±0.60 and 18.06 ±0.43 in T1, T2, T3 groups, respectively. The final gain in face length was 2.50 ±1.80, 4.42 ± 1.45 and 3.17 ±0.21 cm in T1, T2, T3 groups, respectively. There was significant difference ($P<0.01$) in gain in face length among three treatment groups. Significantly ($P<0.01$) higher face length was observed in T2 group than T1 group and no significant difference was observed between T2 and T3 groups.

4.1.2.4 Fortnightly Chest Girth (cm)

Effect of feeding Moringa based diets on fortnightly chest girth (cm) of Deccani lambs under intensive farming system is shown in Table 15 and graphically represented in Graph 7

The initial mean chest girth (cm) was 61.17 ±0.94, 59.58 ±2.41 and 59.00 ±2.86 where as, the final mean chest girth (cm) was 68.33 ±1.46, 69.50±3.22 and 67.16 ±4.04 for treatment groups T1, T2 and T3, respectively. There was no statistical difference among treatment groups for initial and final mean chest girth (cm). From 1^{st} to 5^{th} fortnightly mean chest girth of growing Deccani lambs was increased linearly through out the experimental period.

The overall mean chest girth was 64.69 ±0.98, 63.55 ±1.44 and 62.76 ±1.16 in and the final gain in chest girth was 7.16 ± 0.52, 9.92± 1.62 and 8.16± 1.24 in T1, T2, T3 groups, respectively. The observed chest girth values were non-significantly higher in T2 and T3 group as compared to T1 group lambs.

4.1.2.5 Fortnightly Hip Width (cm)

Effect of feeding Moringa based diets on fortnightly hip width (cm) of Deccani lambs under intensive farming system is shown in Table 16 and graphically represented in Graph 8.

The initial mean hip widthwas 11.17 ±0.48, 11.83 ±0.65 and 10.50 ±0.50 and the final mean hip width was 13.16 ±0.48, 14.42±0.58 and 13.83±0.70 for treatment groups T1, T2 and T3, respectively. Statistical analysis of the data revealed no significant difference among treatment groups for initial and final mean hip width. From $1^{st\ to}$ 5^{th} mean fortnight hip width of growing Deccani lambs increased linearly throughout the experimental period.

The overall mean hip width was 12.41 ±0.32, 12.76 ±0.4 and 12.11 ±0.44 cm in T1, T2, T3 groups, respectively. The final gain in hip width was 2.0 ±0.36, 3.58 ±0.37

and 3.33 ±0.21cm in T1, T2, T3 groups, respectively. There was a significant difference (P<0.01) for final gain in hip width between three treatment groups. T2 group had significantly (P<0.01) higher hip width than T1 group and T2 group was non-significant with T3 group.

4.1.2.6 Fortnightly Tail Length (cm)

Effect of feeding Moringa based diets on fortnightly tail length (cm) of Deccani lambs under intensive farming system is shown in Table 17 and graphically represented in Graph 9.

The initial mean tail length was 13.33 ±0.66, 13.58 ±0.73 and 13.33 ±0.92 and the final tail length was 16.41 ±0.62, 16.83 ±0.60 and 16.56 ±1.05 for T1, T2 and T3 treatment groups, respectively. There was no statistical difference among treatment groups.

The overall mean of tail length was 14.85 ±0.42, 15.17±0.45 and 15.24 ±0.55 cm and the final gain in tail length was 3.08 ±0.21, 3.25 ±0.32 and 3.23 ±0.31 cm in T1, T2 and T3 groups, respectively. The overall mean and final tail length were relatively highest in Moringa supplemented groups compared to control group.

4.1.3 BODY CONDITION SCORE (BCS) INTENSIVE FARMING SYSTEM.

The body condition score of growing Deccani lambs as influenced by experimental diets in intensive farming system is presented in Table 18 and graphically represented in Graph 10. The mean body condition score of growing Deccani lambs in intensive farming at 1, 2, 3, 4, 5 and 6^{th} fortnights was 1.67 ±0.01, 1.68 ±0.01, 1.69 ±0.01, 1.72 ±0.01, 1.83 ±0.01 and 1.91 ±0.01; 1.67 ±0.01, 1.67 ±0.01, 2.0 ±0.00, 2.33 ±0.01, 2.42 ±0.08, and 2.43±0.01 and 1.59 ±0.08, 1.60 ±0.08, 1.67 ±0.01, 2.08 ±0.08, 2.17 ±0.11, 2.10 ±0.11cm in T1, T2 and T3 treatment groups respectively.

The body condition score in lambs was significantly (P<0.05) affected by feeding three experimental diets from 3^{rd} to 6^{th} fortnights where as, in 1^{st} and 2^{nd} fortnight there was no significant difference among the dietary groups. The final body condition score was significant (P<0.05) among the three treatment groups. Significantly (P<0.05) higher BCS was observed in T2 group lambs than T1 group lambs from 3^{rd} to 6^{th} fortnight.

The overall mean BCS was 1.17 ±0.03, 2.1 ±0.14 and 1.9 ±0.10 in T1, T2 and T3 groups, respectively and was not affected by dietary treatments.

4.1.4 CORRELATION CO-EFFICIENT OF BODY WEIGHT WITH BODY MEASUREMENTS

The correlation coefficient of body weight with different measurement is presented in Table 19.

The correlation coefficient (R^2) of body weight with body length, face length, chest girth, height at wither, hip width and tail length in intensive farming system were 0.084, 0.660, 0.856, 0.360, 0.835 and 0.518, respectively. There was a positive and highly significant correlation between body weight and all the body measurements except body length in three treatment groups. Significantly ($P<0.05$) higher coefficient of determination was found between body weight and chest girth compared to other body measurements.

4.1.5 PHYSIOLOGICAL PARAMETERS

4.1.5.1 Fortnightly Changes in Pulse Rate (Beats/Min)

Effect of feeding Moringa based diets on fortnightly pulse rate (Beats/Min) of Deccani lambs fed under intensive farming system is presented in Table 20 and graphically represented in graph 11.

The initial mean pulse rate was 63.5 ±0.99, 66.66 ±0.66 and 65.33 ±1.30 in T1, T2 and T3 groups, respectively and was statistically non-significant among the treatment groups. The final pulse rate was 65.0 ±0.25, 71.0 ±0.66 and 68.33 ±1.30in T1, T2 and T3 groups and the overall mean pulse rate was 64.04 ±0.25, 68.70 ±0.55 and 67.13 ±0.55 for T1, T2 and T3 treatment groups, respectively. Statistical analysis of the data on pulse rate revealed a significant effect ($P<0.01$) in all fortnights except in the first fortnight. T2 group lambs had shown high pulse rate throughout the experiment than T1 group lambs and there was no significant difference between T2 and T3 all fortnights. Similarly, feeding of three treatment diets also significantly ($P<0.01$) effected the overall mean pulse rate in lambs. The pulse rate was significantly higher in T2 than T3 and T1 group lambs, however it is in within the physiological limits.

4.1.5.2 Fortnightly Changes in Respiratory Rate (Beats/Min)

Effect of feeding of Moringa based diets on fornioghtly respiration rate (beats/min) of Deccani lambs fed under intensive farming system is shown in Table 21 and graphically represented in Graph 12.

Table 13. Effect of feeding Moringa based diets on fortnightly height at wither (cm) of Deccani lambs under intensive farming system.

Experimental Diet	Initial height at wither (cm)	Fortnightly height at wither(cm)						Overall mean (cm)	Gain in height at wither(cm)
		1	2	3	4	5	6		
T1	54.66±0.88	55.58±0.79	56.66±0.42	58.33±0.66	59.83±0.87	61.00±0.51	63.00±0.51	58.71±1.07	8.34±1.25
T2	53.66±2.66	56.83±0.66	57.83±2.63	59.33±2.21	60.33±2.27	62.16±0.60	65.16±1.57	59.28±1.38	11.50±1.97
T3	54.16±2.38	56.16±2.55	57.00±2.42	58.66±0.66	59.83±2.16	62.16±2.05	63.50±1.50	58.69±1.35	9.34±2.09
N	6	6	6	6	6	6	6	6	6
SEM	1.158	1.182	1.155	1.083	1.022	0.842	0.736	0.704	1.034
P-value	0.94	0.92	0.82	0.93	0.97	0.82	0.48	0.93	0.46

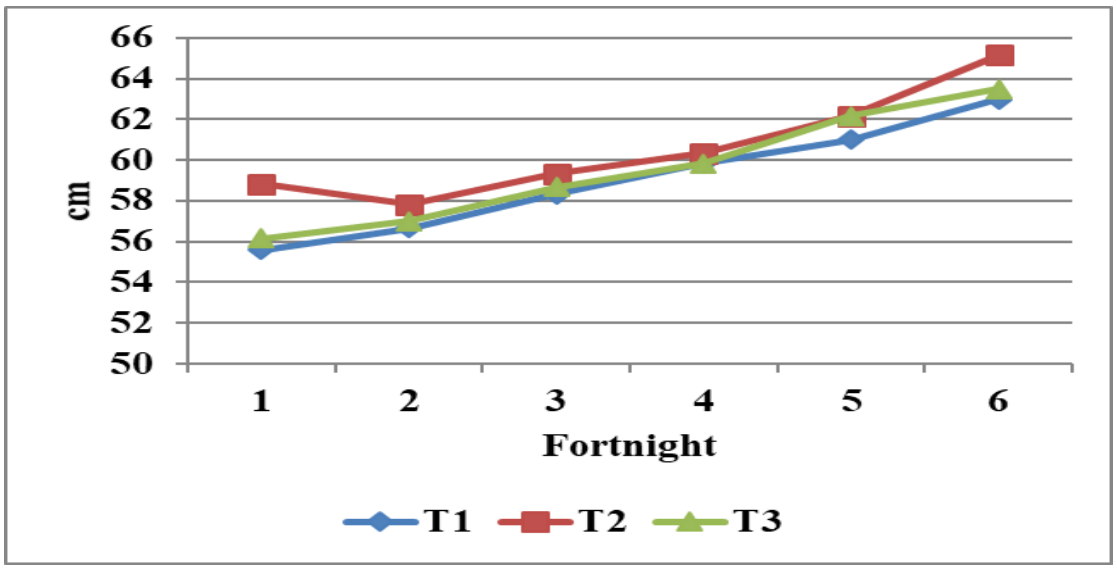
P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table 14. Effect of feeding Moringa based diets on fortnightly face length (cm) of Deccani lambs under intensive farming System

Experimental Diet	Initial face length (cm)	Fortnightly face length (cm)						Overall mean (cm)	Gain in face length (cm)*
		1	2	3	4	5	6		
T1	16.83±0.30	16.91±0.30	17.33±0.30	17.75±0.29	18.35±0.32	18.75±0.28	19.33±0.24	18.01±0.33	2.50±1.80[b]
T2	16.33±0.42	17.15±0.35	17.75±0.35	18.85±0.44	19.33±0.57	20.00±0.65	20.75±0.65	18.53±0.60	4.42±1.45[a]
T3	16.41±0.61	17.05±0.61	17.63±0.60	18.06±0.52	18.41±0.61	19.08±0.65	20.58±0.65	18.06±0.43	3.17±0.21[b]
N	6	6	6	6	6	6	6	6	6
SEM	0.257	0.241	0.242	0.247	0.301	0.329	0.334	0.205	0.255
P-value	0.72	0.92	0.79	0.48	0.35	0.29	0.18	0.62	0.002

[ab] Means with different superscript in a column different significantly: ** P<0.01
P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Graph 5. Effect of feeding Moringa based diets on fortnightly height at withers (cm) of Deccani lambs under intensive farming system



Graph 6. Effect of feeding Moringa based diets on fortnightly face length (cm) of Deccani lambs under intensive farming system

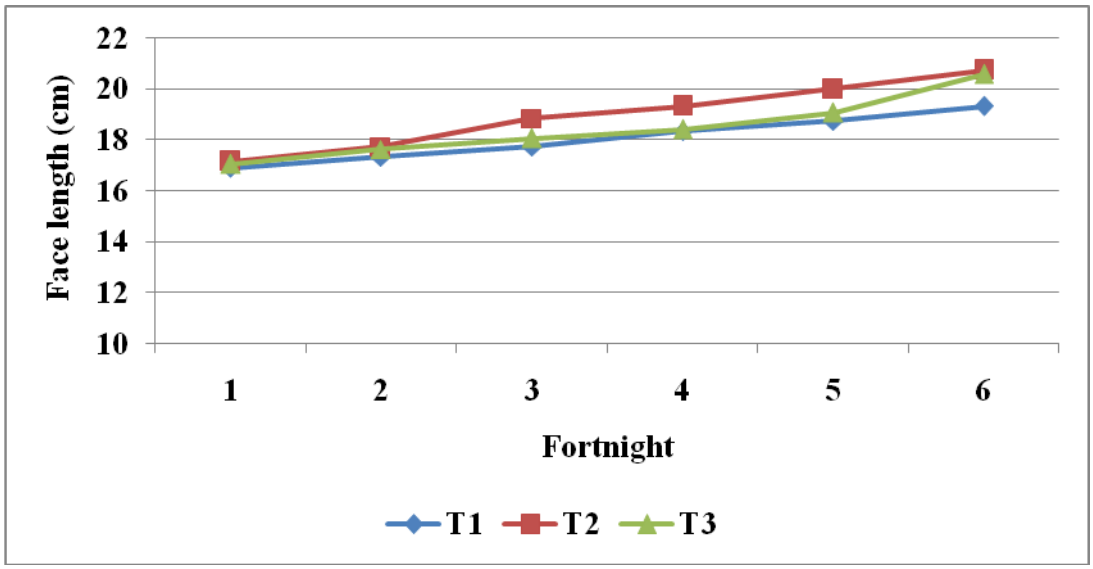


Table 15. Effect of feeding Moringa based diets on fortnightly chest girth length (cm) of Deccani lambs under intensive farming system

Experimental Diet	Initial chest girth (cm)	Fortnightly chest girth length (cm)						Overall mean (cm)	Gain in chest girth (cm)
		1	2	3	4	5	6		
T1	61.17±0.94	59.75±2.98	60.83±2.63	62.33±3.58	63.83±3.93	66.00±1.47	68.33±1.46	64.69±0.98	7.16±0.52
T2	59.58±2.41	61.67±1.17	62.67±1.17	63.83±1.54	65.33±3.05	66.33±3.11	69.50±3.22	63.55±1.44	9.92±1.62
T3	59.00±2.86	60.08±2.49	61.25±3.58	63.33±3.16	65.17±3.05	66.00±3.99	67.16±4.04	62.76±1.16	8.16±1.24
N	6	6	6	6	6	6	6	6	6
SEM	1.240	1.268	1.433	1.531	1.599	1.632	1.676	0.678	0.717
P-value	0.78	0.82	0.87	0.95	0.92	0.99	0.86	0.68	0.30

P- value: Probability value ; N:Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25%MLM; T2: 50%MLM

Table 16. Effect of feeding Moringa based diets on fortnightly hip width (cm) of Deccani lambs under intensive farming system

Experimental Diet	Initial. Length (cm)	Fortnightly hip width (cm)						Overall mean (cm)	Gain in hip width (cm)**
		1	2	3	4	5	6		
T1	11.17±0.48	11.58±.045	11.59±0.55	12.08±0.55	12.58±0.55	13.09±0.48	13.16±0.48	12.41±0.32	2.00±0.36[b]
T2	11.83±0.65	11.90±0.59	12.08±0.52	12.67±0.56	13.08±0.55	13.75±0.53	14.42±0.58	12.76±0.40	3.58±0.37[a]
T3	10.50±0.50	11.08±0.55	12.00±.045	12.50±0.55	13.03±0.42	13.17±0.60	13.83±0.70	12.11±0.44	3.33±0.21 [a]
N	6	6	6	6	6	6	6	6	6
SEM	0.305	0295	0.281	0305	0.288	0.299	0.345	0.222	0.244
P-value	0.69	0.78	0.76	0.74	0.58	0.68	0.35	0.52	0.008

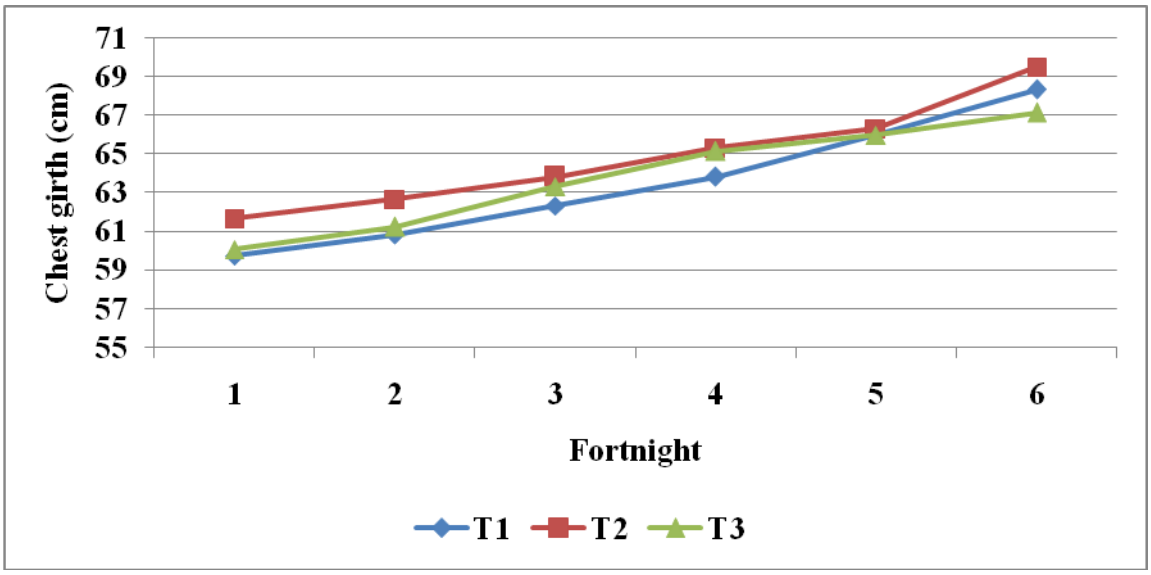
[ab] Means with different superscript in a column different significantly : ** P<0.01
P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25%MLM; T2: 50%MLM

Table 17. Effect of feeding Moringa based diets on fortnightly tail length (cm) of Deccani lambs under intensive farming system

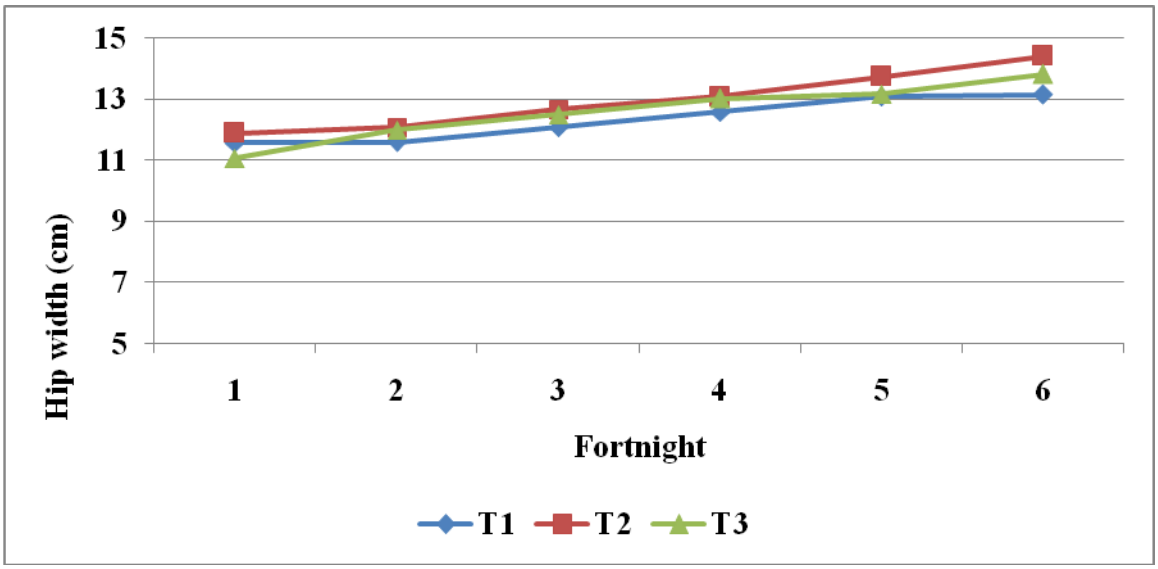
Experimental Diet	Initial tail length (cm)	Fortnightly tail length (cm)						Overall mean (cm)	Gain in tail length (cm)
		1	2	3	4	5	6		
T1	13.33±0.66	13.58±0.93	14.28±.066	14.83±0.65	15.41±.063	16.00±0.74	16.41±0.62	14.85±0.42	3.08±0.21
T2	13.58±0.73	14.00±0.61	14.58±0.55	16.00±0.93	16.40±1.05	16.50±1.056	16.83±0.60	15.24±0.55	3.35±0.32
T3	13.33±0.92	13.75±0.68	14.33±0.79	15.16±0.51	15.75±0.47	16.33±0.40	16.56±1.05	15.17±0.45	3.23±0.31
N	6	6	6	6	6	6	6	6	6
SEM	0.426	0.412	0.369	0.408	0.428	0.426	0.393	0.266	0.251
P-value	0.96	0.92	0.93	0.51	0.60	0.90	0.88	0.83	0.92

P- value: Probability value; N:Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25%MLM; T2: 50%MLM

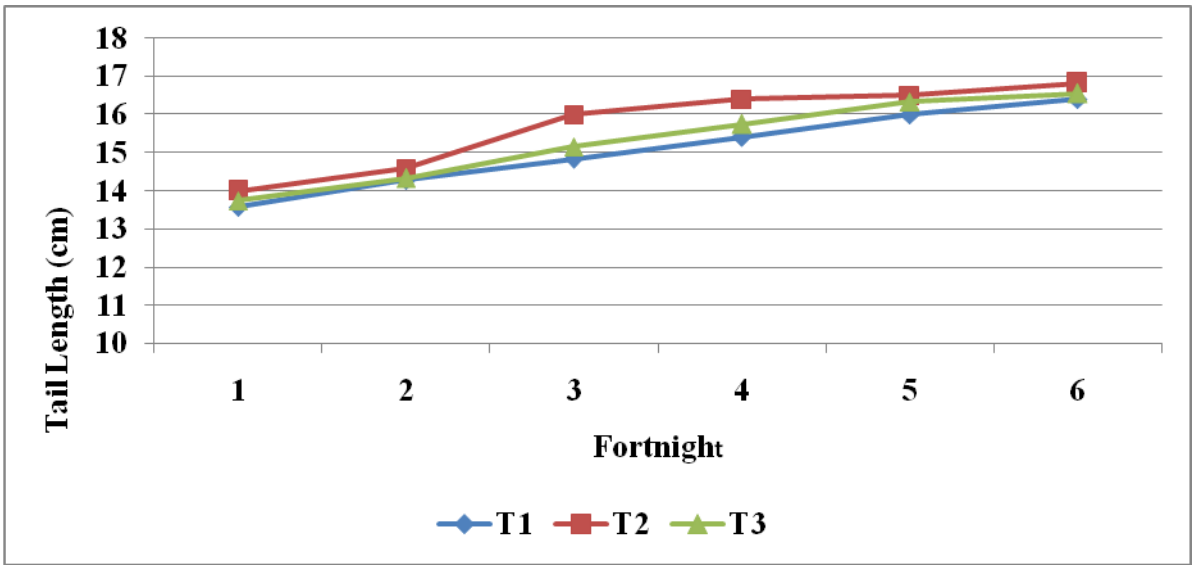
Graph 7. Effect of feeding Moringa based diets on fortnightly chest girth (cm) of Deccani lambs under intensive farming system



Graph 8. Effect of feeding Moringa based diets on fortnightly hip width (cm) of Deccani lambs under intensive farming system



Graph 9. Effect of feeding Moringa based diets on fortnightly tail length (cm) of Deccani lambs under intensive farming system



Graph 10. Effect of feeding Moringa based diets on body condition score of growing Deccani lambsfed inintensive farming system

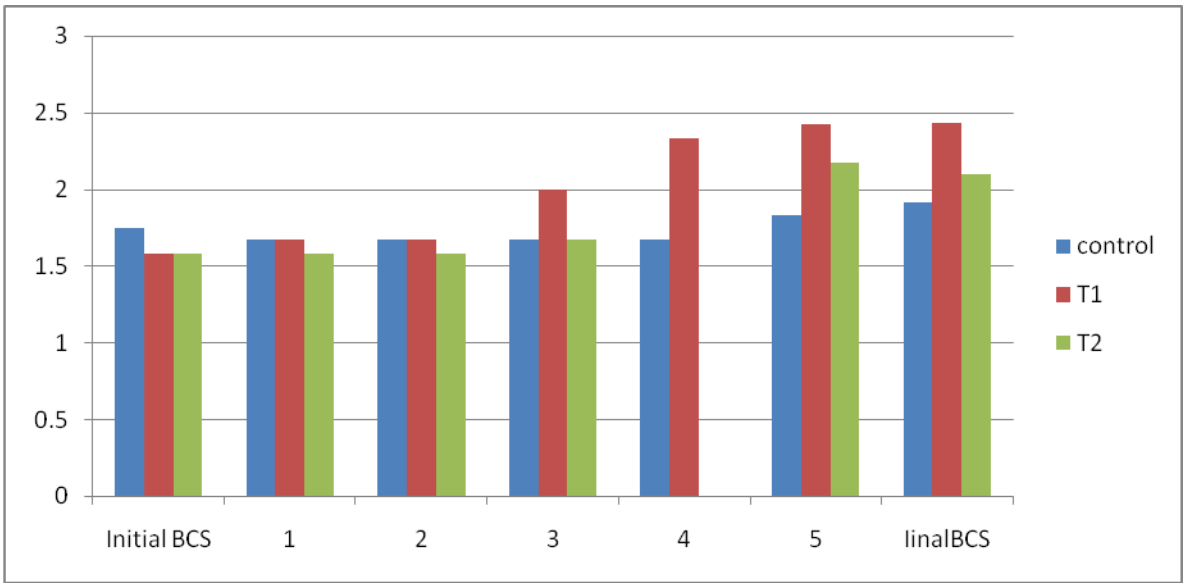


Table 18. Effect of feeding Moringa based diets on body condition score of Deccani lambs fed under in intensive farming system

Experimental Diet	Initial BCS	Fortnightly body condition score						Overall mean BCS
		1	2	3*	4**	5**	6*	
T1	1.75±1.00	1.67± 0.01	1.68± 0.01	1.69± 0.01[b]	1.72± 0.01 [b]	1.83± 0.01[b]	1.91± 0.011 [b]	1.17±0.03
T2	1.58 ±.08	1.67± .011	1.67± .011	2.00 ±0.00[a]	2.33 ±.011[a]	2.42±0.08[a]	2.43± 0.11[a]	2.10±0.14
T3	1.58 ±0.08	1.59±0.08	1.60±0.08	1.67±0.01[b]	2.08±0.08 [a]	2.17 ± 0.11[ab]	2.18± 0.11 [ab]	1.90 ±0.10
N	6	6	6	6	6	6	6	6
SEM	0.054	0.054	0.054	0.060	0.085	0.078	0.077	0.062
P-value	0.79	0.79	0.79	0.02	0.001	0.003	0.01	0.19

[ab] Means with different superscript in a column different significantly: *P<0.05; ** P<0.01
P- value: Probability value; N:Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM T3: 50% MLM

Table 19. Correlation co-efficient of body weights with body measurements of Deccani lambs fed under Intensive farming system

	Body weight	Body length	Face length	Chest girth	Height at wither	Hip width	Tail length
BodyWeight	1	0.084	0.660**	0.856**	0.360	0.835**	0.518*
Body Length	0.084	1	0.338	0.110	0.467	0.380	0.187
Face Length	0.660**	0.338	1	0.627**	0.561*	0.737**	0.406
Chest Girth	0.856**	0.110	0.627**	1	0.391	0.807**	0.506*
Height at wither	0.360	0.467	0.561*	0.391	1	0.483*	0.075
Hip width	0.835**	0.380	0.737**	0.807**	0.483*	1	0.467
Tail Length	0.518*	0.187	0.406	0.506*	0.075	0.467	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 20. Effect of feeding Moringa based diets on fortnightly pulse rate (Beats/Min) of Deccani lambs fed underintensive farming system

Experimental Diet	Initial pulse rate	Fortnightly Pulse Rate						
		1	2**	3**	4**	5**	6**	Overall mean**
T1	63.50±0.99	63.66±0.66	63.66±1.17^{b}	65.00±0.81^{b}	65.00±0.93^{b}	64.50±0.76^{b}	65.00±0.25^{b}	64.04±0.25^{c}
T2	66.66±0.66	67.33±0.88	68.33±0.33^{a}	68.5±0.42^{a}	69.16±0.43^{a}	69.83±0.60^{a}	71.00±0.66^{a}	68.70±0.55^{a}
T3	65.33±1.30	65.83±0.78	65.66±1.02^{ab}	67.83±0.47^{ab}	68.16±0.54^{a}	68.33±0.55^{a}	68.83±1.30^{a}	67.13±0.55^{b}
N	6	6	6	6	6	6	6	6
SEM	0.637	0.560	0.680	0.491	0.656	0.743	0.660	0.505
P-value	0.120	0.160	0.009	0.001	0.002	0.001	0.001	0.002

^{ab} Means with different superscript in a column different significantly: ** P<0.01
P- value: Probability value ; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table 21. Effect of feeding Moringa based diets on fortnightly respiratory rate (breaths /min) of Deccani lambs fed under intensive farming system

Experimental Diet	Initial respiratory rate	Fortnightly respiratory rate (breaths /min)						
		1**	2**	3**	4**	5**	6**	Overall mean**
T1	25.66±1.05	25.00±0.77[b]	25.83±1.16[b]	26.16±1.19[b]	26.33±1.30[b]	26.66±0.91[b]	28.50±0.42[b]	25.87±0.67[b]
T2	27.33±0.80	28.52±0.61[a]	28.83±0.40[a]	30.16±0.40[a]	30.16±0.40[a]	31.16±0.40[a]	32.33±0.71[a]	29.78±0.64[a]
T3	27.33±0.66	28.50±0.42[a]	28.82±0.40[a]	29.83±0.16[a]	29.5±0.50 [a]	30.16±0.47[a]	30.16±0.40[b]	29.18±0.39[a]
N	6	6	6	6	6	6	6	6
SEM	0.501	0.523	0.531	0.593	0.610	0.582	0.478	0.498
P-value	0.310	0.001	0.012	0.003	0.013	0.001	0.001	0.001

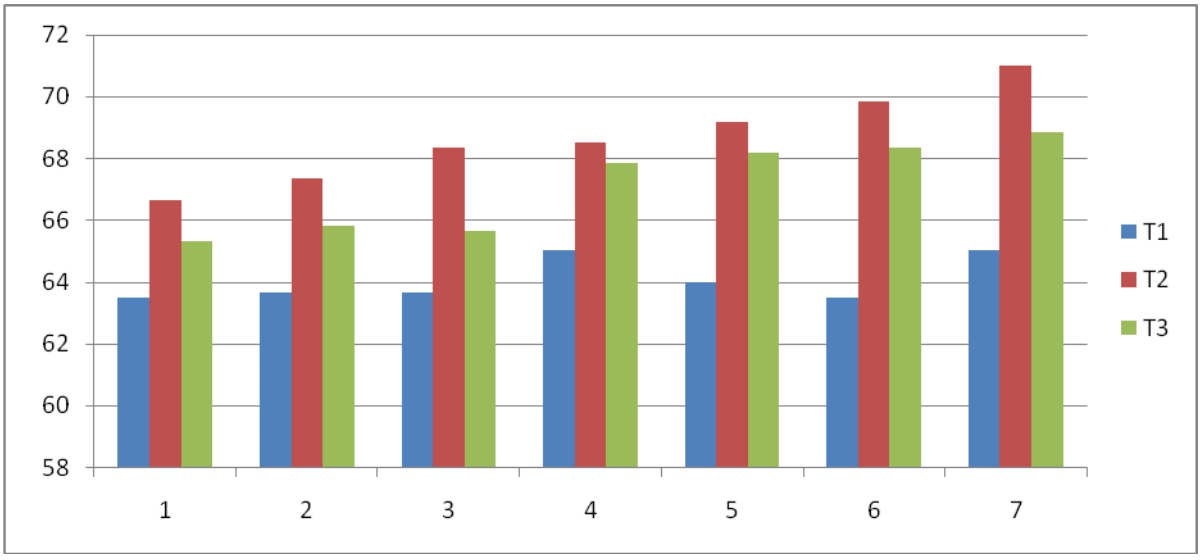
[ab] Means with different superscript in a column different significantly: ** P<0.01
P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM ; T2: 25% MLM; T2: 50% MLM

Table 22. Effect of feeding Moringa based diets on fortnightly rectal temperature (^{0}F) of Deccani lambs fed under intensive farming system

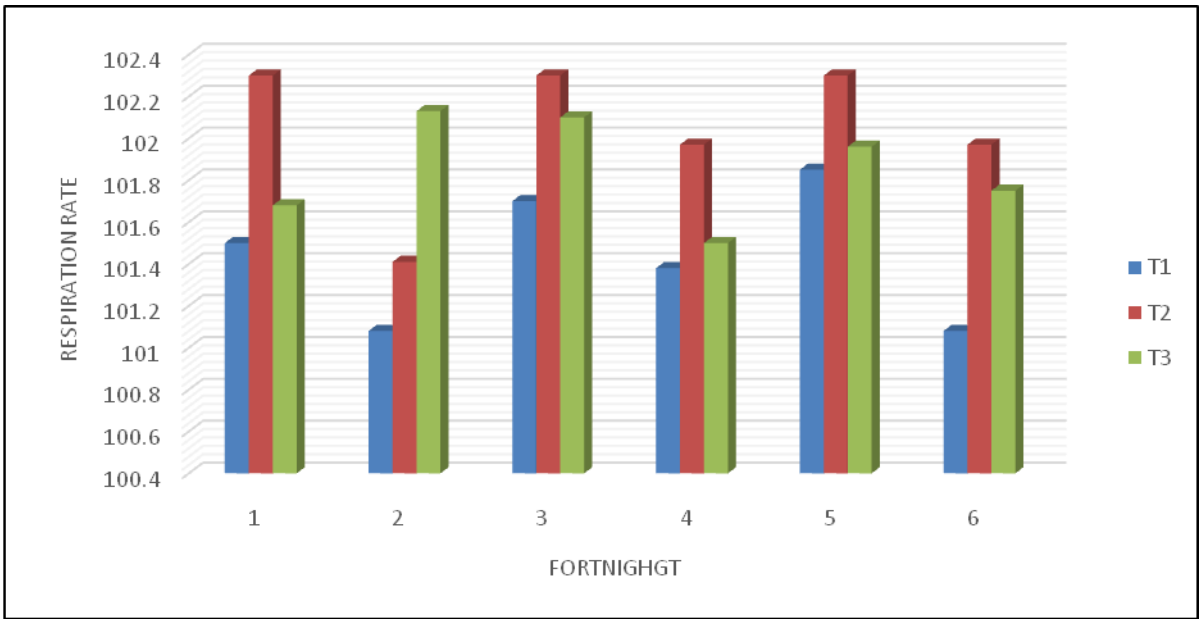
Experimental Diet	Initial rectal temperature	Fortnightly rectal temperature (^{0}F)						
		1	2	3	4	5	6	Overall mean
T1	101.25±0.35	101.5±0.38	101.08±0.27	101.7±0.41	101.38±0.43	101.85±0.27	101.08±0.41	101.1±0.13
T2	101.67±0.31	102.3±0.032	101.41±0.41	102.3±0.24	101.97±0.41	102.31±0.09	101.97±0.32	101.6±0.09
T3	101.97±037	101.68±0.39	102.13±0.24	102.1±0.09	101.5±0.32	101.96±0.40	101.75±0.25	101.5±0.12
N	6	6	6	6	6	6	6	6
SEM	0.196	0.195	0.205	0.166	0.223	0.162	0.205	0.084
P-value	0.32	0.21	0.08	0.36	0.54	0.50	0.18	0.00

P- value: Probability value; N: Number of animals;SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Graph 11. Effect of feeding Moringa based diets on fortnightly pulse rate (Beats/Min) of Deccani lambs under intensive farming system



Graph 12. Effect of feeding Moringa based diets on fortnightly respiratory rate (Breaths/min) of Deccani lambs under intensive farming system.



The initial mean reparation rate (bpm) was 25.66 ±1.05, 27.33 ±0.80 and 27.33 ±0.80 in T1, T2 and T3 groups, respectively and statistically comparable (P>0.05) among the treatment groups. The final mean reparation rate (bpm) was 28.5 ±0.42, 32.33 ±0.71 and 30.16 ±0.40 while, the overall mean reparation rate (bpm) was 25.87 ±0.67, 29.78 ±0.64 and 29.18 ±0.39 for T1, T2 and T3 treatment groups, respectively.

The mean reparation rate (bpm) of all fortnights and overall mean was significantly (P<0.01) effected among the three treatment groups. T2 group of lambs had shown higher mean reparation rate (bpm) throughout the experiment than the T1 group lambs. However, the mean reparation rate (bpm) in lambs was within the normal physiological limits.

4.1.5.3 Fortnightly Changes in Rectal Temperature (^{0}F)

Effect of feeding Moringa based diets on fortnightly rectal temperature (^{0}F) of Deccani lambs fed under intensive farming system is shown in Table 22 and graphically represented in graph13.

The initial mean rectal temperature (^{0}F) was 101.25 ±0.35, 101.67 ±0.31 and 101.97 ±0.37 in T1, T2 and T3 groups, respectively and was statistically non-significant among treatment groups. The final mean rectal temperature (^{0}F) was101.08 ±0.41, 101.97 ±0.32 and 101.75 ±0.25 the overall mean rectal temperature (^{0}F) was 101.1 ±0.13, 101.6 ±0.09 and 101.5 ±0.12 for T1, T2 and T3 treatment groups, respectively. Statistical analysis of the data on mean rectal temperature (^{0}F) revealed nonsignificant effect (P>0.05) in all fortnights and overall mean rectal temperature (^{0}F). Mean rectal temperatures were relatively higher in T2 and T3 group lambs when compared to T1, however, the mean rectal temperature (^{0}F) in lambs was within the normal physiological limits.

4.1.6 HAEMATOLOGICAL PARAMETERS

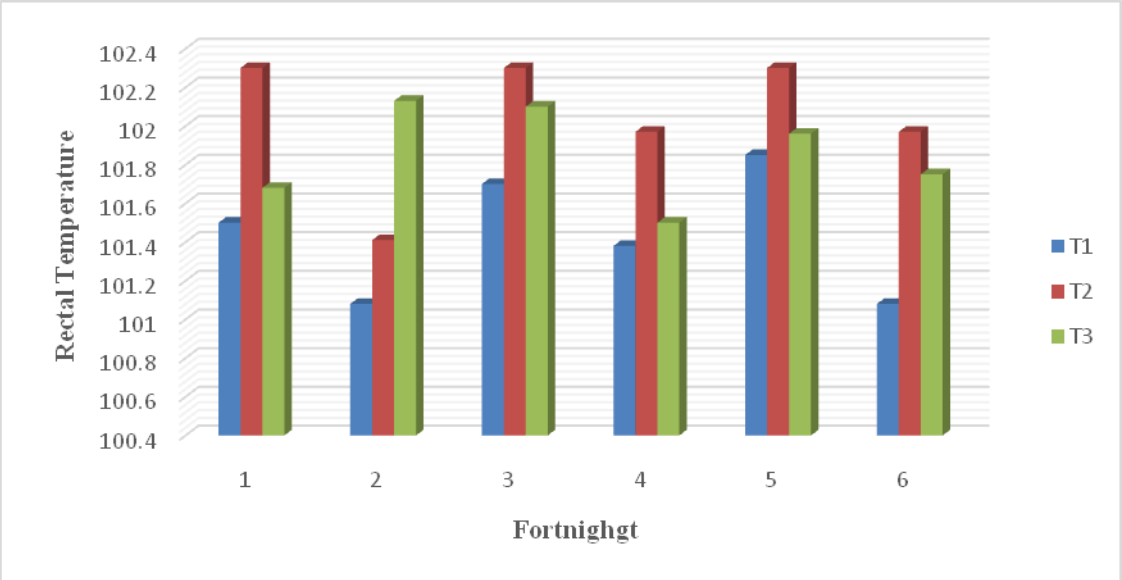
4.1.6.1 WBC (10^3/mm^3)

The estimated WBC (10^3/mm^3) level of growing Deccani lambs fed with MLM based diets under intensive farming systems is presented in Table 23 and Graph14.

The mean WBC levels before start of the experiment were 9.16 ±0.60, 8.50 ±0.42 and 8.16 ±0.30 in T1, T2 and T3 groups respectively. The WBC (10^3/mm^3) levels after the experiment were 9.83 ± 0.45, 13.16±0.60 and 11.33±0.77 for T1, T2 and T3 groups, respectively. Statistical analysis of the data revealed a significant difference (P < 0.01) in the WBC levels among experimental diets at the end of the experiment.

Significantly (P<0.01) higher WBC value was observed in T2 group which was comparable with T3 group while lowest value was observed in T1 dietary group which was also comparable with T3 dietary group.

Graph 13. Effect of feeding Moringa based diets on fortnightly rectal temperature (^{0}F) of growing Deccani lambs underintensive farming system.



4.1.6.2 RBC (millions/mm^3)

The estimated RBC (millions/mm^3) levels in growing Deccani lambs fed with MLM based diets in intensive farming systems are presented in Table 23 and graph 14.

The mean estimated RBC (millions/mm^3) values were at the start of experiment were 9.45±0.43, 10.28±0.24 and 10.01±0.35 and at the end were 9.46±0.53, 11.28±0.65 and 10.50±0.25 in lambs fed with T1, T2 and T3 diets respectively in intensive farming system. The RBC values were significantly (P<0.01) higher in T2 dietary group, whose values were comparable to T3 group. The lowest RBC values were noticed in T1 dietary group and the values were also comparable with T3 group.

4.1.6.3 Haemoglobin (g/dl)

The mean estimated haemoglobin was 9.83±0.30, 10.0±0.57 and 9.33±0.30g/dl before starting the experiment andat the end of the experiment was 9.83±.0.30, 11.90±0.5 and 10.20±0.2g/dlin T1, T2, T3 groups, respectively in intensive farming

system (Table 23). No significant difference was observed in haemoglobin values among the experimental diets. Relatively higher haemoglobin (Hb) values were observed in lambs (T2 and T3) fed with diet containing moringa leaf when compare to control (T1).

4.1.6.4 PCV (%)

The mean estimated levels of PCV (%) of experimental lambs before start of experiment were 22.00±0.16, 23.5±0.80 and 24.51±0.42 and at the end of experiment were 22.33±0.76, 24.91±0.82 and 24.60±0.42 for T1, T2, T3 groups, respectively (Table 23). The data showed significant difference ($P < 0.05$) among three treatment groups. The PCVvalues were significantly ($P<0.05$) higher in T2 group, whose values were comparable to T3 group. The lowest PCV values were noticed in T1 dietary group and the values were also comparable with T3 group.

4.1.6.5 Erythrocytes and Leucocytes Indices

The erythrocytes and leucocytes indices (%) values in growing Deccani lambs reared in intensive farming systems are presented in Table 24 and illustrated in graph 15.

The mean values of MCV (cμ), MCH (pg) and MCHC (%) in lambs before start of the experiment were 27.76±0.53, 28.63±0.21 and 28.36±0.46; 10.58±0.0.51, 9.8±0.42 and 9.00±0.33 and 34.99±0.51, 34.83±0.30 and 33.55±0.61 for T1, T2 and T3 groups, respectively.

The mean values of MCV (cμ), MCH (pg) and MCHC (%) in lambs at the end of experiment were 27.4 ± 0.59, 29.13 ± 0.25, 28.61±0.50; 10.51±0.3, 11.20 ±0.40, 11.08±0.51 and 34.26 ±0.56, 35.51±0.87 and 34.93 ±0.79 in T1, T2 and T3 groups, respectively. Statistical analysis revealed a significant effect ($P<0.05$) on MCV (cμ) among three treatment groups. Statistically higher MCV (cμ) values were observed in T2 group which was comparable with T3 group and lower in T1 group which also comparable with T3 dietary group. No significant differences were noticed in MCH (pg) and MCHC (%) among the experimental diets in the intensive system (Table 24).

The recorded mean lymphocytes (%) values before start of the experiment were 61.87 ±0.59, 59.33 ±1.08 and 61.66±0.55 and at the end of the experiment were 60.33±0.6, 62.16±0.33 and 61.83±0.70 in T1, T2 and T3 groups respectively. The mean neutrophils, monocytes, eosinophils and basophiles percents before start of the

experiment were 33.62 ±0.39, 33.16±0.47 and 33.33 ±0.49; 0.19 ±0.12, 0.07± 0.0 and 0.06 ±00; 2.84±0.30, 2.66 ±0.33 and 3.16 ±0.30; 0.71±0.04, 0.67±0.03 and 0.68±0.01, respectively for T1,T2 and T3 groups and at the end of experiment were 33.57±0.34, 34.0±0.44 and 33.83±0.47; 0.075±0.00, 0.078±0.00 and 0.076±0.00; 2.85±0.07, 3.24±0.17 and 3.15±0.26 and 0.74±0.02, 0.75±0.03 and 0.74±0.01 respectively for T1, T2 and T3 groups. The values of all leucocyte indices were statistically non-significant (P>0.05) among the three treatment groups after the end of experiment. Highest lymphocyctes were found in T3 group than T2 group and comparable with T1 dietary group.

4.1.7 BIOCHEMICAL PARAMETERS

The blood biochemical parameters like blood Glucose (mg/dl), Total protein (g/dl), SGOT (IU/dl) and SGPT(IU/dl) levels of growing Deccani lambs fed with experimental diets in intensive farming system are presented in Table 25 and shown in Graph 16.

4.1.7.1 Total Protein (g/dl)

The mean values for total protein concentrates (g/dl) before start of the experiment were 7.10±0.16, 7.18±0.14 and 7.13±0.19 and were 7.04±0.15, 7.85±0.13 and 7.41±0.10 at the end of the experiment for T1, T2 and T3 dietary groups, respectively in intensive system. Statistical analysis revealed a significance difference (P<0.01) in total protein concentrates among three dietary diets after the experiment. The total protein values were significantly (P<0.01) higher in T2 dietary group, whose values were comparable to T3 group. The lowest total protein values were noticed in T1 dietary group and the values were also comparable with T3 group.

4.1.7.2 Serum Albumin (g/dl)

The overall mean values for serum albumin (g/dl) before start of the experiment were 3.32±0.09, 3.24±0.07 and 3.17±0.02 and were 3.45± 0.08, 3.53±0.08 and 3.51±0.03 at the end of the experiment for T1, T2 and T3 dietary groups, respectively in intensive system (Table 25). Statistical analysis of the data at the end of the experiment revealed a non-significant difference for serum albumin among different experimental diets. The mean serum albumin levels of Deccani lambs were relatively higher for T2 and T3 groups than control group.

Table 23. Effect of feeding Moringa based diets on blood parameters of Deccani lambs under intensive farming system.

Experimental Diet	WBC10^3/mm^3		RBC millions/mm^3		Hb g/dl		PCV %	
	Before	After**	Before	After*	Before	After	Before	After*
T1	9.16 ± 0.60	9.83 ± 0.45[b]	9.45 ± 0.43	9.46±0.53 [b]	9.83±0.30	9.83±.00	22.16±0.30	22.33±0.76[b]
T2	8.50±0.42	13.16±0.60 [a]	10.28±0.24	11.28±0.65[a]	10.00±0.57	11.90±0.5	23.50±0.80	24.91±0.82[a]
T3	8.16±0.30	11.33±0.77[ab]	10.01±0.35	10.50±0.25[ab]	9.33±0.33	10.20±0.2	24.51±0.40	24.60±0.42 [ab]
N	6	6	6	6	6	6	6	6
SEM	0.269	0.472	0.214	0.296	0.249	0.257	0.423	0.448
P-value	0.32	0.007	0.28	0.03	0.73	0.22	0.43	0.04

[ab] Means with different superscript in a column different significantly:* P<0.05; ** P<0.01
P- value: Probability value ; N: Number of animals; SEM: Standard Error Mean
WBC: White blood cell, RBC: Red blood cell, PCV: Packed cell volume, Hb: Haemoglobin
T1: 0% MLM, T2: 25%MLM, T2: 50%ML

4.1.7.3 Serum Glucose (mg/dl)

The serum glucose concentration (mg/dl) in growing Deccani lambs fed with experimental diet in intensive farming system were 51.48± 2.24, 56.63±5.41 and 57.35±5.2 and 51.16± 2.21, 51.66±4.80 and 54.83±5.29 for T1, T2 and T3 test diets before and after the experiments respectively (Table 25).

There was no significant difference among treatment groups. Concentration of serum glucose was non-significantly lower in T2 and T3 group lambs when compared with T1 group lambs, however, glucose levels were within normal range of 50-89 (mg/dl) as reported by Dhanotiya, (2004).

4.1.7.4 Serum Glutamic Oxaloacetic Transaminase (SGOT)

The SGOT and SGPT are the 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 the indicators of healthy functional liver.

The overall mean of serum glutamic oxaloacetic transaminase (SGOT) (IU/dl) values before start of the experiment were 38.48±0.99, 39.68±0.41 and 38.91±0.55 in T1, T2 and T3 respectively and the same was rose to 38.60±0.98, 40.45 ±0.98, and 39.60±0.80 at the end of experiment. In the present study, no significant difference was observed in SGOT when the growing lambs fed with experimental diets.

4.1.7.5 Serum Glutamic Pyruvic Transaminase (SGPT)

The mean values recorded for SGPT (IU/dl) before start of the experiment were 6.88±0.12, 6.98±0.07 and 6.96±0.14 and were 6.83± 0.09,7.15±0.04 and 7.50±0.46 at the end of the experiment for T1, T2 and T3 dietary groups, respectively in intensive system.

No significant difference was observed for SGPT levels among the experimental group lambs under intensive farming system and are within the normal range of 2.0-7.5 IU/dl (Ramesh Kumar et al, 2003). However, slight increase was observed in *Moringa olefera* leaf meal supplemented lambs (T2 and T3) at the end of experiment when compared to the start of experiment.

4.1.8 NUTRIENT DIGESTIBILITY

The digestibility of various nutrients in growing Deccani lambs fed with Moringa leaf meal-based concentrate mixture under intensive farming system is presented in Table 26 and Graph 17

Table 24. Effect of feeding Moringa based diets on erythrocytes and leucocytes indices of Deccani lambs under intensive farming system

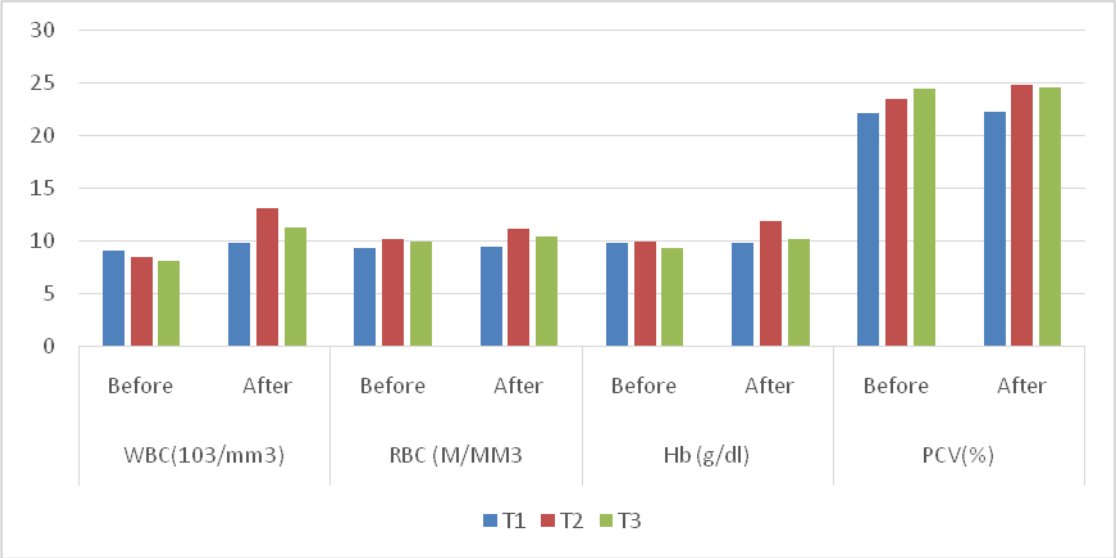
Experimental Diet	Erythrocytes						Leucocytes Indices (%)									
	MCV(cμ)		MCH (pg)		MCHC (%)		Lymphocytes		Neutrophil		Monocytes		Eosinophil		Basophil	
	Before	After*	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
T1	27.76± 0.53	27.4± 0.59 [b]	10.58± 0.51	10.51± 0.3	34.99± 0.51	34.26± 0.56	61.87± 0.59	60.33± 0.6	33.62± 0.39	33.5± 0.34	0.19± 0.12	0.075± 0.00	2.84± 0.30	2.85± 0.07	0.71± 0.04	0.73± 0.02
T2	28.63± 0.28	29.13± 0.25 [a]	9.80± 0.42	11.20± 0.40	34.83± 0.30	35.51± 0.87	59.33± 1.08	62.16± 0.33	33.16± 0.47	34.00± 0.44	0.070± 0.00	0.078± 0.00	2.66± 0.33	3.29± 0.17	0.67± 0.03	0.75± 0.03
T3	28.36± 0.46	28.60± 0.50 [ab]	9.00± 0.33	11.08± 0.51	33.55± 0.61	34.93± 0.79	61.66± 0.55	61.83± 0.70	33.33± 0.49	33.83± 0.47	0.06± 0.00	0.076± 0.00	3.16± 0.30	3.15± 0.26	0.68± 0.01	0.74± 0.01
N	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SEM	0.254	0.311	0.278	0.235	0.314	0.430	0.508	0.363	0.280	0.258	0.040	0.001	0.178	0.106	0.018	0.013
P-value	0.38	0.04	0.07	0.47	0.09	0.46	0.06	0.08	0.16	0.18	0.39	0.52	0.54	0.52	0.74	0.88

[ab] Means with different superscript in a column different significantly :* P<0.05

P- value: Probability value; N:Number of animals; SEM: Standard Error Mean

T1: 0% MLM, T2: 25% MLM, T2: 50% MLM

Graph 14. Effect of feeding Moringa based diets on blood parameters of Deccani lambs under intensive farming system



Graph 15. Effect of feeding Moringa based diets on erythrocytes indices of Deccani lambs under intensive farming system

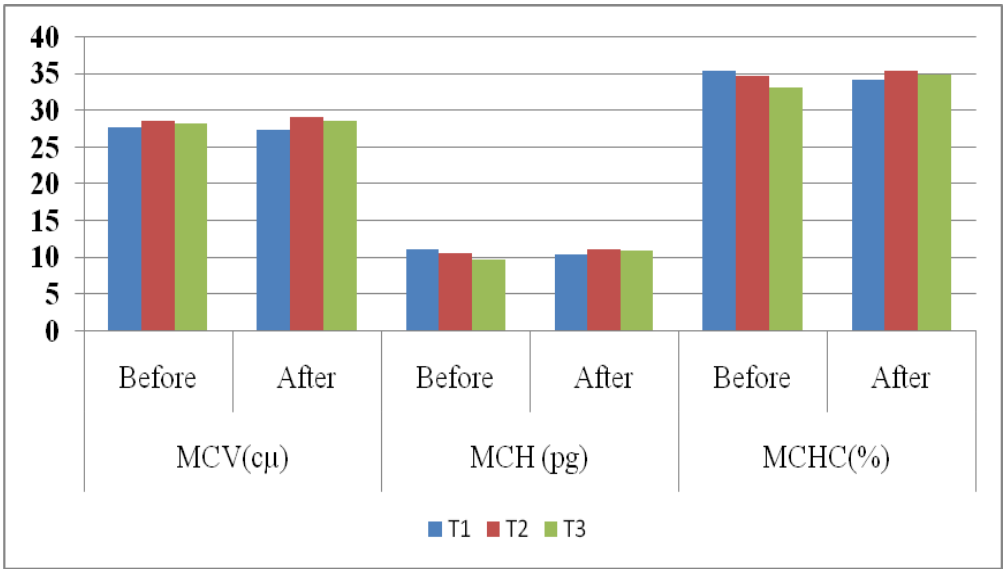


Table 25. Effect of feeding Moringa based diets on blood biochemical parameters of Deccani lambs under intensive farming system

Experimental Diet	Serum protein (gm/dl)		Serum albumin (gm/dl)		Serum glucose (mg/dl)		SGOT (IU/dl)		SGPT (IU/dl)	
	Before	After**	Before	After	Before	After	Before	After	Before	After
T1	7.10±0.16	7.04±0.15 [b]	3.32± 0.09	3.45±0.08	51.48±2.44	51.16± 2.21	38.48± 0.99	38.60±0.98	6.88± 0.122	6.83± 0.09
T2	7.18±0.14	7.85±0.13[a]	3.24±0.07	3.53±0.08	56.63±5.41	51.66±4.80	39.68±0.41	40.45±0.39	6.98±0.070	7.15±0.042
T3	7.13±0.19	7.41±0.10[ab]	3.17±0.02	3.51±0.03	57.35±5.27	54.83±5.29	38.91±0.85	39.60±0.80	6.96±0.149	7.50±0.461
N	6	6	6	6	6	6	6	6	6	6
SEM	0.925	0.109	0.040	0.038	2.548	2.375	0.446	0.454	0.657	0.162
P-value	0.97	0.002	0.35	0.67	0.62	0.81	0.56	0.26	0.75	0.25

[ab] Means with different superscript in a column different significantly: ** P<0.01

P- value: Probability value; N: Number of animals; SEM: Standard Error Mean

SG0T: Serum Glutamic Oxaloacetic Transaminase; SGPT: Serum Glutamic Pyruvic Transaminase

T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table 26. Effect of feeding Moringa based diets on nutrient digestibility of Deccani lambs under intensive system

Treatment	Dry matter	Organic matter	Crude protein	Crude fibre	Ether extract	Nitrogen free extract*	Neutral detergent fibre	Acid detergent fibre
T1	64.81± 0.93	67.21±1.40	69.64± 2.35	62.90 ±0.61	78.89±3.33	70.10±1.36 [b]	69.78±0.52	62.62±1.60
T2	66.21±0.69	68.60±0.89	71.40±2.37	63.14±0.71	80.70±2.97	75.23±1.24[a]	71.82±0.88	66.38±1.51
T3	65.14±0.45	67.86± 0.80	70.93±2.15	62.95±0.81	79.72±3.25	72.88±1.12[ab]	70.84±0.42	65.32±1.85
N	6	6	6	6	6	6	6	6
SEM	0.406	0.593	1.256	0.536	1.747	0.844	0.401	0.977
P	0.38	0.66	0.86	0.66	0.92	0.03	0.11	0.29

[ab] Means with different superscript in a column different significantly : [*] P<0.05
P- value: Probability value ; N:Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

4.1.8.1 Dry Matter Digestibility

The average dry matter digestibility coefficient recorded for T1, T2 and T3 were, 64.81±0.93, 66.21±0.69 and 65.14±0.45, respectively. Statistical analysis of the data revealed that there was no significant difference in the digestibility of dry matter among various treatment groups. The dry matter digestibility coefficient (%) was non-significantly higher in T2 and T3 than T1 group lambs.

4.1.8.2 Organic Matter Digestibility

The average organic matter digestibility coefficients were 67.21 ±1.40, 68.60±0.89 and 67.86 ±0.80 for T1, T2 and T3 groups, respectively. Organic matter digestibility coefficients (%) were non-significantly higher in T2 and T3 treatment groups when compared with the control (T1) group lambs.

4.1.8.3 Crude Protein (CP) Digestibility

The crude protein (CP**)** digestibility coefficients of experimental lambs in intensive farming system were 69.64±2.35, 71.40±2.37 and 70.93±2.15 for T1, T2 and T3, treatment groups. The CP digestibility was found to be numerically higher in T2 and T3 group as compared to control group lambs, however the differences are not significant.

4.1.8.4 Crude Fibre (CF) Digestibility

The average crude protein (CP**)** digestibility recorded for T1, T2 and T3 treatment groups were, 62.90 ±0.61, 63.14±1.45 and 62.95±0.81, respectively in intensive farming system (Table 26). Relatively higher CF digestibility was observed in Moringa leaf meal supplemented group (T2 and T3) compared to control group (T1) lambs, however the differences were not significant.

4.1.8.5 Ether Extract (EE) Digestibility

The Ether Extract (EE) digestibility coefficients (%) of experimental animals in intensive management systems are presented in Table 26. The average ether extract (EE) digestibility coefficients observed for T1, T2 and T3 were 78.89 ±3.33, 80.70 ± 2.97 and 79.72 ±3.25, respectively in intensive farming system. There was no significant difference in the ether extract digestibility among the three experimental diets. But the lambs fed with diets containing Moringa oleifera shown relatively higher ether extract digestibility coefficient (%).

4.1.8.6 Nitrogen Free Extract (NFE) Digestibility

The average Nitrogen Free Extract (NFE**)** digestibility coefficients (%) in intensive system were 70.10±1.36, 75.23±1.24 and 72.88±1.12 in T1, T2 and T3 treatment groups respectively.

The statistical analysis of data revealed a significant (P<0.05) effect of treatments on nitrogen free extract digestibility. The Nitrogen free extract digestibility was significantly (P<0.05) higher in the T2 group when compared to the control (T1) group. T3 group had no significant difference with T1 and T2 groups.

4.1.8.7 Neutral Detergent Fibre (NDF) Digestibility

The average Neutral Detergent Fibre (NDF) digestibility coefficients (%) of growing Deccani lambs in intensive farming systems were, 69.78±0.52, 71.82±0.88 and 70.84±0.42 in T1, T2 and T3 dietary groups, respectively. The neutral detergent fibre digestibility was non-significantly higher in T2 and T3 group than T1 group lambs.

4.1.8.8 Acid Detergent Fibre (ADF) Digestibility

The Acid Detergent Fibre (ADF) digestibility coefficients (%) of growing Deccani lambs in intensive farming systems were 62.62±1.60, 66.38±1.51and 65.32±1.85 in T1, T2 and T3 dietary groups, respectively. Acid Detergent Fibre digestibility was non-significantly higher in T2 and T3 group compared to T1 group lambs.

4.1.9 FEEDING BEHAVIOUR INTENSIVE FARMING SYSTEM.

During the growth trial growing Deccani lambs were observed for four hours each for five days to study the difference in behavioural traits like eating, drinking, ruminating, standing and sleeping when fed on different experimental diets. Feeding behaviour in lambs fed on different experimental diets is presented in Table 27 and depicted in Graph 18.

Time spent (min) for eating, drinking water, rumination, standing and sleeping by lambs in T1, T2 and T3 was 114±1.87, 5.0 ±0.37, 40.0 ±4.47, 20.0±2.00, 64 ±2.92; 120.0 ±1.87, 6.0 ±0.37, 48.0 ±1.87, 22.0 ±1.87, 44.0 ±1.16 and 115.0 ±4.06, 5.0 ±0.45, 45.0 ±2.24, 21.0 ±2.45 and 54.0±4.2, respectively. Percentage of total time spent in eating, drinking water, ruminating, standing and sleeping was 46.25±0.78, 2.8±0.16, 16.16±0.78 8.33±0.83 and 26.26±0.48 for lambs fed on T1 diets and 50.0 ±0.78, 2.5±0.16, 20.0 ±0.93, 9.16±0.78 and 18.33±1.75 for lambs fed T2 diets and 47.91±1.69,

2.8±0.19, 18.75±0.72, 8.75±1.02 and 22.5±0.68 for lambs fed on T3 diets. Time spent and per cent of total time spent on eating and sleeping were significantly (P<0.01) higher in T2 group lambs than T3 and T1 group lambs and no significant difference was noticed between T1 and T3 group lambs.

4.1.10 FAECAL CONSISTENCY SCORE

Faecal consistency of the lambs was recorded for five days by collecting the faecal samples immediately 48 hours after starting the animals to feed on the experimental diets. Faecal consistency score values of lambs are presented in Table 28 and Graph 19.

Faecal consistency is used as a tool to assess how a diet is digested and overall animal health. Faecal consistency score was 1.35±0.64, 2.42±0.30 and 2.24±0.16 in T1, T2 and T3 groups, respectively. The fecal consistency score was significantly (P<0.01) higher in the T2 groups when compared to the control (T1) group. T3 group had no significant difference with T1and T2 groups.

4.1.11 CARCASS CHARACTERISTICS

At the end of the experimental period three representative lambs from each group were randomly selected and slaughtered to study the effect of feeding different levels of Moringa leaf meal on carcass characteristics.

4.1.11.1 Live Weight, Carcass Weight and Dressing Percentage

The details of pre slaughter weight, empty body weight hot carcass weight is presented in Table 29 and Graph 20.

The mean live body weight (kg) of lambs fed T1, T2 and T3 diets at slaughter was 21.33±7.41, 22.30 ±3.41 and 26.16±7.41, respectively. The mean empty body weight (kg) and hot carcass weight (kg) of lambs fed T1, T2 and T3 diets at slaughter was 17.33 ±0.49 and 10.3±0.52; 17.46 ±1.96 and 10.7 ± 1.95; 22.5 ±1.77 and 14.5 ±1.69, respectively in intensive system of farming.

The mean dressing percentage on pre slaughter weight and empty body weight was 48.75±0.69, 59.34±1.38; 47.55 ±2.06, 63.60± 4.48 and 48.10±2.21, 61.8 ±3.23, respectively for T1, T2 and T3 groups in intensive system.

` No significant difference was observed for the pre slaughter weight, empty body weight hot carcass weight and dressing percent among the three groups. T3 group lambs had relatively higher pre-slaughter, empty live and hot carcass weights than T2 and T1

groups. However, the overall dressing percentage o empty live body was relatively higher in T2 group than T3 and T1 group in lambs.

4.1.11.2 Weight of Organs on Pre-slaughter Weight Basis

The weights of edible and non-edible offal in intensive farming system presented in Table 29a.

The weights of liver, kidney, heart, testis and spleen were 0.23±0.04, 0.28±0.03 and 0.30±0.02; 0.06±0.01, 0.08±0.00 and 0.09±0.00; 0.07±0.00, 0.11±0.02 and 0.11± 0.02; 0.14±0.03, 0.11±0.06 ,0.13±0.05 and 0.04±0.01,0.06 ±0.01 and 0.06 ±0.01, respectively ofin T1,T2 and T3 dietary groups.The total weight of edible offals were 0.57±0.02,0.64±0.04 and 0.70±0.10 kg, respectively in T1,T2 and T3 dietary groups. Statistical analysis revealed no significant effect of treatment groups on total weight of edible offals.

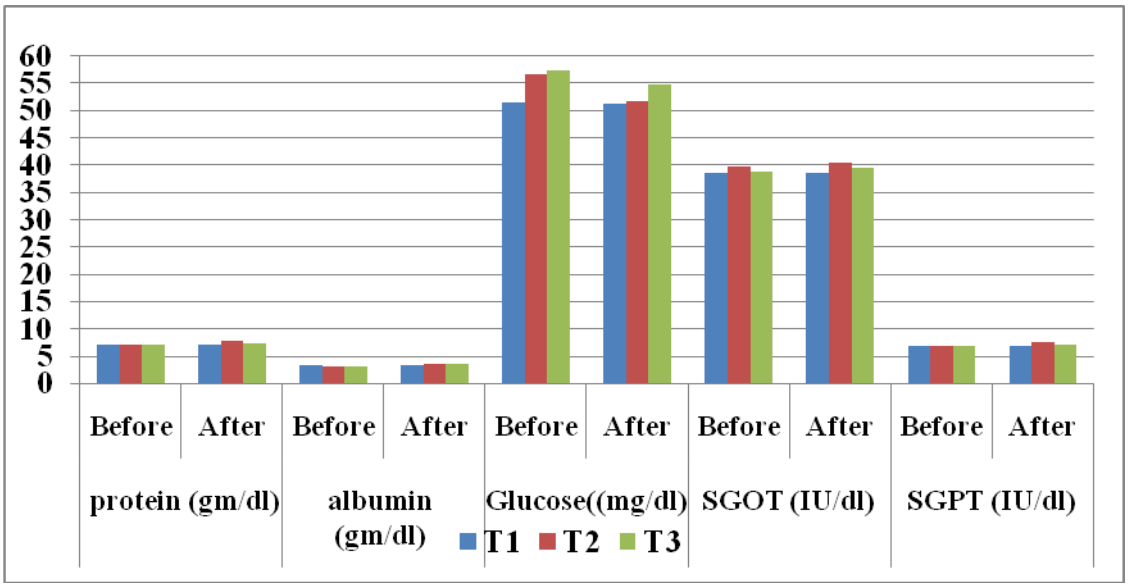
The weight of head, leg, skin, blood, stomach and intestine were 1.52±0.06, 1.11±0.06 and 2.05±0.03; 2.75±0.09, 2.8±0.4 and 2.91±0.5; 3.2±0.32, 2.55±0.14 and 2.55±0.48; 0.48±0.02, 0.70±1.12 and 0.73±0.11; 0.26±0.01, 0.45±0.12 and 0.31 ±0.06; 1.13±0.03, 0.88±0.19 and 1.10±0.32 and 0.83±1.93, 0.90±0.08 and 0.99±0.55, respectively in T1, T2 and T3 dietary groups. The total weight of non-edible organs in T1, T2 and T3 were 5.90±0.39, 5.51±0.17 and 8.18±0.51, respectively. Statistical analysis revealed no significant effect of treatment groups on total weight of edible offals.

Relatively higher edible and non-edible offal weights were observed with Moringa based diets supplemented lambs (T2 and T3).

4.1.12 COST OF PRODUCTION

The cost of feed per Kg body weight gain in growing Deccani lambs fed with experimental diets in intensive system was Rs 129.35, 108.83 and 119.41, respectively for T1, T2 and T3. Diet (T2) with replacement of 25 % ground nut cake protein with *Moringa oliefera* leaf meal was found to be more economical than T1 and T3 diets in intensive farming system (Table 30).

Graph 16. Effect of feeding Moringa based diets on blood biochemical parameters of Deccani lambs under intensive farming system



Graph 17. Effect feeding Moringa based diets on nutrient digestibility of Deccani lambs under intensive system

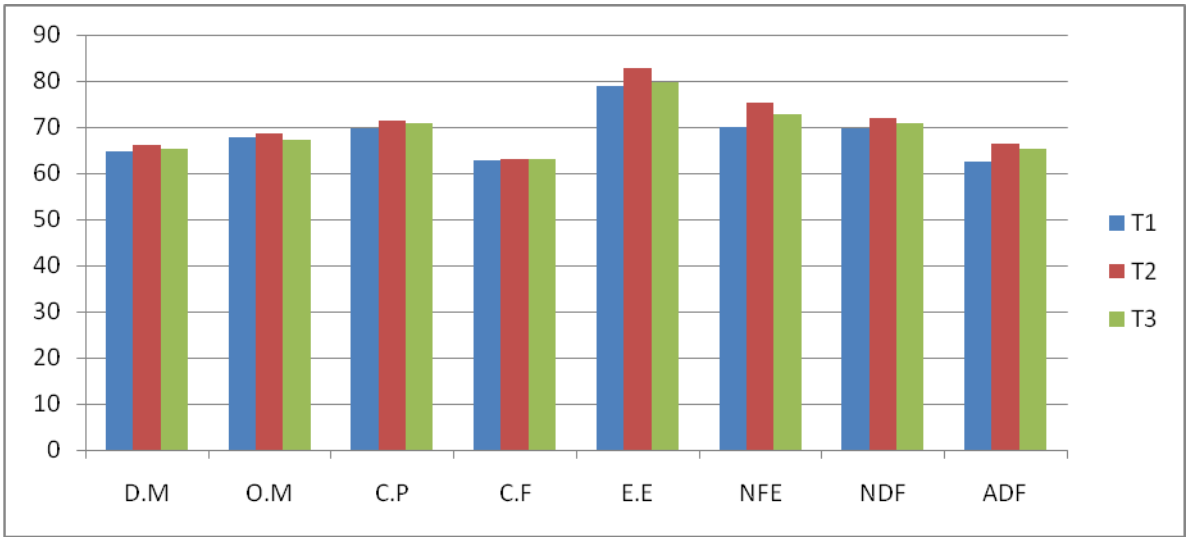


Table 27. Effect of feeding Moringa based diets on behavioural activities of Deccani lambs under intensive farmingsystem

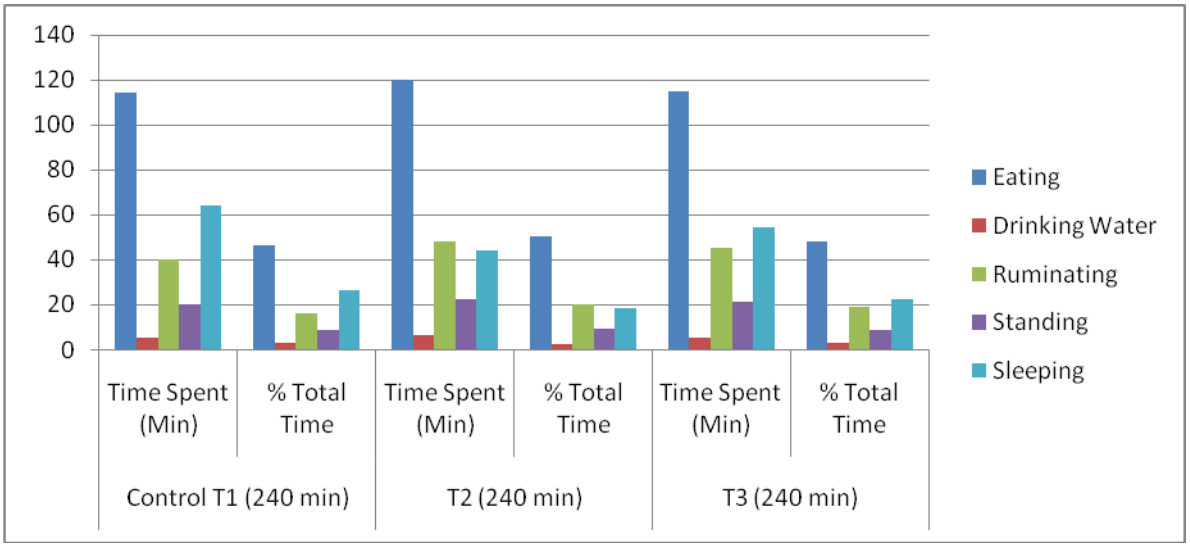
Treatments	Eating		Drinking water		Rumination		Standing		Sleeping	
	Time spent (Min)**	% Total Time**	Time spent (Min)	% Total Time	Time spent (Min)	% Total Time	Time spent (Min)	% Total Time	Time spent (Min)**	% Total Time**
T1	114±1.87[b]	46.25±0.78 [b]	5.00 ±0.37	2.80±0.16	40.00±4.47	16.16±0.78	20.00±2.00	8.33± 0.83	61.00±2.92[a]	26.26±0.48[a]
T2	120±1.87[a]	50.00±0.78[a]	6.00± 0.37	2.50±0.16	48.00±1.87	20.00±0.93	22.00±1.87	9.16±0.78	44.00±1.16[c]	18.33±1.75[c]
T3	115±4.06[b]	47.91±1.69[b]	5.00 ±0.45	2.80±0.19	45.00±2.24	18.75±0.72	21.00±2.45	8.75± 1.02	54.00±4.20[b]	22.50±0.68[b]
SEM	0.949	0.395	0.228	0.95	0.749	0.312	0.388	0.161	0.192	0.801
P-Value	0.009	0.009	0.206	0.206	1.00	1.00	1.55	1.55	0.00	0.00

[ab] Means with different superscript in a column different significantly: ** P<0.01

P- value: Probability value **N**: Number of animals **SEM**: Standard Error Mean

T1: 0% MLM; **T2**: 25% MLM; **T2**: 50% MLM

Graph 18. Behavioural traits of Deccani lambs under Intensive farming system.



Graph 19. Faecal Consistency Score (FCS) of lambs under intensive System

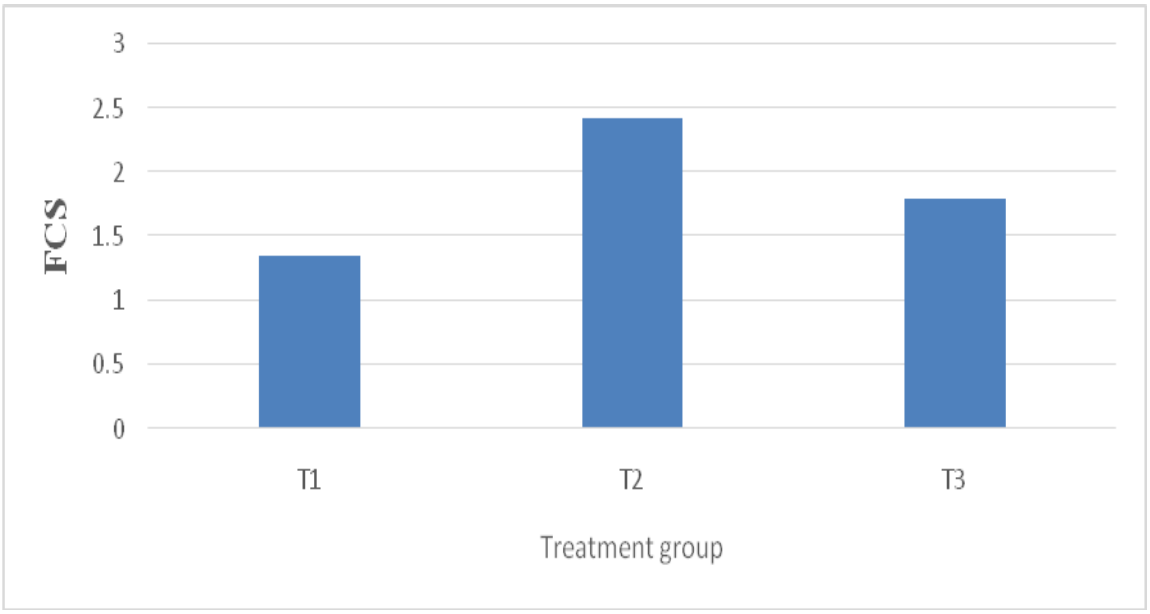


Table 28. Effect of feeding Moringa based diets on faecal consistency score (FCS) of Deccani lambs under intensive System

Exp.Diet	Day	Faecal Consistency Score (FCS)
T1	1	1.50
	2	1.30
	3	1.17
	4	1.50
	5	1.30
Mean		**1.35 ±0.64^{b}**
T2	1	3.3
	2	2.0
	3	3.0
	4	2.0
	5	1.80
Mean		**2.42±0.30^{a}**
T3	1	2.1
	2	2.0
	3	3.0
	4	2.1
	5	2.0
Mean		**2.24±0.16^{ab}**
N	6	**6**
SEM		**0.156**
P-value		**0.008**

^{ab} Means with different superscript in a column different significantly: ** P<0.01
P- value: Probability value N: Number of animals SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table 29 . Effect of feeding Moringa based diets on carcass characteristics of Deccani lambs under intensive system

Treatments	Pre-slaughter live weight (kg)	Empty live weight (kg)	Hot carcass weight (kg)	Dressing % (PSW)	Dressing % (ELW)
T1	21.33 ±7.41	17.33 ±0.49	10.30±0.52	48.75±0.69	59.34±1.38
T2	22.30 ±3.41	17.46 ±1.96	10.70±1.95	47.55±2.06	63.60±4.48
T3	26.16 ±7.41	22.50±1.77	14.50±1.69	48.10±2.21	61.80±3.23
N	3	3	3	3	3
SEM	1.566	0.936	0.883	1.764	0.997
P	0.47	0.32	0.47	0.66	0.53

P- value: Probability value N: Number of animals SEM: Standard Error Mean
T1: 0% MLM T2: 25% MLM T2: 50% MLM

Graph 20 Dressing percent on empty live weight

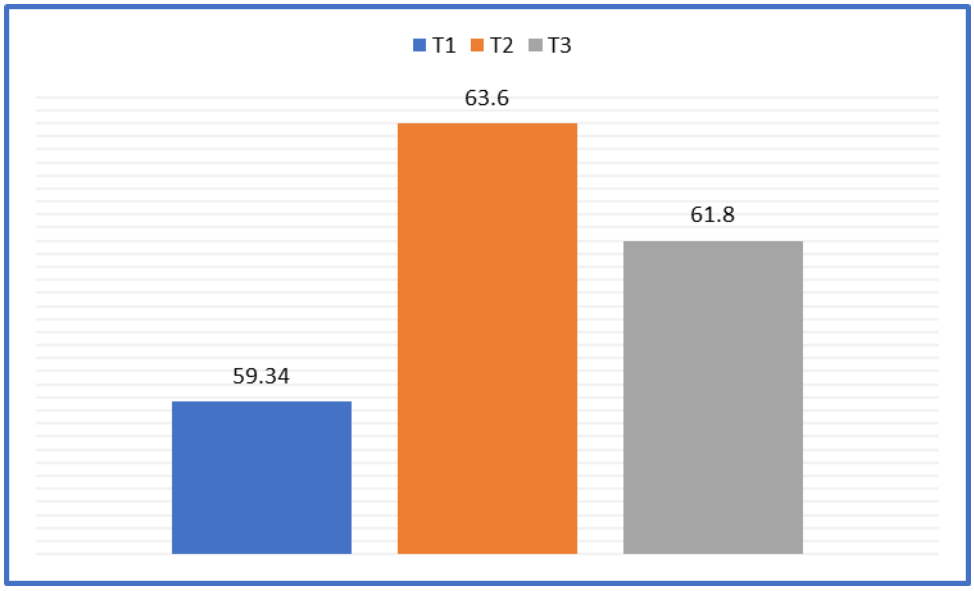


Table 29a. Effect of feeding Moringa based diets on weight (kg) of organs on pre slaughter weight of lambs under intensive Farming system

Diet	Edible offal (kg)					Non-edible offal (kg)								
	Liver	**Kidney**	**Heart**	**Testis**	**Spleen**	**Total weight**	**Head**	**Leg**	**Skin**	**Blood**	**Lung**	**Stomach**	**Intestine**	**Total weight**
T1	0.239 ± 0.04	0.066 ± 0.01	0.07 ± 0.00	0.14 ± 0.03	0.04 ± 0.00	0.57 ± 0.02	1.52 ± 0.06	2.75 ±0.09	3.2 ± 0.32	0.48 ± 0.02	0.26 ± 0.01	1.13 ± 0.03	0.83 ± 1.93	5.90 ± 0.63
T2	0.28 ± 0.03	0.08 ± 0.007	0. 11 ± 0.02	0.11 ± 0.06	0.06 ± 0.01	0.64 ± 0.14	1.11 ±0.06	2.8 ±0.4	2.55 ± 0.14	0.70 ±1.12	0.45 ± 0.012	0.88 ±0.19	0.90 ± 0.08	5.51 ± 0.17
T3	0.306 ±0.02	0.09 ± 0.00	0.11 ±0.02	0.13 ± 0.05	0.06 ± 0.01	0.70 ±0.12	2.05 ± 0.03	2.91 ± 0.5	2.55 ±0.48	0.73 ±0.11	0.31 ±0.06	1.10 ± 0.32	0.99 ± 0.05	8.18 ± 0.51
N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
SEM	0.019	0.001	0.010	0.028	0.007	0.059	0.129	0.206	0.178	0.062	0.049	0.146	0.041	0.298
P	0.39	0.29	0.46	0.91	0.77	0.73	0.84	0.86	0.82	0.23	0.29	0.80	0.14	0.28

P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table 30. Cost (Rs) of Feed ingredients and cost of economicsof the Moringa based diets underintensive farming system

Ingredients	Cost /Kg (Rs)	T1		T2		T3	
		Parts (Kg)	Cost (Rs)	Parts (Kg)	Cost (Rs)	Parts (Kg)	Cost (Rs)
D.O.R.B	13.00	29.00	377.00	26.70	347.10	24.50	318.50
Moringa Leaves (D.M.B)	45.00	-	-	7.30	328.50	14.50	652.50
G.N.C	32.50	20.00	650.00	15.00	487.50	10.00	325.00
C.S.C	24.80	13.00	322.40	13.00	322.40	13.00	322.40
Red gram Chunni	17.80	35.00	623.00	35.00	623.00	35.00	623.00
Salt	6.00	1.00	6.00	1.00	6.00	1.00	6.00
Mineral mixture	110.00	2.00	220.00	2.00	220.00	2.00	220.00
Total	-	100.00	2198.40	100.00	2334.50	100.00	2467.40
Processing Cost (Rs)	1.00	-	100.00	-	100.00	-	100.00
Total Cost (Rs)	-	-	2298.40	-	2434.50	-	2567.40
Cost of feed / Kg	-	-	22.98	-	24.34	-	25.67
Total Feed Intake (Kg)	-	-	30.50	-	30.80	-	30.75
Total concentrate mix Cost (Rs)	-	-	701.00	-	749.67	-	789.35
Cost of APBN1/Paragrass @1.00 /Kg	1.00	295.00	295.00	244.00	244.00	246.00	246.00
Total Cost	-	-	996.01	-	993.67	-	1035.35
Body weight gain (kg)	-	-	7.70	-	9.13	-	8.67
Total Cost/Kg Gain	-	-	129.35	-	108.83	-	119.41

T1: 0% MLM. T2: 25% MLM. T2: 50% MLM

Experiment II

The results of feeding *Moringa oleifera* based diets on the performance of growing Deccani lambs in semi-intensive farming are tabulated, statistically analysed and presented in this chapter

4.2 GROWTH PERFORMANCE

Growth trial was conducted for a period of 90 days to evaluate the effect of experimental diets on body weights, average daily gains and dry matter intake in growing Deccani sheep in semi-intensive farming system.

4.2.1 Fortnightly Body Weights

The fortnightly body weight changes of growing Deccani lambs under semi-intensive farming system is presented in Table 31 and graphically represented in Graph 21.

The initial mean body weight (kg) of experimental lambs was 18.80 ±1.59, 18.83 ±1.26 and 18.70 ±0.08 that increased to 26.02 ±1.94, 27.16 ±1.00 and 26.36 ±0.98 at the end of the experiment in T1, T2 and T3 groups, respectively. The overall mean body weight (kg) of Deccani lambs in T1, T2 and T3 was 22.64 ±1.01, 23.04 ±1.09 and 22.61 ±0.95, respectively. Statistical analysis of the data revealed no significant difference in the fortnightly body weights of the lambs from 1st to 6th fortnights and overall mean body weights among three treatment groups. However, there was a linear increase in body weights in all three treatment groups. Numerically higher body weight was observed in T2 and T3 groups than T1 group lambs throughout the experiment.

4.2.1.1 Total Weight Gain

The total gain in body weight (kg) was 7.22 ±0.58, 8.33 ±0.48 and 7.66±0.54 in lambs fed with T1, T2 and T3 diets, respectively in semi-intensive farming system. There was no significant difference for total weight gain (kg) among the treatment group lambs, however total weight gain (kg) was higher in Moringa supplemented group lambs (T2 and T3) when compared to T1.

4.2.1.2 Average Daily Gain

The overall Average Daily Gain (ADG) observed in the lambs in semi-intensive farming systems is presented in Table 31 and Graph 22.

The average daily gain (g) was 80.20 ±6.47, 92.60 ±5.07 and 85.11±6.10 g in T1, T2 and T3 groups, respectively. The average daily gain was non-significantly higher in T2 group (92.60±5.07 g) followed by T3 (85.11±6.10 g) and T1 (80.20±6.47g) groups.

4.2.1.3. Dry Matter Intake (DMI)

The average daily dry matter intake (kg/day) in Deccani growing lambs fed with experimental diets under semi-intensive farming system was 1.02 ±0.07, 1.14 ±0.03 and 1.05 ±0.03 for T1, T2 and T3 diets, respectively. The values recorded for average DMI per 100 kg body weight were 3.95±0.03, 4.21±0.06 and 4.01±0.05 kg, respectively for T1, T2 and T3 group lambs. Statistical analysis of the data on DMI (kg/100kg) was significant (P<0.01) among the treatment groups. T2 group lambs had a signifianctly higher DMI (kg/100 kg body weight) compared to T1 and T3 groups and there was no significant difference between T1 and T3 groups (Table 32).

4.2.1.4 Feed Conversion Ratio

The feed conversion ratio under semi-intensive farming system is presented in Table 33.

The FCR in T1, T2 and T3 diets were 12.71 ±0.47, 12.31 ±0.42 and 12.54 ±0.41, respectively. There was no significant difference in FCR among the three dietary groups. The feed conversion efficiency was realtively lower in Moringa based groups (T2 and T3) compared to T1 groups. Further, T2 recorded better FCR compared to diet T3.

4.2.2 BIO METRIC MEASUREMENTS

4.2.2.1 Fortnightly Body Length

The fortnightly body length changes (cm) of growing Deccani lambs fed with three experimental diets in semi-intensive farming system is shown in Table 34 and in Graph 23.

The initial mean body length was 49.50±1.23, 51.83±2.63 and 55.66±1.38 for treatment groups T1, T2 and T3, respectively. The mean final body length was 64.5 ±0.56, 70.0 ±0.57 and 69.5 ±1.68 for T1, T2 and T3 treatment groups, respectively. Statistical analysis revealed a significant difference (P<0.01) among three treatment groups for final body length. T2 group lambs had significantly higher body length than T1 group but comparable with T3 group lambs. Lowest body length was observed in T1 group and was statistically significant with T2 and T3 group lambs. From 2nd to 5th

fortnights the mean body length was significantly (P<0.05) higher in T3 group. The findings indicated that the mean fortnight body length of growing Deccani lambs increased linearly throughout the experimental period.

The overall mean of body length was 57.68 ±1.88, 58.41 ±2.26 and 63.78 ±4.86 cm in T1, T2, T3 groups, respectively.

4.2.2.2 Fortnightly Height at Withers (cm)

The fortnightly height at withers (cm) of growing Deccani lambs from first to sixth fortnights of experimental lambs in semi-intensive farming system is presented in Table 35 and graphically represented in Graph 24.

The initial mean height at withers (cm) was 55.66 ±1.87, 58.83 ±0.87 and 59.50 ±0.56 and the final height at withers (cm) was 68.5 ±1.64, 77.16±0.83 and 76.16±0.65 for treatment groups T1, T2 and T3, respectively. There was a statistical difference (P<0.01, 0.05) among three treatment groups for 1st, 5th and final fortnights. T2 group lambs had significantly higher height at withers than T1 group lambs for 1st, 5th and final fortnights for height at withers (cm).

The overall mean of height at wither was 62.92 ±1.78, 67.42 ±2.25 and 67.34 ±1.90 in T1, T2, T3 groups, respectively.

4.2.2.3 Fortnightly Face Length (cm)

The fortnight face length changes of growing Deccani lambs from first to sixth fortnights in semi-intensive farming system is presented in Table 36 and graphically represented in Graph 25.

The initial face length (cm) was 18.33 ±0.49, 16.50 ±0.67 and 16.16 ±0.60 cm and the final face length (cm) was 23.33 ±0.66, 23.5±0.50 and 22.66±0.42 for treatment groups T1, T2 and T3, respectively. In first fortnight, the mean face length was 17.66 ±0.55, 20.16 ±0.47 and 18.16 ±0.66 cm for treatment groups T1, T2 and T3, respectively. First fortnight face length was statisticaly significant (P<0.05) among the treatment groups. T2 group lambs had significantly (P<0.05) higher face length (cm) than T1 group lambs and which was comparable with T3 group lambs. From 1st to 5th

Table 31. Effect of feeding Moringa based diets on body weight (kg) and ADG (g) of Deccani lambs under semi-intensive farming system

Experimental Diet	Initial Body weight	Fortnightly body weight gain (kg)						Overall mean	Total weight gain	ADG (g)
		1	2	3	4	5	6			
T1	18.80±1.59	20.33±1.54	21.75±1.89	22.75±1.96	24.36±1.99	24.28±1.99	26.02±1.94	22.61±1.01	7.22±0.58	80.20±6.47
T2	18.83±1.26	20.50±1.26	21.85±1.15	23.08±1.31	24.65±1.39	25.33±1.24	27.16±1.00	23.04±1.09	8.33±0.48	92.60±5.07
T3	18.70±0.08	20.33±0.79	21.93±0.03	22.91±0.9	23.85±1.01	24.71±0.97	26.36±0.98	22.64±0.95	7.66±0.54	85.11±6.10
N	6	6	6	6	6	6	6	6	6	6
SEM	0.683	0.673	0.755	0.793	0.829	0.804	0.760	0.563	0.310	3.444
P-value	1.00	0.99	0.99	0.98	0.93	0.88	0.84	0.94	0.84	0.71

P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table 32. Effect of feeding Moringa based diets on Dry Matter Intake (DMI) of Deccani lambs under semi intensive farming system.

Experimental Diet	Body weight (kg)	Dry matter intake (kg)		Drymatter Intake (Kg/Day)	Dry Matter Intake (Kg/100Kg B.W)**
		Fodder	Experimental Diet		
T1	26.5 ± 1.94	0.77±0.07	0.24±0.00	1.02 ± 0.07	3.95± 0.03[b]
T2	27.5 ± 1.00	1.06±0.19	0.24±0.00	1.14 ± 0.03	4.21 ± 0.06[a]
T3	26.36 ± 0.98	0.81±0.03	0.24±0.00	1.05 ± 0.03	4.01 ± 0.05[b]
N	6	6	6	6	6
SEM	0.762	0.001	0.001	0.031	0.032
P-value	0.84	0.76	0.65	0.31	0.001

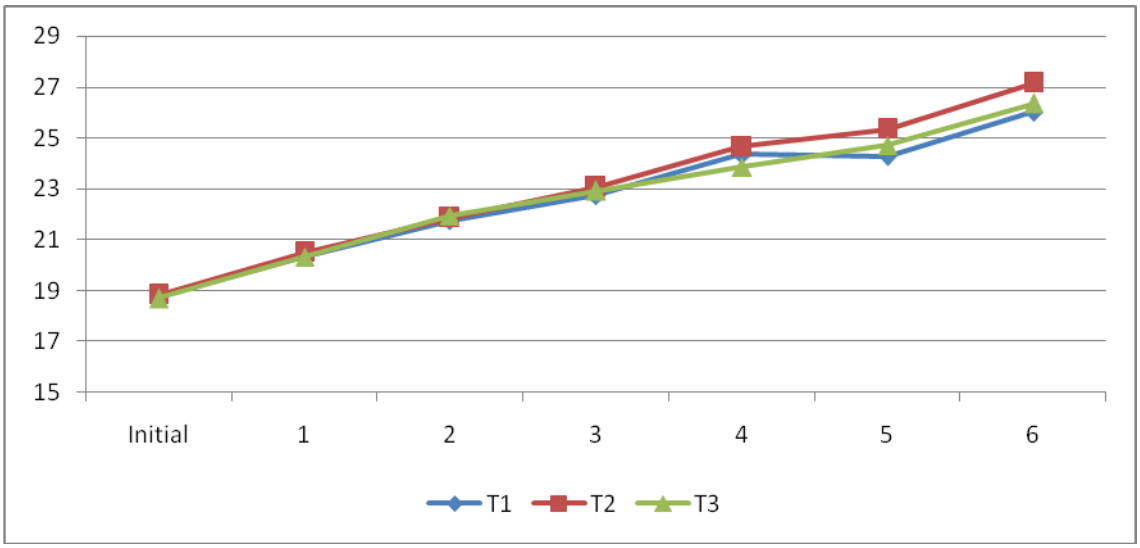
[ab] Means with different superscript in a column different significantly : [**] P<0.01
P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table 33. Effect of feeding Moringa based diets on overall performance of Deccani lambs under semi- intensive farming system

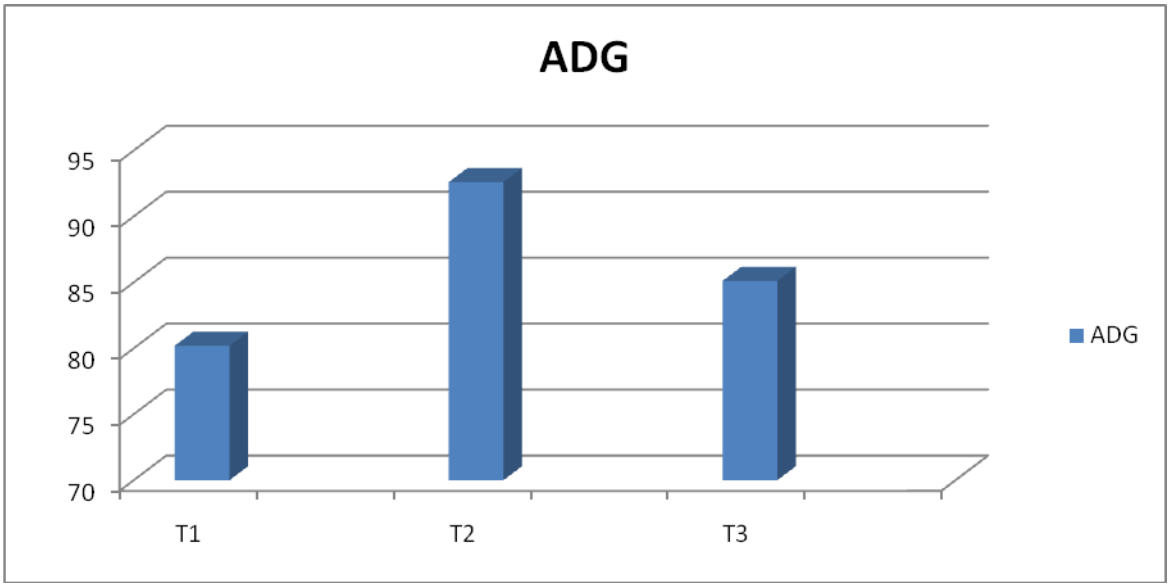
Sr.No.	Parameter	T1 (Control)	T2	T3
1.	Feed Intake (kg/Day)	1.46±0.14	1.49±0.14	1.45±0.13
2.	Dry Matter Intake (kg/Day)	1.02 ± 0.07	1.14 ± 0.03	1.05 ± 0.03
3.	Total Feed Intake (kg)	131.4±3.07	134±1.45	130.51±3.00
4.	Total Dry Matter Intake(kg)	91.8±1.70	102.6±2.29	94.5±1.05
5.	Weight gain (kg)	7.22±0.58	8.33±0.48	7.66±0.54
6.	Average daily gain (gm)	80.2±6.47	92.6±5.07	85.11±6.10
7.	Feed Conversion Ratio (F.C.R)	12.71±0.47	12.31±0.42	12.54±0.41

T1: 0 % MLM; T2: 25% MLM; T2: 50 % MLM

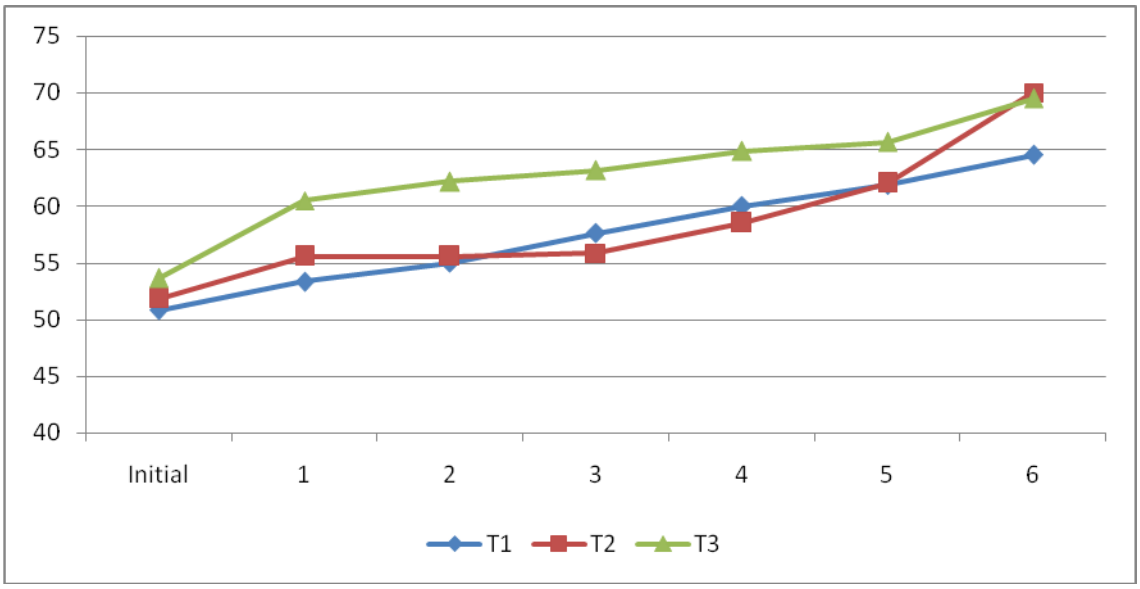
Graph 21. Effect of feeding Moringa based diets on body weight (kg) of Deccani lambs under semi-intensive farming system



Graph 22. Effect of feeding Moringa based diets on ADG (g) of Deccani lambs under semi-intensive farming system



Graph 23. Effect of feeding Moringa based diets on fortnightly body length (cm) of Deccani lambs under semi-intensive farming system



fortnightly mean face length (cm) of growing Deccani lambs increased linearly throughout the experimental period.

The overall mean face length (cm) was 21.09 ±0.60, 20.16 ±0.88 and 19.37 ±0.64 in T1, T2, T3 groups, respectively. The final gain in face length was 5.0 ±0.51, 7.0 ± 0.81 and 6.5 ±0.66 cm in T1, T2, T3 groups, respectively. The final gain in face length was numerically highest in T2 group (7.0 ± 0.81 cm) and lowest in T1 group (5.0 ±0.51cm).

4.2.2.4 Fortnightly Chest Girth (cm)

The fortnightly chest girth changes of growing Deccani lambs from first to sixth fortnights under semi-intensive farming system is shown in Table 37 and in Graph 26.

The initial mean chest girth (cm) was 65.5 ±2.12, 68.33 ±1.53 and 67.0 ±1.30 and the final mean chest girth (cm) was 80.33 ±2.59, 83.66±1.55 and 81.66 ±0.60 for treatment groups T1, T2 and T3, respectively. There was no statistical difference among treatment groups for initial and final mean chest girth (cm). The observed chest girth values were non-significantly higher in T2 and T3 group as compared to T1 group lambs. From 1st to 5th fortnightly mean chest girth of growing Deccani lambs was increased linearly throughout the experimental period.

The overall mean chest girth was 73.87 ±2.26, 75.82 ±2.25 and 75.85 ±1.91 in T1, T2, T3 groups, respectively. The observed chest girth values were non-significantly higher in T2 and T3 group as compared to T1 group lambs.

4.2.2.5 Fortnightly Hip Width (cm)

The fortnightly hip width changes of growing Deccani lambs from first to sixth fortnights under semi-intensive farming system is shown in Table 38 and in Graph 27.

The initial mean hip width was 12.50 ±0.71, 12.50 ±0.67 and 12.66 ±0.71 and the final mean hip width was 19.33 ±0.33, 20.83 ±0.30 and 19.83 ±0.16 for treatment groups T1, T2 and T3, respectively. Statistical analysis of the data revealed no significant difference between treatment groups for initial hip width while it was significant ($P<0.05$) in 5^{th} and final fortnights among three treatment groups. The mean hip width was higher in T2 group lambs than T1 group lambs and T2 group was comparable with T3 group lambs. The lowest mean hip width was observed in T1 group which is also comparable with T3 group.

The overall mean hip width was 16.37 ±0.95, 17.14 ±1.16 and 16.99 ±1.02 cm in T1, T2, T3 groups, respectively. The final gain in hip width was 6.83 ±0.60, 8.33 ± 0.49 and 7.17 ±0.65 cm in T1, T2, T3 groups, respectively. The overall mean and gain in hip width were non-significantly higher in T2 and T3 groups than T1 group.

4.2.2.6 Fortnightly Tail Length (cm)

The fortnightly changes in tail length of growing Deccani lambs from first to sixth fortnights of three experimental diets under semi-intensive farming system is shown in Table 39 and in graph 28.

The initial mean tail length was 11.66 ±0.61, 12.83 ±0.30 and 13.16 ±0.47 cm and the final tail length was 18.33 ±0.51, 21.0 ±0.51 and 20.50 ±0.67cm for T1, T2 and T3 treatment groups, respectively. The final mean tail length was significant ($P<0.05$) among three treatment groups. Highest tail length was observed T2 group lambs than T1 group lambs and there was no difference between T2 and T3 group lambs. From 1^{st} to 5^{th} fortnights tail length increased linearly throughout the experiment.

The overall mean of tail length was 16.18 ±0.90, 16.73 ±0.89 and 17.35 ±0.91 cm in T1, T2, T3 groups, respectively. The overall mean and final tail length were also non-significantly highest in Moringa supplemented groups compared to control group.

Table 34. Effect of feeding Moringa based diets on fornightly body length (cm) of Deccani lambs under semi-intensive farming system

Experimental Diet	Initial body Length	Fortnightly body length gain (cm)						Overall mean (cm)	Gain in body length (cm)
		1	2**	3*	4*	5*	6**		
T1	49.50±1.23	53.33 ±1.20^{b}	55.0 ±0.96 ^{b}	57.66±.0.80^{ab}	60.0±1.00^{ab}	61.83±0.90^{b}	64.50±0.5^{b}	57.68±1.88	15.00 ± 1.09
T2	51.83±2.63	55.56±2.52 ^{b}	55.16±1.9^{b}	55.83±1.93^{b}	58.5±1.64 ^{b}	62.00±1.26^{b}	70.50±0.5^{a}	58.41±2.26	18.17±2.40
T3	55.66±1.38	60.50±2.04 ^{a}	62.16±1.4^{a}	63.16±1.68 ^{a}	64.83±1.5^{a}	67.66±2.01^{a}	70.00±1.6^{a}	63.78±4.86	16.84±4.20
N	6	6	6	6	6	6	6	6	6
SEM	1.116	1.309	1.132	1.128	1.009	1.032	0.881	1.803	1.001
P-value	0.09	0.06	0.00	0.01	0.01	0.02	0.00	0.94	0.33

^{ab} Means with different superscript in a column different significantly:* P<0.05; ** P<0.01
P- value: Probability value ; N:Number of animalsl; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table 35. Effect of feeding Moringa based diets on fornightly height at withers (cm) of Deccani lambs under semi-intensive farming system

Experimental Diet	Initial height at withers (cm)	Fortnightly height at withers (cm)						Overall mean (cm)	Gain in height at withers *
		1*	2	3	4	5**	6**		
T1	55.66±1.87	59.83±.08[b]	64.16±1.92	64.50±1.76	64.66±1.70	65.83±1.62 [b]	68.5±1.64 [b]	62.92±1.78	14.5±1.14[b]
T2	58.83±0.87	65.00±1.21[a]	66.66±1.37	66.83±1.24	69.33±1.23	71.5±0.95 [a]	77.16±0.83[a]	67.42±2.25	18.33±0.80[a]
T3	59.50±0.56	64.16±0.09[ab]	65.10±1.02	67.16±1.40	69.00±1.14	71.00±0.96 [a]	76.16±0.65 [a]	67.34±1.90	16.66±0.84[ab]
N	6	6	6	6	06	6	6	6	6
SEM	0.783	0.976	0.855	0.901	0.911	0.908	1.088	1.187	1.002
P-value	0.09	0.04	0.51	0.19	0.05	0.00	0.00	0.21	0.03

[ab] Means with different superscript in a column different significantly:* P<0.05; ** P<0.01
P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25%MLM; T2: 50%MLM

4.2.3 BODY CONDITION SCORE (BCS)

The body condition score of growing Deccani lambs fed with Moringa based concentrate mixture and reared in semi-intensive farming system is presented in Table 40 and in Graph 29.

The mean body condition score of growing Deccani lambs at start and by the end of 1, 2, 3, 4, 5 and 6th fortnights were 1.48 ±0.13, 1.75 ±0.11, 1.75 ±0.11, 1.75 ±0.11,1.78 ±0.01,1.85 ±0.11 and 1.98 ±0.10; 1.33 ±0.25, 1.66 ±0.10, 1.75 ±0.11, 2.00 ±0.00, 2.33 ±0.10, 2.41 ±0.08, and 2.50 ±0.00 and 1.58 ±0.63, 1.50 ±0.08, 1.50 ±0.08, 2.00 ±0.10, 2.00 ±0.08, 2.00 ±0.08 and 2.16 ±0.10 cm, in T1, T2 and T3 treatment groups respectively. The body condition score was significantly (P<0.01) affected in lambs in 3rd, 4th, 5th and final fortnights among three treatment groups. The final body condition score was significantly (P<0.01) higher in T2 group than T3 and T1 groups. The overall mean BCS was 1.17±0.03, 2.0 ±0.16 and 1.8 ±0.11 in T1, T2 and T3 groups, respectively. The overall mean BCS was numerically higher in Moringa based groups than control group.

4.2.4 CORRELATION CO-EFFICIENT OF BODY WEIGHTS WITH BODY MEASUREMENTS

The correlation coefficient of body weight with different body measurement is presented in Table 41.

The correlation coefficient (R^2) of body weight with body length, face length, chest girth, body height, hip width and tail length in semi- intensive farming system group were 0.270, 0.363, 0.517, 0.525, 0.165 and 0.497, respectively. A positive and highly significant correlation was observed between body weight and chest girth, height at withers and tail length in treatment groups. Significantly (P<0.05) higher coefficient of determination was found between body weight and height at withers compared to other body measurements.

4.2.5 PHYSIOLOGICAL PARAMETERS

4.2.5.1 Fortnightly Changes in Pulse Rate (Beats/Min)

The pulse rate changes in growing Deccani lambs under semi-intensive farming system is presented in Table 42 and in Graph 30. The initial mean pulse rate was 63.83 ±0.94, 66.66 ±0.74 and 65.16 ±1.26 in T1, T2 and T3 groups, respectively and were statistically non-significant among treatment groups. The final pulse rate was 68.66

Table 36. Effect of feeding Moringa based diets on fornightly face length (cm) of Deccani lambs under semi-intensive farming system

Experimental Diet	Initial. Length (cm)	Fortnightly face length (cm)						Overall mean(cm)	Gain in face length (cm)
		1*	2	3	4	5	6		
T1	18.33±0.49	17.66±0.55[b]	21.00±0.51	21.16±0.54	21.16±0.71	22.50±0.76	23.33±0.66	21.09±0.60	5.00±0.51
T2	16.50±0.67	20.16±0.47[a]	19.83±0.40	20.00±0.36	21.16±0.47	22.00±0.44	23.5±0.50	20.16±0.88	7.00±0.81
T3	16.16±0.60	18.16±0.60[ab]	19.16±0.70	19.16±0.70	20.16±0.47	20.66±0.42	21.66±0.42	19.37±0.64	6.50±0.66
N	6	6	6	6	6	6	6	6	6
SEM	0.396	0.396	0.352	0.360	0.343	0.359	0.354	0.436	0.412
P-value	0.05	0.01	0.93	0.06	0.19	0.09	0.05	0.17	0.13

[ab] Means with different superscript in a column different significantly:* P<0.05;
P- value: Probability value ; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table 37. Effect of feeding Moringa based diets on fornightly chest girth (cm) of Deccani lambs under semi-intensive farming system

Experimental Diet	Initial Chest girth (cm)	Fortnightly chest girth (cm)						Overall mean(cm)	Gain in Chest girth (cm)
		1	2	3	4	5	6		
T1	65.5±2.12	69.77±2.02	73.50±1.82	74.33±1.54	76.83±3.27	79.33±3.09	80.33±2.59	73.87±2.26	14.83±1.80
T2	68.33±1.53	71.83±1.46	76.00±3.90	76.95±2.24	77.66±1.64	83.16±1.72	83.66±1.55	75.82±2.25	15.33±0.84
T3	67.00±1.30	70.16±1.68	76.83±0.65	76.33±2.33	77.5±0.34	81.16±0.62	81.66±0.60	75.85±1.91	14.66±1.14
N	6	6	6	6	6	6	6	6	6
SEM	0.914	0.980	1.490	1.249	1.177	1.146	1.007	1.198	1.886
P-value	0.95	0.56	0.27	0.20	0.71	0.79	0.52	0.76	0.23

P- value: Probability value ; N: Number of animals; SEM: Standard Error Mean
T1: 0 % MLM; T2: 25 % MLM; T2: 50 % MLM

±0.33, 72.83 ±0.58 and 71.16 ±0.57 in T1, T2 and T3 groups whereas, the overall mean pulse rate was 65.68 ±0.63, 69.09 ±0.78 and 67.87 ±0.65 for T1, T2 and T3 treatment groups, respectively

The mean fortnightly pulse rate was significantly (P<0.05) different during the experimental period in all fortnights under the semi-intensive farming system. Similarly, the overall mean pulse rate also significant (P<0.01) among the three treatment groups. The pulse rate was significantly higher in T2 than T1 group lambs, however it was in within the normal physiological limits.

4.2.5.2 Fortnightly Changes in Respiratory Rate (Beats/Min)

The respiratory rate in growing Deccani lambs reared in semi-intensive farming system is shown in Table 43 and in Graph 31.

The initial mean respiration rate (bpm) was 26.16 ±0.87, 27.66 ±0.71 and 27.33 ±0.55 and the final mean respiration rate (bpm) was 32.66 ±0.33, 34.16 ±0.51 and 33.16 ±0.55 for in T1, T2 and T3 groups, respectively. The overall mean respiration rate (bpm) was 28.04 ±0.69, 30.54 ±0.78 and 29.59 ±0.62 for T1, T2 and T3 treatment groups, respectively.

The observed respiratory rate was significant (0.05) in all fortnights except in 5th fortnight among the treatment groups. Higher mean respiratory rate was noticed in T2 and T3 dietary groups compared to T1 group throughout the experiment. The overall mean respiratory rate was relatively higher in lambs fed with Moringa based diets (T2 and T3) than control (T1), however it was within the normal physiological limits

4.2.5.3 Fortnightly Changes in Rectal Temperature (^{0}F)

The rectal temperature of growing Deccani lambs in semi-intensive farming system is shown in Table 44 and graphically represented in Graph 32.

The initial mean rectal temperature (^{o}F) was 101.56 ±0.21, 102.1 ±0.05 and 101.8 ±0.17 in T1, T2 and T3 groups, respectively and was statistically non-significant among treatment groups. The final mean rectal temperature (^{o}F) was 102.5 ±0.22, 102.3 ±0.24 and 102.6 ±0.42 and the overall mean rectal temperature (^{o}F) was 102.1±0.13, 102.0 ±0.09 and 102.1 ±0.12 for T1, T2 and T3 treatment groups, respectively.

4.2.5.3 Fortnightly Changes in Rectal Temperature (^{0}F)

The rectal temperature of growing Deccani lambs in semi-intensive farming system is shown in Table 44 and graphically represented in Graph 32.

Table 38. Effect of feeding Moringa based diets on fornightly hip width (cm) of Deccani lambs under semi-intensive farming system

Experimental Diet	Initial hip width (cm)	Fortnightly hip width (cm)						Overall mean(cm)	Gain in hip width (cm)
		1	2	3	4	5*	6**		
T1	12.50±0.71	13.66±0.71	15.83±0.47	17.00±0.57	17.66±0.49	18.66±0.49^{b}	19.33±0.33^{b}	16.37±0.95	6.83± 0.60
T2	12.50±0.67	14.16±0.79	16.16±0.70	18.00±0.51	18.83±0.30	20.00±00^{a}	20.83±0.30^{a}	17.14±1.16	8.33±0.49
T3	12.66±0.71	13.83±0.87	16.50±0.50	17.50±0.56	18.66±0.21	19.50±0.22^{ab}	19.83±0.16^{ab}	16.99±1.02	7.17±0.65
N	6	6	6	6	6	6	6	6	6
SEM	0.397	0.434	0.315	0.305	0.230	0.216	0.213	0.581	0.352
P-value	0.98	0.90	0.71	0.43	0.07	0.02	0.006	0.86	0.19

^{ab} Means with different superscript in a column different significantly: * P<0.05, ** P<0.01

P- value: Probability value; N: Number of animals; SEM: Standard Error Mean

T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table 39. Effect of feeding Moringa based diets on fornightly tail length (cm) of Deccani lambs under semi-intensive farming system

Experimental Diet	Initial tail length(cm)	Fortnightly tail length (cm)						Overall mean(cm)	Gain in tail length (cm)
		1	2	3	4	5	6*		
T1	11.66±0.61	14.33±0.55	16.33±0.33	17.00±0.40	17.66±0.33	17.83±0.30	18.33±0.51[b]	16.18±0.90	6.67±0.71
T2	12.83±0.30	14.83±0.30	17.50±0.84	17.50±0.80	18.16±0.79	19.16±0.50	21.0±0.51[a]	16.73±0.89	8.17±0.33
T3	13.16±0.47	15.50±0.56	16.30±0.34	17.16±0.68	17.66±0.61	18.50±0.67	20.5±0.67[a]	17.35±0.91	7.34±0.61
N	6	6	6	6	6	6	6	6	6
SEM	0.304	0.290	0.331	0.357	0.335	0.3353	0.35	0.506	0.323
P-value	0.10	0.27	0.26	0.86	0.80	0.28	0.02	0.66	0.64

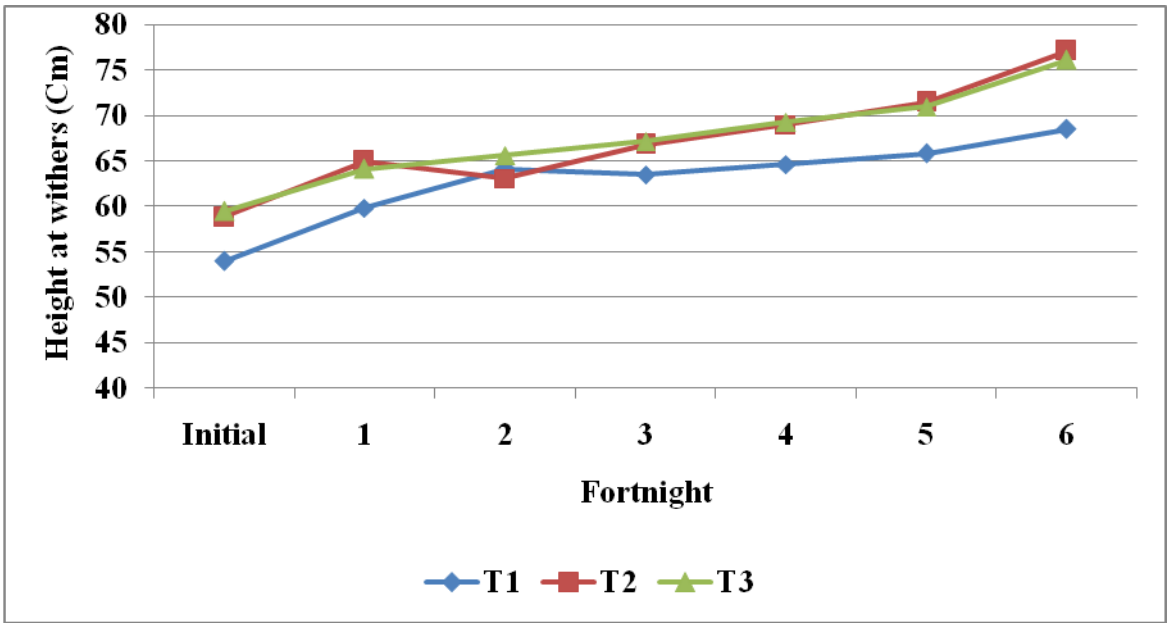
[ab] Means with different superscript in a column different significantly: [*] P<0.05

P- value: Probability value

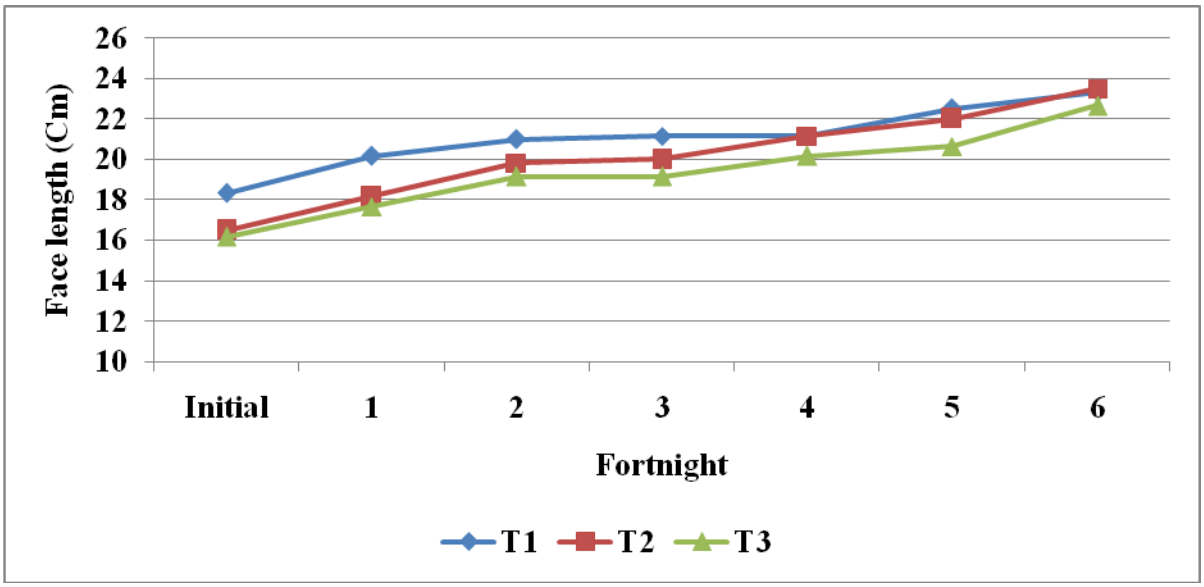
N: Number of animals; SEM: Standard Error Mean

T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

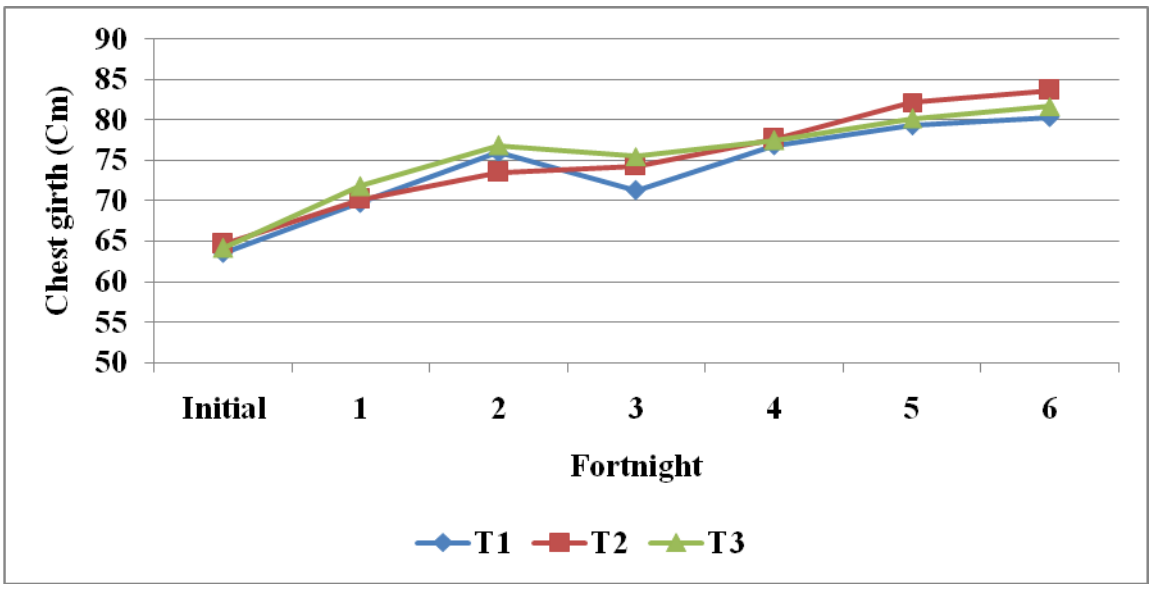
Graph 24. Effect of feeding Moringa based diets on fortnightly height at withers (cm) of Deccani lambs under semi-intensive farming system



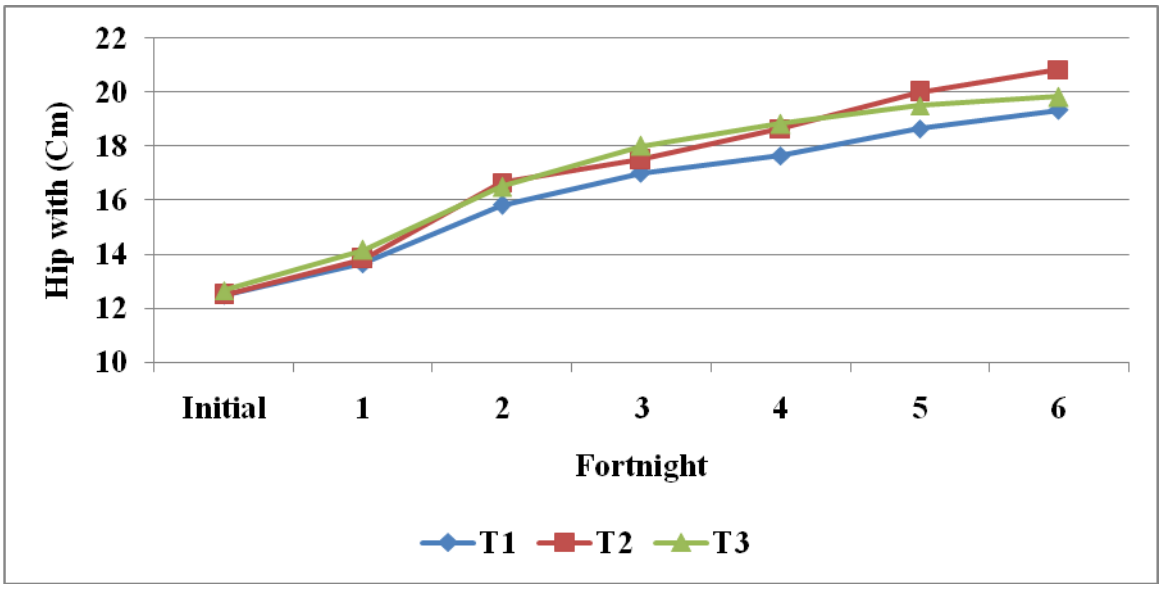
Graph 25. Effect of feeding Moringa based diets on fornightly face length (cm) of Deccani lambs under semi-intensive farming system



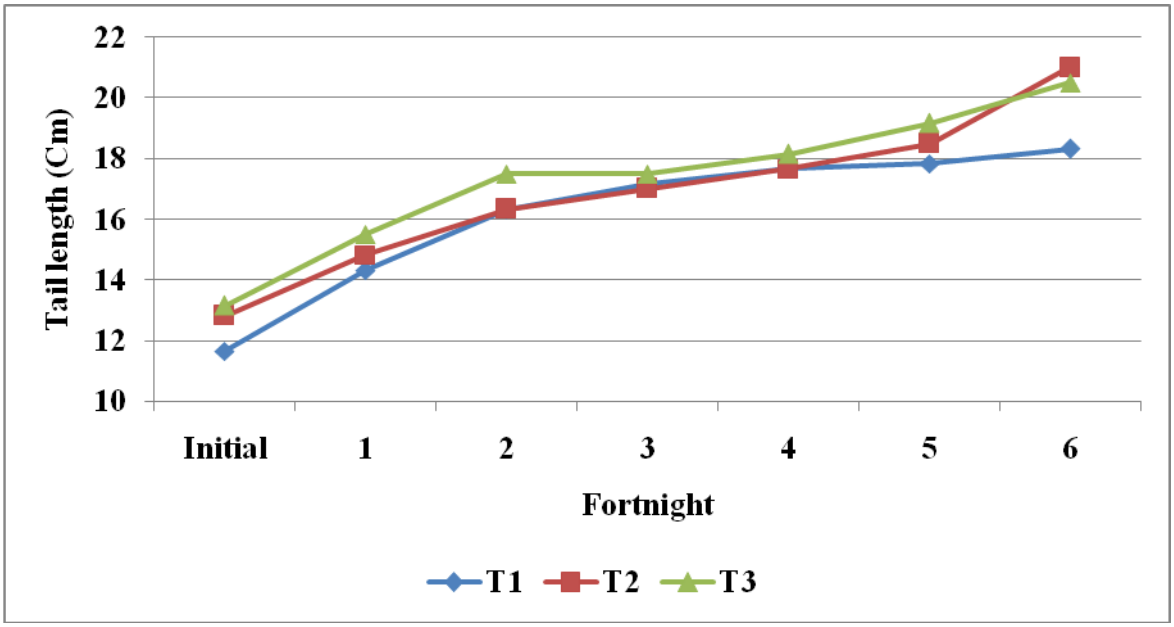
Graph 26. Effect of feeding Moringa based diets on fornightly chest girth (cm) of Deccani lambs under semi-intensive farming system



Graph 27. Effect of feeding Moringa based diets on fornightly hip width (cm) of Deccani lambs under semi-intensive farming system



Graph 28. Effect of feeding Moringa based diets on fornightly tail length (cm) of Deccani lambs under semi-intensive farming system



The initial mean rectal temperature (°F) was 101.56 ±0.21, 102.1 ±0.05 and 101.8 ±0.17 in T1, T2 and T3 groups, respectively and was statistically non-significant among treatment groups. The final mean rectal temperature (°F) was 102.5 ±0.22, 102±0.24 and 102.6 ±0.42 and the overall mean rectal temperature (°F) was 102.1±0.13, 102.0 ±0.09 and 102.1 ±0.12 for T1, T2 and T3 treatment groups, respectively.

The observed mean rectal temperature was relatively higher in T2 and T3 groups compared with T1 group, however, it was within the normal physiological limits in all the three treatment groups in semi-intensive farming system.

4.2.6 BLOOD PARAMETERS

4.2.6.1 WBC (10^3/mm^3)

The estimated WBC (10^3/mm^3) levels of growing Deccani lambs fed with experimental diets in semi-intensive farming systems are presented in Table 45 and Graph 33.

The mean WBC levels before start of the feeding experimental diets were 9.66±0.72, 10.36±0.42 and 10.50±0.76 in T1, T2 and T3 groups, respectively. The mean recorded WBC (10^3/mm^3) levels after the experiment were 9.83± 0.45, 12.83±0.33 and 11.33±0.77 in T1, T2 and T3 groups, respectively. Statistical analysis of the data

revealed a significant difference (P<0.01) in the WBC levels among experimental diets at the end of the experiment. Significantly (P<0.01) higher WBC values were observed in T2 dietary group which was comparable with T3 dietary group and lowest values were observed in T1 dietary group which also comparable with T3 dietary group.

4.2.6.2 RBC (millions/mm^3)

The estimated RBC (millions/mm^3) levels in growing Deccani lambs fed with experimental diets under semi- intensive farming systems are presented in Table 45 and Graph 33.

The mean estimated RBC (millions/mm^3) values at the start of experiment were 8.90±0.45, 9.60 ±0.56 and 9.68±0.32 and it was 9.28±0.46, 11.4±0.29 and 10.5±0.44 at the end of the experiment in lambs fed with T1, T2 and T3 diets, respectively in semi-intensive farming system. Statistical analysis of the data showed a significant difference (P<0.01) in RBC values among three dietary groups at the end of the experiment.

RBC values were significantly higher in T2 dietary group which was comparable with T3 dietary group and lowest RBC values were noticed in T1 dietary group which also comparable with T3 group at the end of the experiment.

4.2.6.3 PCV (%)

The mean estimated levels of PCV (%) of experimental lambs before start of experiment were 21.00±0.73, 22.16±0.16 and 23.16±0.40 whereas, at the end of experiment were 21.83±0.79, 24.16±0.16 and 23.16±0.30 for T1, T2, T3 dietary groups, respectively and the values were statistically not significant. The observed PCV values were relatively higher in T2 and T3 groups when compared to T1 group.

4.2.6.4 Haemoglobin (g/dl)

The lambs in groups T1, T2, T3 had a mean estimated Hb (gm/dl) of 9.16±0.30, 8.80 ±0.30 and 8.50±0.42 before starting of the experiment and the estimated Hb (g/dl) levels at the end of the experiment were 10.80±0.30, 11.25±0.30 and 9.66±0.44, in semi-intensive system. Statistical analysis of the data revealed a significant (P<0.05) difference among the three dietary groups after the experiment. The haemoglobin values were higher in T2 group than T3 and T1 groups at the end of experiment.

4.2.6.5 Erythrocyte and Leucocyte Indices

The erythrocyte and leucocyte indices (%) in growing Deccani lambs reared in semi- intensive farming systems are presented in Table 46 and illustrated in Graph 34.

Table 40. Effect of feeding Moringa based diets on body condition score of Deccani lambs under semi- intensive farming system

Experimental Diet	Initial BCS	Fortnightly body condition Scores						Overall mean
		1	2	3*	4**	5**	6 **	
T1	1.48± 0.13	1.75±0.11	1.75±0.11	1.75±0.11^{ab}	1.78±0.10^{b}	1.85±0.11^{b}	1.98±0.10^{a}	1.77±0.03
T2	1.33±0.25	1.66±0.10	1.75±0.11	2.00±0.00^{a}	2.33±0.10^{a}	2.41±0.08^{a}	2.50±0.00^{c}	2.00±0.16
T3	1.58± 0.08	1.58±0.08	1.85±0.08	19.50±0.10^{b}	2.00±0.08^{a}	2.10±0.08^{a}	2.16±0.10^{b}	1.80±0.11
N	6	6	6	6	6	6	6	6
SEM	0.063	0.057	0.059	0.059	0.085	0.083	0.069	0.679
P-value	0.28	0.52	0.43	0.04	0.001	0.001	0.002	0.362

^{ab} Means with different superscript in a column different significantly : * P<0.05, * P<0.01

P- value: Probability value; N: Number of animals; SEM: Standard Error Mean

T1: 0% MLM; T2: 25%MLM; T2: 50%MLM

Table 41. Correlation co-efficient of body weights with body measurements of growing Deccani lambs under semi-intensive farming System

	Body weight	Body length	Face length	Chest girth	Body height	Hip width	Tail length
Body weight	1	0.270	0.363	0.517(*)	0.525(*)	0.165	0.497(*)
Body Length	0.270	1	0.409	0.298	0.442	0.563(*)	0.086
Face Length	0.363	0.409	1	0.162	0.176	0.258	0.089
Chest Girth	0.517(*)	0.298	0.162	1	0.462	0.137	0.049
Height	0.525(*)	0.442	0.176	0.462	1	0.604(**)	0.635(**)
Hip width	0.165	0.563(*)	0.258	0.137	0.604(**)	1	0.303
Tail Length	0.497(*)	0.086	0.089	-0.049	0.635(**)	0.303	1

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Graph 29. Effect of feeding Moringa based diets on body condition score of Deccani lambs under semi- intensive farming system

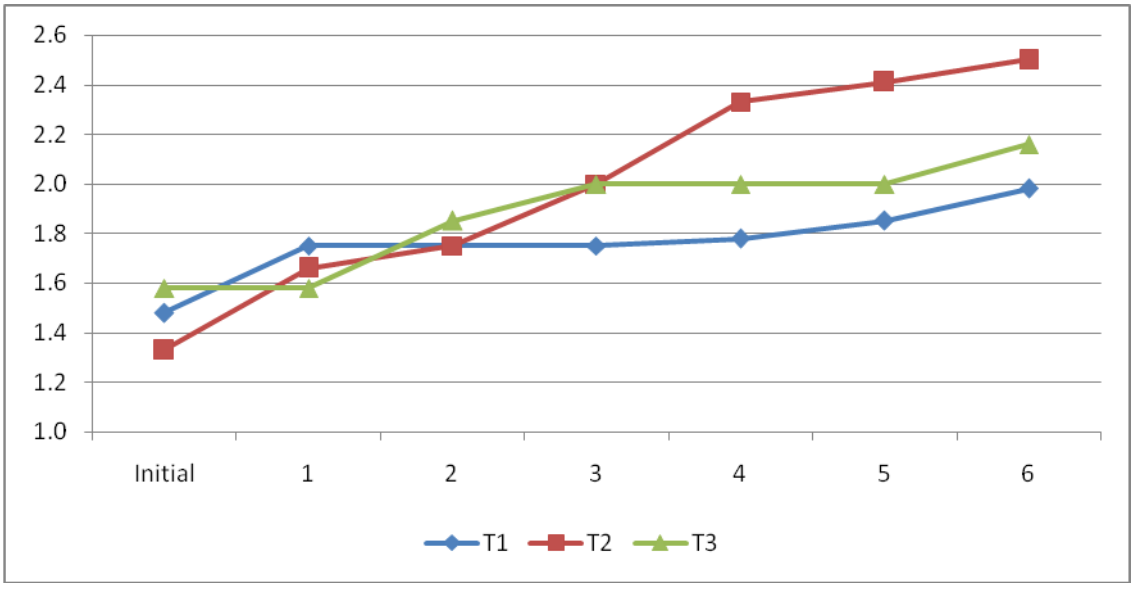


Table 42. Effect of feeding Moringa based diets on Pulse Rate (beats/ min) of Deccani lambs under semi-intensive farming system

Experimental Diet	Initial Pulse rate	Fornightly pulse rate						Overall mean**
		1**	2**	3*	4**	5**	6 **	
T1	63.83±0.94	63.83±0.47^{b}	65.16±0.70^{b}	66.33±0.55^{b}	65.83±0.79^{b}	66.16±1.40^{b}	68.66±0.3^{b}	65.68±0.6^{b}
T2	66.66±0.74	67.50±0.83^{a}	68.33±0.32^{a}	68.5±0.50^{a}	69.16±0.50^{a}	70.66±0.58^{a}	72.83±0.5^{a}	69.09±0.7^{a}
T3	65.16±1.26	66.83±0.64^{a}	67.16±0.64^{ab}	67.83±0.43^{ab}	68.16±0.45^{a}	69.83±0.45^{a}	71.16±0.5^{b}	67.87±0.6^{a}
N	6	6	6	6	6	6	6	6
SEM	0.639	0.520	0.456	0.345	0.476	0.685	0.479	0.493
P-value	0.20	0.002	0.001	0.020	0.001	0.002	0.001	0.001

^{ab} Means with different superscript in a column different significantly : * P<0.05,**P<0.01
P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25%MLM; T2: 50%MLM

Table.43. Effect of feeding Moringa based diets on respiratory rate (Breaths/min) of Deccani lambs under semi- intensive farming system

Experimental Diet	Initial Respiratory rate	Fornightly Respiratory Rate						Overall mean
		1**	2*	3**	4*	5	6 **	
T1	26.16±0.87	25.50±0.61^{b}	27.16±0.54^{b}	28.50±0.22^{b}	29.16±0.40^{b}	29.16±1.13	32.66±0.3^{b}	28.04±0.69
T2	27.66±0.71	29.16±0.94^{a}	29.66±0.71^{a}	30.50±0.42^{a}	30.83±0.42^{a}	31.83±0.61	34.16±0.5^{a}	30.54±0.78
T3	27.33±0.55	28.33±0.55^{a}	28.83±0.47^{ab}	29.50±0.34^{ab}	29.83±0.40^{ab}	31.16±0.47	33.16±0.5^{b}	29.59±0.62
N	6	6	6	6	6	6	6	6
SEM	0.423	0.548	0.389	0.271	0.273	0.503	0.427	0.449
P-value	0.336	0.007	0.019	0.003	0.032	0.071	0.001	0.06

^{ab} Means with different superscript in a column different significantly : * P<0.05,**P<0.01

P- value: Probability value; N: Number of animals; SEM: Standard Error Mean

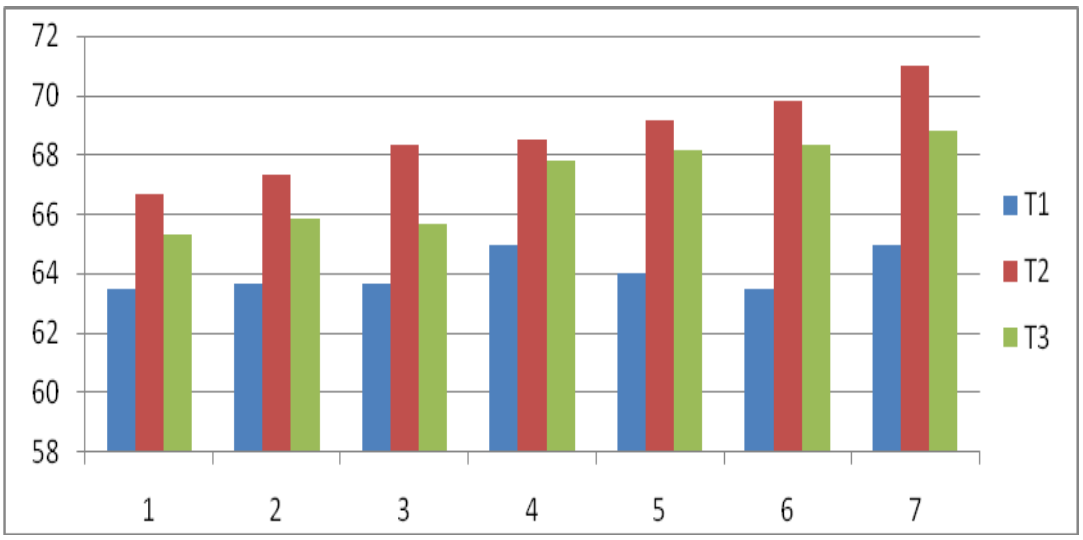
T1: 0% MLM; T2: 25%MLM; T2: 50%MLM

Table 44. Effect of feeding Moringa based diets on rectal temperature (^{0}F) of growing Deccani lambs under semi intensive farming system

Experimental Diet	Initial Rectal Temperature (^{0}F)	Fornightly Rectal Temperature (^{0}F)						Overall mean
		1	2	3	4	5	6	
T1	101.56±0.21	101.8±0.28	102.1±0.05	102.1±0.08	102.3±0.33	102.5±0.19	102.5±0.22	102.1±0.13
T2	102.1±0.05	102.1±0.07	102.03±0.21	102.2±0.09	102.1±0.10	102.3±0.21	102.3±0.24	102.0±0.09
T3	101.8±0.17	102.05±0.02	102.2±0.19	102.04±0.14	102.2±0.17	102.6±0.21	102.6±0.42	102.1±0.12
N	6	6	6	6	6	6	6	6
SEM	0.102	0.097	0.093	0.065	0.122	0.117	0.198	0.064
P-value	0.09	0.628	0.653	0.312	0.915	0.602	0.081	0.731

P- value: Probability value; N:Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50%

Graph 30. Effect of feeding Moringa based diets on Pulse Rate (beats/ min) of Deccani lambs under semi-intensive farming system



Graph 31. Effect of feeding Moringa based diets on Respiratory rate (Breaths/min) of Deccani lambs under semi-intensive farming system

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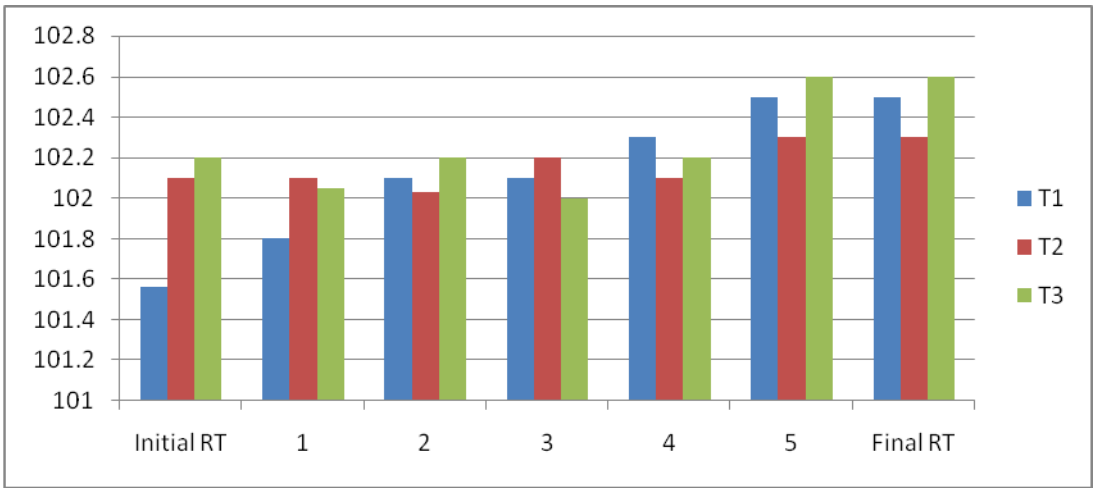
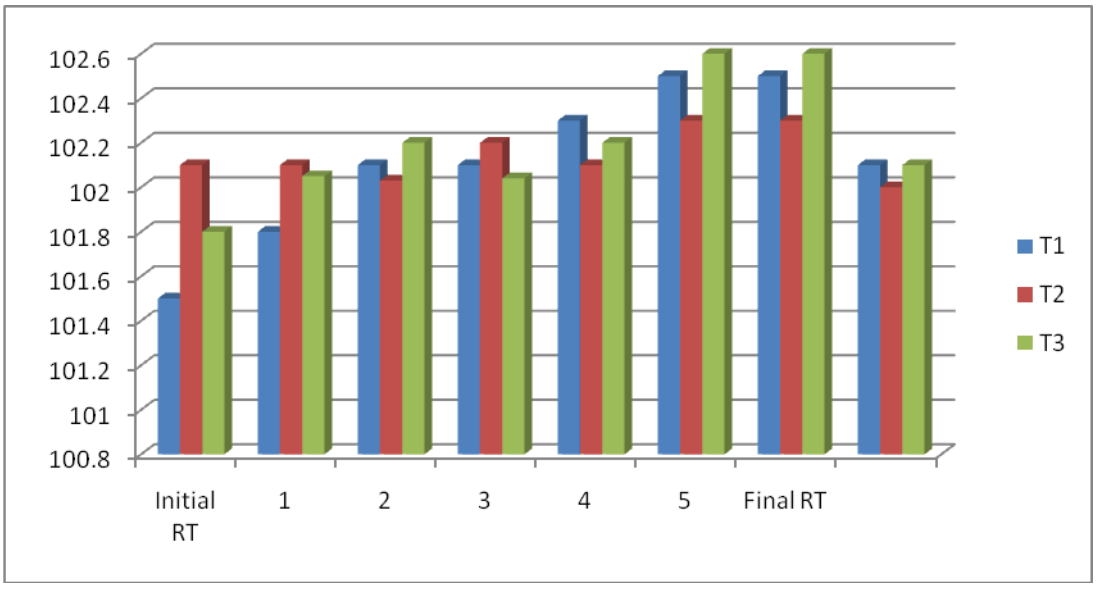


Graph 32. Effect of feeding Moringa based diets on rectal temperature (^{0}F) of growing Deccani lambs under semi intensive farming system



The mean values of MCV (cμ), MCH (pg) and MCHC (%) in lambs before start of the experiment were 27.08±0.36, 28.2±0.39 and 28.35±0.46; 11.1±0.29, 10.65±0.35 and 10.41±0.27 and 35.47±0.55, 34.83±0.30 and 34.16±0.54 for T1, T2 and T3 groups respectively.

The mean values of MCV (cμ), MCH (pg) and MCHC (%) in lambs at the end of experiments were 26.96± 0.49, 28.91±0.35 and 28.61 ± 0.50; 11.0± 0.30, 11.02 ± 0.23 and 10.5 ±0.51 and 35.5±0.56, 34.8±0.50, 34.16 ± 0.79 in T1, T2 and T3 groups, respectively. The observed MCV (cμ) values were statistically significant ($P<0.05$) in MCV (cμ) among three treatment groups. Higher MCV (cμ) values were observed in T2 group than T1 group and there was no significant between T2 and T3 groups. No significant differences were noticed in MCH (pg) and MCHC (%) at the end of the experiment among the experimental diets in the semi-intensive system (Table 46).

The mean lymphocytes (%) values before start of the experiment were 61.87 ±0.59, 59.16±1.22 and 61.66± 1.36 and at the end of the experiment were 60.66±0.42, 63.00±0.68 and 61.83±0.60 in T1, T2 and T3 groups, respectively. The lymphocyte values were significant ($P<0.05$) among the three treatment groups at the end of the experiment. Highest values were noticed in T2 dietary group which was comparable

with T3 group. The lowest values observed in T1 dietary group which also comparable with T3 group. The mean neutrophils, monocytes, eosinophils and basophils percent before start of the experiment were 33.62 ±0.39, 33.16 ±0.33 and 32.33 ±0.49; 0.19 ±0.12, 0.07 ±0.00 and 0.06 ± 0.00; 2.84 ± 0.30, 2.66 ±0.33 and 3.16 ±0.75; 0.71 ±0.04, 0.63 ±0.02 and 0.68 ±0.01, respectively for T1, T2 and T3 groups and at the end of experiment were 33.57 ± 0.34, 34.0 ±0.44 and 32.83 ±0.44; 0.075 ±0.002, 0.078 ±0.001 and 0.076 ±0.002; 2.85 ±0.17, 3.09 ±0.26 and 3.15± 0.07 and 0.75 ±0.02, 0.7 ±0.03 and 0.74 ±0.01, respectively for T1, T2 and T3 groups.

The values of neutrophils, monocytes, eosinophils and basophils were statistically non-significant among the three treatment groups after end of the experiment.

4.2.7 Blood Biochemical Parameters

The blood biochemical constituents like blood glucose (mg/dl), Total protein (g/dl), SGOT (IU/ dl) and SGPT (IU/dl) levels of Deccani lambs fed with experimental diets insemi intensive farming systems are presented in Table 47 and Graph 35.

4.2.7.1 Total Protein (g/dl)

The mean total protein concentration (g/dl) before start of the experiment was 6.75 ±0.20, 6.53 ±0.30 and 5.70 ±0.44 and at the end of experiment was 6.05 ±0.19, 7.09 ±0.32 and 6.98 ±0.19 for T1, T2 and T3 test diets, respectively. Statistical analysis revealed a significant difference ($P<0.05$) in total protein concentration in lambs fed with MLM at different levels at the end of the experiment. The observed total protein concentration was significantly ($P<0.05$) higher in T2 group than control group (T1) and no difference was observed between T2 and T3 groups.

4.2.7.2 Serum Albumin (g/dl)

The mean serum albumin concentration (g/dl) before start of the experiment was 2.85 ±0.11, 2.99 ±0.10 and 2.83 ±0.15 and at the end of experiment was 3.03 ±0.15, 3.11 ±0.10 and 2.88 ±0.15 for T1, T2 and T3 experimental groups, respectively. Statistical analysis of the data revealed a non-significant difference in serum albumin among different experimental diets. The reported serum albumin values were numerically higher in T2 group followed by T1 and T2 groups. The total albumin values in intensive farming system among experimental groups were within the normal range of 2.4 to 3.0 (g/dl) (Dhanotiya, 2004).

4.2.7.3 Serum Glucose (mg/dl)

The mean serum glucose concentration (mg/dl) before start of the experiment was 69.62 ±3.92, 70.83 ±6.90 and 64.81 ±5.63 while at the end of experiment was 70.53±3.55, 56.08 ±5.42 and 61.83 ±5.41 for T1, T2 and T3 experimental diets, respectively. No significant difference was observed among the three treatment groups in semi-intensive farming system. The concentration of serum glucose was non-significantly lower in T2 and T3 group lambs when compared with T1 group lambs. The blood glucose levels in the experimental groups were within the normal range of 50-89 (mg/dl) as reported by Dhanotiya (2004).

4.2.7.4 Serum Glutamic Oxaloacetic Transaminase (SGOT)

The mean SGOT (IU/dl) values before start of the experiment were 51.16 ±2.21, 52.16 ±3.54 and 52.83 ±5.29 and at the end of experiment were 51.30±1.07, 54.38 ±3.54 and 53.50 ±0.85 for T1, T2 and T3 experimental diets, respectively. No significant difference was observed in SGOT when the growing lambs fed with experimental diets in semi-intensive farming system. The SGOT values in among experimental groups were within the normal range of 32 to 84 (IU/ dl) (Dhanotiya, 2004).

4.2.7.5 Serum Glutamic Pyruvic Transaminase (SGPT)

The mean SGPT (IU/dl) values before start of the experiment were 6.83 ±0.09, 7.16 ±0.11 and 6.98 ±0.19 and at the end of experiment were 7.06 ±0.24, 7.43 ±0.09 and 7.65 ±0.43 for T1, T2 and T3 experimental diets, respectively. Statistical analysis revealed a non-significant difference in SGPT values among three different experimental diets. The SGPT values were within the normal range of 2.0 to 7.5 (IU/ dl) Ramesh Kumar *et al.* (2003).

4.2.8. NUTRIENT DIGESTIBILITY

The digestibility of various nutrients in growing Deccani lambs fed with experimental diets under semi-intensive farming system are presented in Table 48 and Graph 36.

4.2.8.1 Dry matter Digestibility

The mean dry matter (DM) digestibility coefficients recorded for diets T1, T2 and T3 were 60.84±0.73, 62.61±1.05, and 61.23±1.32 per cent, respectively. The dry matter digestibility coefficient (%) was non-significantly higher in T2 and T3 than T1

group. Among the Moringa leaf meal supplemented lambs, T2 lambs showed relatively higher (62.61±1.05) dry matter digestibility coefficient than T3 (61.23±1.32).

4.2.8 .2 Organic Matter Digestibility

The average organic matter digestibility coefficients (%) recorded for T1, T2 and T3 were, 67.37 ±0.80, 68.30 ±0.89and 67.85 ±1.30, respectively in semi-intensive system. Feeding of *Moringa oleifera* based diets had no significant effect on the organic matter digestibility in the semi-intensively reared lambs. Organic matter digestibility coefficients (%) were numerically higher in T2 and T3 groups than T1 group (Table 48).

4.2.8 .3 Crude Protein (CP) Digestibility

The average crude protein digestibility coefficients (%) recorded for T1, T2 and T3 diets were, 68.75 ±2.08, 71.86 ±2.55 and 69.55 ±2.08, respectively. The CP digestibility was numerically higher in T2 and T3 groups when compared to control group, however, no significant difference was found among treatment groups

4.2.8 .4 Crude Fibre (CF) Digestibility

The average crude fibre (CF) digestibility coefficients recorded for T1, T2 and T3 were, 62.26 ±0.39, 63.51 ±1.24 and 61.95 ±0.84, respectively in semi-intensive system. The observed crude fibre digestibility was numerically higher in T2 and T3 groups than control group, however, no significant difference was found in between treatment groups (Table 48).

4.2.8 .5 Ether Extract (EE) Digestibility

The ether Extract (EE) digestibility coefficients (%) of experimental animals fed with T1, T2 and T3 diets were, 82.08 ±4.10, 86.11 ±1.59 and 83.34 ±2.98, respectively in semi-intensive system. There was no significant difference in the ether extract digestibility among the three experimental diets. But the lambs fed with diets containing MLM in concentrate mixture shown higher ether extract digestibility coefficient.

4.2.8 .6 Nitrogen free Extract (NFE) Digestibility

The average Nitrogen Free Extract (NFE**)** digestibility coefficients (%) in semi-intensive system were 71.58 ±1.34, 74.36 ±1.30 and 71.99 ±1.41 in T1, T2 and T3 groups, respectively. The NFE digestibility coefficients (%) recorded in T2 was non-significantly higher and lowest in T1 group (Table 48).

4.2.8 .7 Neutral Detergent Fibre (NDF) Digestibility

The average Neutral Detergent Fibre (NDF) digestibility coefficients (%) of growing Deccani lambs fed with experimental diets in semi-intensive farming systems were, 69.05 ±0.51, 71.34 ±1.30 and 70.38 ±0.35 in T1, T2 and T3 groups, respectively. Statistical analysis of the data revealed a significant ($P<0.05$) difference among the treatment groups. Higher NDF digestibility was observed in T2 group lambs which was comparable with T3 group and lower NDF digestibility was noticed in T1 group lambs which also comparable with T3 group (Table 48).

4.2.8 .8 Acid Detergent Fibre (ADF) Digestibility

The average Acid Detergent Fibre (ADF) digestibility coefficients (%) of growing Deccani lambs fed with experimental diets in semi-intensive farming systems were, 64.77 ±1.21, 68.39 ±1.18 and 66.47 ±1.06 in T1, T2 and T3 groups, respectively. Statistical analysis of the data revealed a significant ($P<0.05$) difference among the treatment groups. Higher ADF digestibility was observed in T2 group lambs which was comparable with T3 group and lower ADF digestibility was noticed in T1 group lambs which also comparable with T3 group (Table 48).

4.2.9 FAECAL CONSISTENCY SCORE

Faecal consistency of the lambs was recorded for five days by collecting the faecal samples immediately 48 hours after starting the animals to feed on the experimental diets. Faecal consistency score values of lambs are presented in Table 49 and Graph 37.

The mean faecal consistency score values for lambs fed on T1, T2 and T3 diets were 1.51 ±0.10 2.62 ±0.25 and 2.24 ±0.13, respectively. There was a significant difference ($P<0.01$) in faecal consistency score among three treatment groups. T2 group lambs had higher FCS than T1 group lambs in semi-intensive farming system.

4.2.10 CARCASS CHARACTERISTICS

At the end of the experimental period three representative lambs from each group were randomly selected and slaughtered to study the effect of feeding experimental diets with different levels of Moringa leaf meal on carcass characteristics.

4.2.10.1 Live Weight, Carcass Weight and Dressing Percentage

The details of pre slaughter weight, empty body weight, hot carcass weight is presented in Table 50 and Graph 38.

Table 45. Effect of feeding Moringa based diets on blood parameters of Deccani lambs under Semi-intensive farming system

Experimental Diet	WBC $10^3/mm^3$		RBC millions/mm^3		PCV %		Hb g/dl	
	Before	After**	Before	After**	Before	After	Before	After*
T1	9.66±0.45	9.83±0.45^{b}	8.90±0.45	9.28±0.46^{b}	21.00±0.73	21.83±0.79	9.16±0.30	9.66±0.44^{b}
T2	10.66±0.42	12.83±0.33^{a}	9.61±0.56	11.4±0.29^{a}	22.16±0.16	24.16±0.16	8.80±0.30	11.25±0.30^{a}
T3	10.5±0.76	11.33±0.77^{ab}	9.68±0.32	10.5±0.44^{ab}	23.16±0.40	23.16±0.30	8.50±0.42	10. 08±0.32^{b}
N	6	6	6	6	6	6	6	6
SEM	0.370	0.305	0.263	0.305	0.497	0.481	0.205	0.255
P-value	0.52	0.006	0.43	0.006	0.21	0.11	0.20	0.02

^{ab} Means with different superscript in a column different significantly : * P<0.05;**P<0.01

P- value: Probability value; N: Number of animals; SEM: Standard Error Mean

WBC: White blood cell; RBC: Red blood cell; PCV: Packed cell volume; Hb: Haemoglobin

T1: 0% MLM; T2: 25%MLM; T2: 50% MLM

Table 46. Effect of feeding Moringa based diets on Erythrocytes and Leucocytes Indices of Deccani lambs under semi-intensive farming system

Experimental Diet	Erythrocytes						Leucocytes Indices (%)									
	MCV(cμ)		MCH (pg)		MCHC (%)		Lymphocytes		Neutrophil		Monocytes		Eosinophil		Basophil	
	Before	After	Before	After	Before	After	Before	After*	Before	After	Before	After	Before	After	Before	After
T1± S.E.	27.08± 0.36	26.96± 0.49 [b]	11.10± 0.29	10.50± 0.51	35.47± 0.55	34.16± 0.79	61.87± 0.59	60.66± 0.42 [b]	33.62± 0.39	33.50± 0.34	0.19± 0.12	0.075± 0.002	2.84± 0.30	3.15± 0.26	0.71± 0.04	0.70± 0.02
T2± S.E.	28.20± 0.39	28.91± 0.35[a]	10.65± 0.35	11.20± 0.23	34.83± 0.30	35.5± 0.30	59.16± 0.57	63.00± 0.68 [a]	33.16± 0.33	34.0± 0.44	0.07± 0.002	0.078± 0.001	2.66± 0.33	2.85± 0.17	0.60± 0.02	0.75± 0.03
T3± S.E.	28.35± 0.46	28.61± 0.50 [a]	10.41± 0.27	11.00± 0.30	34.16± 0.54	34.8± 0.56	61.66± 0.55	61.80± 0.70 [ab]	32.33± 0.49	32.63± 0.47	0.06± 0.004	0.076± 0.002	3.16± 0.30	3.15± 0.7	0.68± 0.01	0.74± 0.01
N	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
SEM	0.262	0.323	0.159	0.430	0.291	0.032	0.623	0.380	0.280	0.258	0.040	0.001	0.178	0.106	0.017	0.139
P-value	0.09	0.01	0.21	0.46	0.18	0.46	0.71	0.03	0.16	0.18	0.39	0.52	0.54	0.52	0.19	0.88

[ab] Means with different superscript in a column different significantly : *P<0.05 P- value: Probability value

N:Number of animals SEM: Standard Error Mean T1: 0% MLM T2: 25% ML T3: 50% MLM

Table 47. Effect of feeding Moringa based diets on blood biochemical parameter of Deccani lambs under semi-intensive farming system

Experimental Diet	Total Protein(gm/dl)		Serum Albumin (gm/dl)		Serum Glucose (mg/dl)		SGOT (iu/dl)		SGPT (iu/dl)	
	Before	After*	Before	After	Before	After	Before	After	Before	After
T1	6.75±0.20	6.97±0.2[b]	2.85±0.11	3.03±0.5	69.61±3.2	70.53±3.55	51.16±2.21	51.30±1.07	6.83±0.09	7.06±0.24
T2	6.53±0.30	7.09±0.3[a]	2.99±0.10	3.11±0.10	70.83±6.0	56.08±5.42	52.16±3.54	54.38±3.23	7.16±0.11	7.43±0.09
T3	5.70±0.44	6.98±0.1[a]	2.83±0.5	2.88±0.15	64.81±5.3	61.83±5.41	52.83±5.29	53.50±0.85	6.98±0.19	7.65±0.43
N	6	6	6	6	6	6	6	6	6	6
SEM	0.212	0.188	0.072	0.079	3.112	3.011	1.110	1.196	0.082	0.170
P-value	0.09	0.03	0.62	0.51	0.73	0.14	0.84	0.58	0.27	0.39

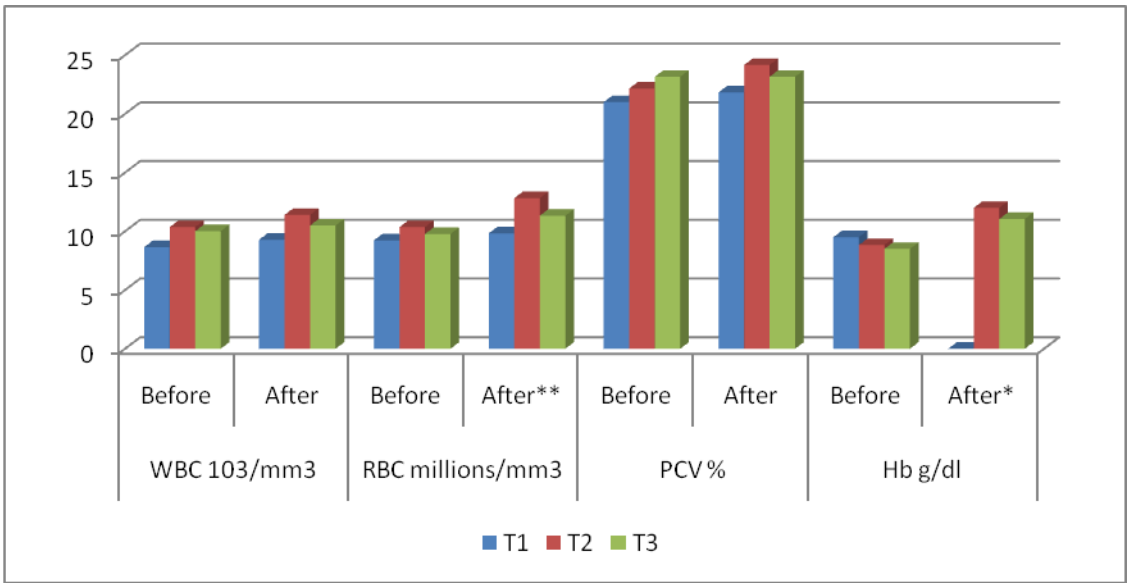
[ab] Means with different superscript in a column different significantly: * P<0.05

P- value: Probability value ; N: Number of animals; SEM: Standard Error Mean

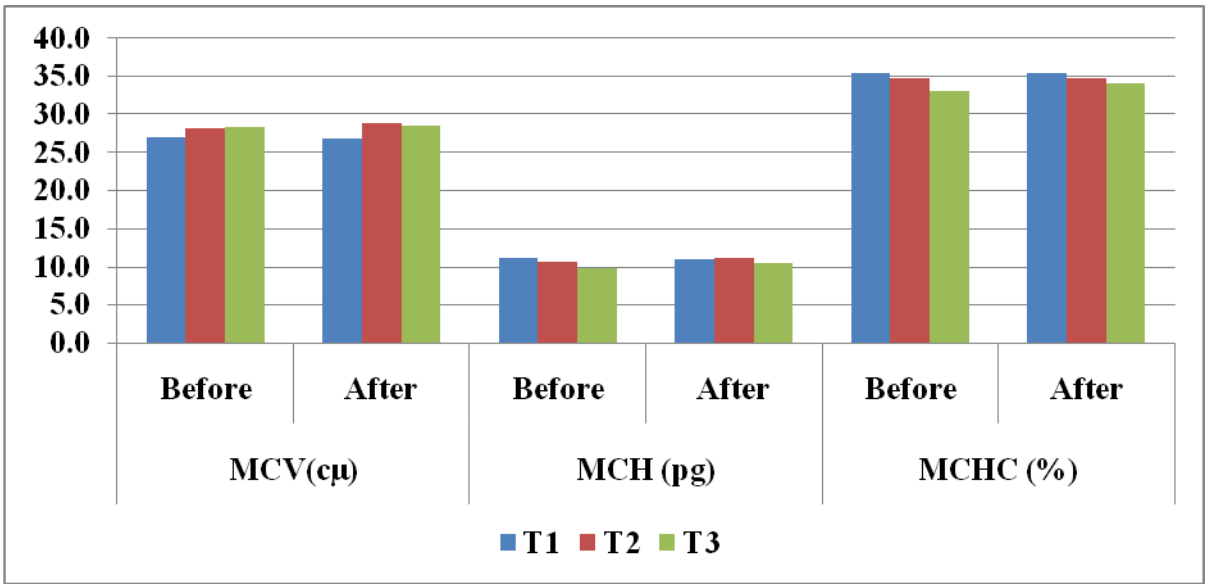
T1: 0% MLMT2: 25% MLMT2: 50% MLM

SGOT: Serum Glutamic Oxaloacetic Transaminase SGPT: Serum Glutamic Pyruvic Transaminase

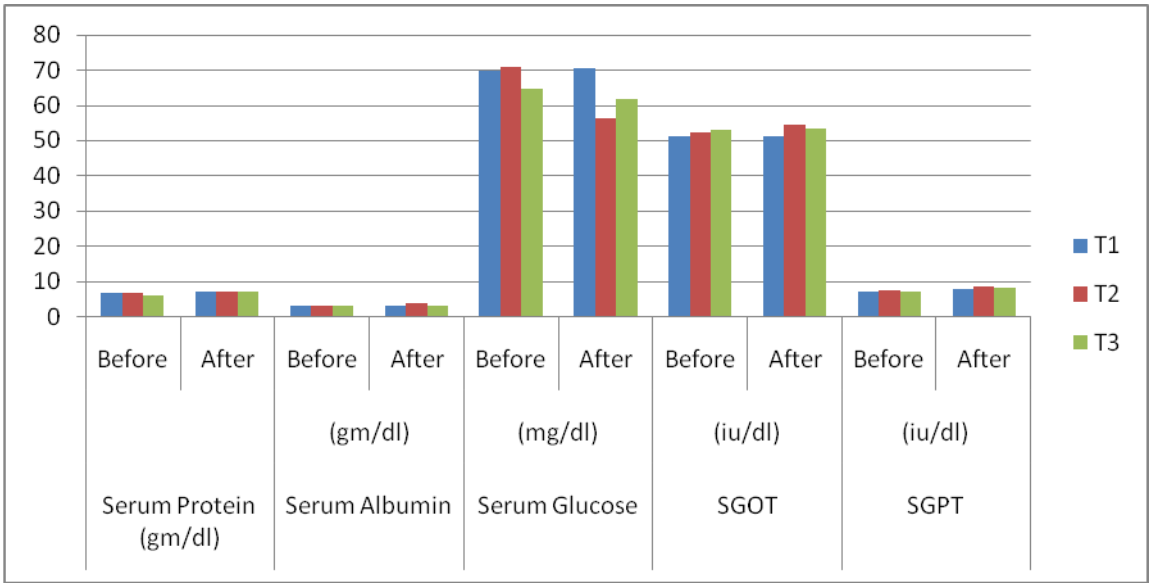
Graph 33. Effect of feeding Moringa based diets on blood parameters of Deccani lambs under Semi-intensive farming system



Graph 34. Effect of feeding Moringa based diets on Erythrocytes and Leucocytes Indices of Deccani lambs under semi-intensive farming system



Graph 35. Effect of feeding Moringa based diets on blood biochemical parameter of Deccani lambs under semi-intensive farming system



The mean live body weight (kg) of lambs fed with T1, T2 and T3 diets before slaughter was 26.73 ±3.88, 27.7 ±1.85 and 27.26 ±1.18, respectively. The mean empty body weight (kg) and hot carcass weight (kg) of lambs fed on T1, T2 and T3 diets were 21.6 ±3.60, 21.7 ±1.59 and 21.5 ±1.25 and 13.3 ±1.83, 13.13 ±1.33 and 13.4±0.52, respectively in semi-intensive system of farming.

The mean dressing percentage on pre slaughter weight and empty body weight was 48.87±0.34, 50.50± 0.81 and 49.26 ± 0.41 and 60.0 ±1.40, 67.5 ±1.39, 62.46 ±8.09, respectively for T1, T2 and T3 groups.

Pre-slaughter weight and empty liveweight were non-significantly (P>0.05) higher in lambs fed with Moringa group (T1) than T3 and T1 groups while hot carcass weight was numerically higher in T3 groups when compared with T2 and T1 groups. There was a non-significant difference in dressing percentage on pre slaughter weight and empty live weight basis in all three treatment groups. However, the T2 group had numerically higher dressing percentage (67.5 ±1.39) on empty live weight compared to T1 (60.0±1.40) and T3 (62.46 ±8.09) groups (Table 50).

4.2.10. 2 Weight of Organs on Pre-Slaughter Weight Basis

The weights of edible and non-edible offal in semi-intensive farming system presented in Table 50a.

Table 48. Effect of experimental diet on nutrient digestibility of Deccani growing lambs in semi-intensive farming system

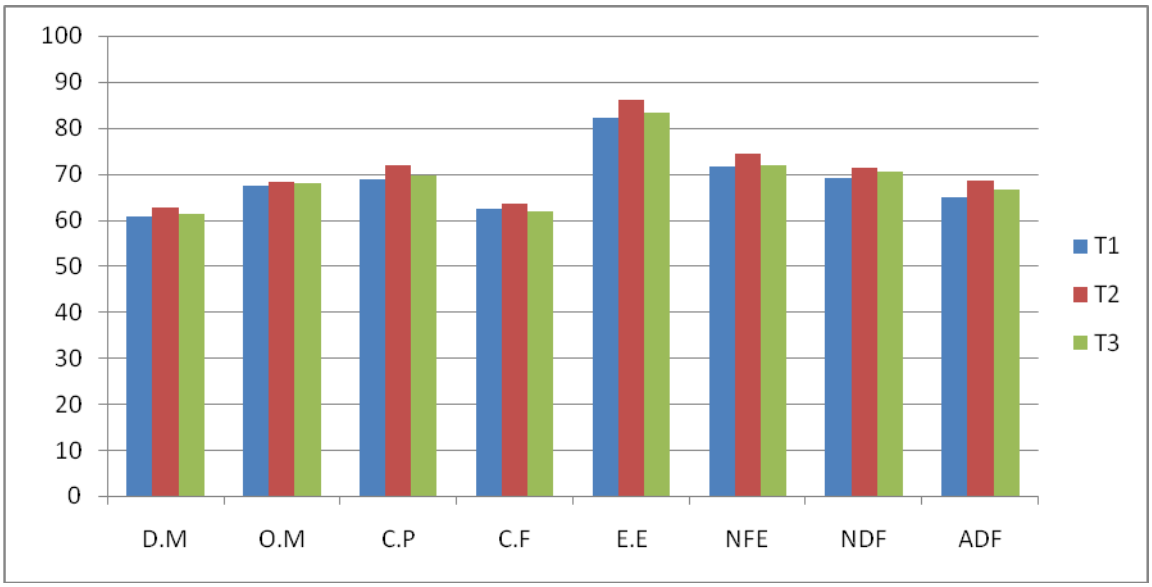
Experimental Diet	Dry matter	Organic matter	Crude fibre	Crude fat	Ether extract	Nitrogen free extract	Nuetral detergent fibre*	Acid detergent fibre*
T1	60.84± 0.73	67.37±0.80	68.75± 2.08	62.26 ±0.39	82.08±4.10	71.58±1.34	69.05±0.51^{b}	64.77±1.21^{b}
T2	62.61±1.05	68.30±0.89	71.86±2.55	63.51±1.24	86.11±1.59	74.36±1.30	71.34±0.66^{a}	68.39±1.18^{a}
T3	61.23±1.32	67.85±1.30	69.55±2.08	61.95±0.81	83.34 ±2.98	71.99±1.41	70.38±0.35^{ab}	66.47±1.06^{ab}
N	6	6	6	6	6	6	6	6
SEM	0.604	0.553	1.259	0.536	1.713	0.789	0.363	0.814
P	0.48	0.61	0.61	0.44	0.65	0.32	0.02	0.02

^{ab} Means with different superscript in a column different significantly : * P<0.05

P- value: Probability value; N: Number of animals; SEM: Standard Error Mean

T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Graph 36. Effect of experimental diets on nutrient digestibility of Deccani growing lambs in semi-intensive farming system



Graph 37. Faecal Consistency Score (FCS) of lambs Semi-Intensive farming System

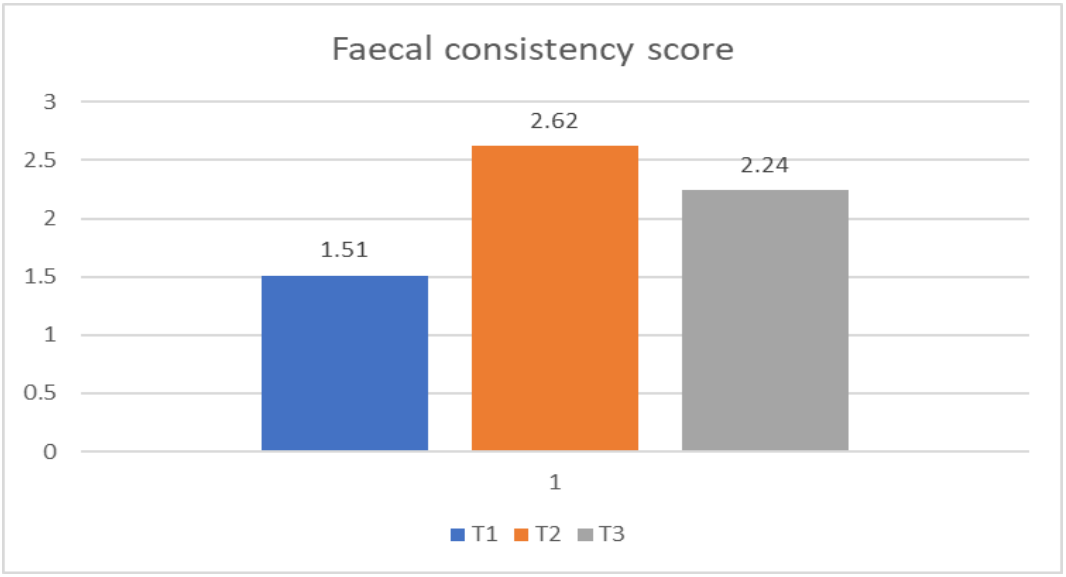


Table 49. Faecal Consistency Score (FCS) of lambs in semi-intensive System.

Experimental Diet	Day	Faecal Consistency Score (FCS)**
T1	1	1.60
	2	1.50
	3	1.17
	4	1.50
	5	1.80
Mean		1.51± 0.01[b]
T2	1	3.3
	2	2.5
	3	3.0
	4	2.5
	5	1.8
Mean		2.62± 0.25[a]
T3	1	2.1
	2	2.0
	3	2.5
	4	2.1
	5	2.50
Mean		2.24± 0.13[ab]
N		5
SEM		0.152
P-value		0.00

[ab] Means with different superscript in a column different significantly : ** P<0.01
P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM T2: 25% MLM T2: 50% MLM

Graph 38. Empty live weight dressing percentage

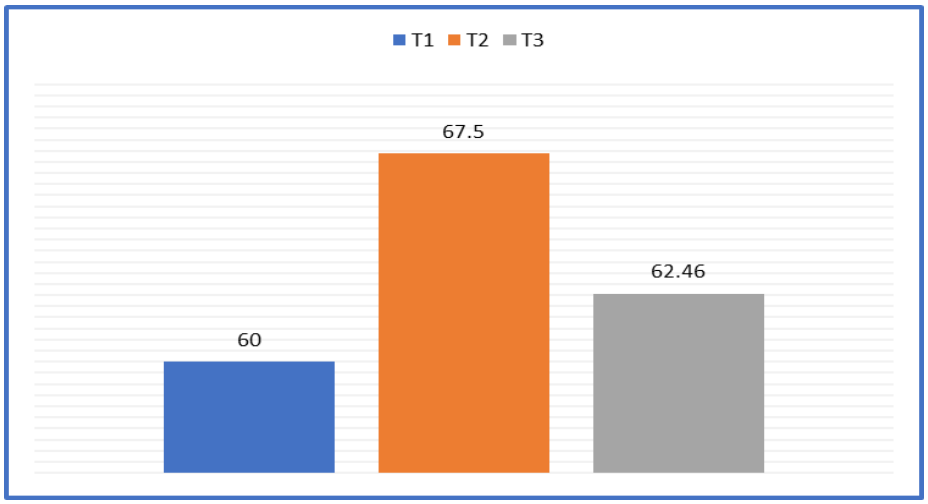


Table 50. Carcass characteristics of Deccani growing lambs fed with experimental diets under semi-intensive system

Experimental Diet	Pre-slaughter live weight (kg)	Empty live weight (kg)	Hot carcass weight (kg)	Dressing % (PSW)	Dressing % (ELW)
T1	26.7 ±3.88	21.6 ±3.60	13.3±1.83	48.87±0.34	60.00±1.40
T2	27.7±1.85	21.7 ±1.59	13.13±1.33	50.50 ±0.81	67.50 ±1.39
T3	27.26 ±1.18	21.5 ±1.25	13.4 ±0.52	49.26±0.41	62.46 ±8.09
N	3	3	3	3	3
SEM	1.296	1.242	0.676	0.337	6.235
P	0.96	0.79	0.96	0.34	0.18

P- value: Probability value
N: Number of animals
SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50 % MLM

Table 50a. Weight of organs on pre slaughter weight (kg) of Deccani growing lambs fed with experimental diets under semi-intensive system

Expt. Diets	Edible offal (kg)						Non-edible offal (kg)							
	Liver	Kidney	Heart	Testis	Spleen	Total weight	Head	leg	Skin	Blood	Lung	Stomach	Intestine	Total weight
T1	0.41 ±0.04	0.07 ±0.01	0.10 ±0.01	0.20 ±0.06	0.05 ±0.01	0.86 ±0.13	1.9 0 ±0.31	1.34 ±0.59	2.36 ±0.09	0.82 ± 0.19	0.32 ±0.04	0.91 ± 0.39	0.45 ± 1.93	12.21 ± 2.08
T2	0.3 5±0.07	0.06 ±0.01	0. 11 ±0.01	0.21 ±0.01	0.06 ±0.02	0.79 ±0.10	1.80 ±0.19	1.40 ±0.71	2.74 ±0.03	0.74 ±0.13	0.25 ±0.04	1.24 ± 0.25	5.15 ± 2.13	13.93 ± 2.73
T3	0.42 ±0.02	0.07 ±0.08	0.11 ±0.03	0.24 ±0.05	0.06 ±0.03	0.91 ±0.01	2.05 ±0.03	0.69 ±0.08	2.13 ±0.07	0.86 ± 0.06	0.29 ±0.02	0.86 ± 0.30	6.06 ± 0.73	12.95 ± 0.91
N	3	3	3	3	3	3	3	3	3	3	3	3	3	3
SEM	0.029	0.005	0.006	0.020	0.003	0.052	0.110	0.291	0.131	0.072	0.017	0.163	0.887	1.042
P	0.63	0.63	0.74	0.84	0.78	0.69	0.81	0.61	0.15	0.82	0.34	0.93	0.82	0.91

P- value: Probability value; N: Number of animals; SEM: Standard Error Mean
T1: 0% MLM; T2: 25% MLM; T2: 50% MLM

Table 51. Cost (Rs) of feed ingredients and cost of economics of the experimental diets in semi-intensive farming system

Ingredients	Cost /Kg (Rs)	T1		T2		T3	
		Parts (Kg)	Cost (Rs)	Parts (Kg)	Cost (Rs)	Parts (Kg)	Cost (Rs)
D.O.R.B	13.00	29.00	377.00	26.70	347.10	24.5	318.50
Moringa Leaves (DMOL)	45.00	-	-	7.30	328.50	14.5	652.50
G.N.C	32.50	20.00	650.00	15.00	487.50	10.00	325.00
C.S.C	24.80	13.00	322.40	13.00	322.4	13.00	322.4
Chunni	17.80	35.00	623.00	35.00	623.00	35.00	623.00
Salt	6	1.00	6.00	1.00	6.00	1.00	6.00
Min.Mix	110	2.00	220.00	2.00	220.00	2.00	220.00
Total	-	100.00	2198.40	100.00	2334.5	100.00	2467.40
Processing Cost (Rs)	1	-	100	-	100	-	100
Total Cost (Rs)	-	-	2298.40	-	2434.5	-	2567.40
Cost of feed / Kg	-	-	22.98	-	24.34	-	25.67
Total Feed Intake (Kg)	-	-	21.9	-	22.49	-	21.75
Total feed Cost (Rs)	-	-	503.23	-	547.40	-	558.32
Cost of APBN1/paragrass @1.00/Kg	-	295.00	295.00	244.00	244.00	246.00	246.00
Total Cost	-	-	798.23	-	791.40	-	804.32
Body weight gain (kg)	-	-	7.22	-	8.33	-	7.66
Total Cost/Kg Gain	-	-	110.55	-	95.00	-	105.00

T1: 0% MLM. T2: 25% MLM. T2: 50% MLM

The weights of liver, kidney, heart, testis and spleen were 0.411 ±0.04, 0.351 ±0.07 and 0.422 ±0.02 kg; 0.079 ±0.01, 0.065 ±0.01, 0.072 ±0.008 kg; 0.109 ±.01, 0.1 ±0.01, 0.113 ±0.003 kg; 0.207 ±0.06, 0.216 ±0.01 and 0.24 ±0.05 kg and 0.059 ±0.01, 0.061 ±0.02 and 0.067 ±0.03 kg, respectively in T1, T2 and T3 groups.

The total weights of edible offals for T1, T2 and T3 groups were 0.865 ±0.13, 0.794 ±0.10 and 0.914 ±0.019 kg, respectively. Statistical analysis of the data revealed non significant difference for total edible offals among three treatment groups.

The total weight of non- edible offals for T1, T2 and T3 groups were 12.21 ±2.08, 13.93 ±2.73 and 12.95 ±0.91 kg, respectively. No significant difference was observed on among three treatment groups for non- edible offals.

4.2.11 COST OF PRODUCTION

The cost of feed per kg body weight gain in growing Deccani lambs fed with experimental diets in semi-intensive system was Rs 110.55, 95.00 and 105.00, respectively for T1, T2 and T3 diets. The total cost and cost of production per one kg of meat was lower in T2 and T3 group lambs which received concentrate mixture containing *Moringa oleifera* than control group lambs. (Table 51).

CHAPTER V

DISCUSSION

EXPERIMENT- I (INTENSIVE FARMING SYSTEM)

The results of the study presented in the fourth chapter are discussed in this chapter in order to have comprehensive information on the effect of feeding Moringa (*Moringa oleifera*) leaf meal-based diets on productive performance of growing Deccani sheep in intensive farming system**.**

5.1 CHEMICAL COMPOSITION OF EXPERIMENTAL DIETS

Proximate composition of feed ingredients and Moringa leaves used in the present study are shown in Table 7. The data indicated that the crude protein content of *Moringa oleifera* was 24.39%, this makes the Moringa leaves to be a good potential source of supplementary protein in animal diets. This level of crude protein content is of particular nutritional significance as it may meet animal's protein and energy requirements and boost the immune system against diseases. Moringa is reported to have high quality protein which is easily digested and that is influenced by the quality of its amino acids (Babeker and Bdalbagi, 2015).

The crude protein content of the Moringa leaves used in the present study was comparable with values (25.95% and 22.6% in DM) reported by Manh *et al.* (2005) and Sánchez *et al*. (2006a) respectively, but higher than the values (29.7% and 26.74%) were obtained by Fadiyimu *et al.* (2010) and Divya *et al.* (2014). The ADF content of moringa leaves in the present study was comparable with Tona *et al.* (2014) while it is disagreement with the values reported by Asaolu *et al.* (2010) and Sultana *et al.* (2015). The variations in nutritive value of moringa leaves could be due to the age of harvest, soil type and fertility, proportion of leaf and stem and agro-ecological zone where trees are growing.

5.1.1 GROWTH PERFORMANCE

5.1.1.1 Fortnightly Body Weights

The overall mean body weight (kg) was relatively higher in Deccani lambs fed with diets having either at 25% or 50% Moringa leaf meal as protein source in the concentrate mixture. The amino acid supply from this protein concentrate may be of particular nutritional significance as it may meet sheep's protein needs and boost immune system against diseases (Brisibe *et al*., 2009). The numerically higher values in the group supplemented with moringa leaf meal show that it could contribute towards

better livestock performance in terms of bodyweight changes and high yield of good-quality products as it contains an appreciable level of essential nutrients. Nutrition is far the most important environment influence on animal growth and development before and after birth (Widdoson and Lister, 1991).

The results of the present study are in concurrence with the findings of Damor *et al.* (2017), Yosuf *et al.* (2018) and Syed Ali (2017) who reported non-significant body changes in goats. In contrast to the present findings, Asaulo *et al.* (2012) Tono *et al.* (2014) and Sultana *et al.* (2015) had recorded significant gain in body weight of goats fed on diets with different level of inclusion of *Moringa oleifera* leaves.

5.1.1.2 Total Weight Gain

Live weight gain was significantly (P<0.01) higher in lambs fed on diets having either at 25 or 50% *Moringa oliefera* leaf meal as protein source in the concentrate mixture (Table 9). Among the *Moringa oliefera* leaf meal supplemented groups, T2 (75% groundnut cake+ 25% *Moringa oliefera* leaf meal) recorded comparatively higher live weight gain than T3 (50% groundnut cake+ 50% *Moringa oliefera* leaf meal) lambs. This could be due to lower tannins and higher digestibility of nutrients in T2 as compared to T3. Tannins in *Moringa oliefera* leaf meal complexes especially with proteins and protect them from microbial degradation which can have both negative and positive effects on their utilisation (Reed, 1995). Species with moderate levels of tannins having higher proportion of escape protein than those without tannins has been reported (Albrecht and Broderick, 1990). Condensed tannins (CT) protect labile plant proteins in the rumen and may consequently increase the supply of high-quality proteins entering the duodenum (Mangan, 1988) and increases animal performance (Rao *et al.*, 2013). Higher live weight might also be due to positive effect of Moringa on intake, digestibility and nitrogen balance.

Ther results obtained in the present study are in agreement with Tona *et al.* (2014) Sultana *et al.* (2015) and Damor *et al.* (2017) who reported the significant increase in total body weight gain in goats fed with different levels of *Moringa olifera* leaves. Dissimilar results were reported by Babeker and Bdalbagi (2015) and Syed Ali *et al.* (2018).

5.1.1.3 Average Daily Gain

The average daily gain (ADG) was significantly (P<0.01) higher in lambs fed on diets having either at 25% Moringa leaf meal as protein source in the concentrate mixture (Table 9). However, T2 (75% groundnut cake+ 25% *Moringa oliefera* leaf meal) lambs recorded relatively higher average daily gain compared to T3 (50%

groundnut cake+ 50% *Moringa oliefera* leaf meal). This could be due to lower tannins and higher digestibility of nutrients in T2 as compared to T3. Higher digestibility of nutrients with efficient utilization of absorbed nitrogen might be the reason for increased ADG in supplemented lambs. The present findings are in concurrence with findings of Moyo *et al.* (2012a), Tona *et al.* (2014), Sultana *et al.* (2015) and Bebekar and Bdalbagi (2015), Damor *et al.* (2017), who reported that feeding of *Moringa oleifera* leaves significantly increased average daily body weight gain in goats. Syed Ali *et al* (2017), Bhavana Aharwal *et al* (2018) who reported non-significant difference in average daily body weight gain among the treatment groups.

Shinde *et al.* (1995b), Pal *et al.* (1997b), Patel *et al.* (2004) and Porwal (2006) also reported higher body weight gain in intensive system than semi intensive system.

5.1.1.4 Dry Matter Intake

The acceptability of feed is probably one of the prime parameters for ascertaining utility of the non-conventional feed resource. The daily average dry matter intake (DMI) per 100 kg body weight was comparatively higher in Deccani lambs fed with T2 (75% groundnut cake + 25% *Moringa oliefera* leaf meal) and T3 (50% groundnut cake+ 50% *Moringa oliefera* leaf meal) diets (Table 10). The non-significant increase in the DMI among the experimental groups could be due to lower fibre content of the Moringa leaves thereby enhancing the palatability and digestibility. The observations made in present study are in concurrent with Aregheore *et al.* (2002), Asaolu *et al.* (2010), Damor *et al.* (2017) and Bhavana Aharwal *et al.* (2018) who reported non-significant difference in DM intake in animals supplemented with *Moringa oleifera* leaves.

In contrast to our findings Sarwatt (2002), Sultana *et al.* (2015), Babeker and Bdalbagi (2015) and Suliman (2016), Kholif *et al.* (2016) and Padama Meel (2018) reported significant increase in dry matter intake on Moringa leaves supplementation.

Higher dry matter intake in T2 and T3 groups in intensive system might be attributed to high quality feed supplementation and more resting time in shade. From the experiment, it is also evident that the feeding system has a greater influence on the quantum and quality of feed intake, which resulted in animal comfort and improved productive performance.

5.1.1.5 Feed Conversion Ratio

The feed conversion ratio (FCR) was significantly ($P<0.05$) lower in Deccani lambs fed with T2 (75% groundnut cake + 25% *Moringa oliefera* leaf meal) and T3 (50% groundnut cake+ 50% *Moringa oliefera* leaf meal) compared to T1 diets. Further,

T2 recorded better FCR compared to diet T3. This could be due to better digestibility of nutrients with efficient utilization of absorbed nitrogen when compared with control diet. The present study results are in agreement with the findings of Bhalerao (2018) and Krishna Mohan and Charyulu (1983), Asaolu *et al.* (2010) who reported the lower lower feed conversion ratio in goats fed with different levels of Moringa leaves. Similar results were reported by Kochewad *et al. (*2018) in Decani lambs when reared in intensive farming system.

5.1.2 BIOMETRICAL MEASUREMENTS

The biometric measurements indicate the skeletal growth of the animals. Body length and height at withers are the measures of bony growth while chest girth is a measure of development of muscles, bones and fat and it had close relationship with live weight. (Pomeroy, 1955).

5.1.2.1 Fortnightly Body Length

The rate of weight gain in terms of body weights and average daily gains was reflected in their concomitant growth pattern observed in body length in all the experimental groups. The body length was much pronounced from 4^{th} to 6^{th} six fortnight of the experiment in all the animal groups. Statistical analysis revealed a significant difference ($P<0.05$) among three treatment groups in final fortnight (6^{th} fortnight). T2 group lambs had significantly ($P<0.05$) higher body length than T1 group lambs. This could be due to more bony growth and associated weight gain as result of better digestibility of nutrients with efficient utilization of absorbed nitrogen with Moringa leaf supplementation in T2 lambs.

The results of the present study are comparable with the findings of Bharambe and Burte (2012), Padama Meel (2018) and Jagritisrivastav (2019). In contrast to these results Adegun and Aye (2011) found a significant increase in final body length when sheep was fed with Moringa based multi nutrient blocks.

5.1.2.2 Fortnightly Height at Withers

There was no significant difference ($P>0.05$) in height at withers (HW) among the treatment group lambs, however HW was higher in Moringa supplemented group lambs (T2 and T3) when compared to T1. It reflects the beneficial effect of feeding *Moringa oleifera* based diets to lambs in intensive farming system. This could be due to more weight gain along with bony growth as result of better digestibility of nutrients with efficient utilization of absorbed nitrogen in T1 and T2 lambs fed with moringa leaf supplementation. These findings are in agreement with reports of Padama Meel (2018) who reported that body weight gain increased in goat kids fed with Moringa leaves. In

contrast to these results Adegun and Aye (2011) found a significant increase in final height at wither when sheep was fed with Moringa based multi nutrient blocks.

5.1.2.3 Fortnightly Face Length

Significantly (P<0.05) higher face length was observed in T2 group than T1 group and no significant difference was observed between T2 and T3 groups. This could be due to more weight gain along with bony growth as a result of better digestibility and efficient utilization of nutrients in *Moringa oleifera* based diets. The findings of Iqbal *et al.* (2013) on the face length revealed that Deccani sheep showed similar values of the present study.

5.1.2.4 Fortnightly Chest Girth

The circumference of chest of the animals is an important indicator of animal health, body weight and size and which helps in respiration. The rate of weight gain in terms of body weight and average daily gain was reflected in concomitant growth of chest girth in all the experimental group lambs. The growth of chest girth was much pronounced from fourth to sixth fortnights in all the experimental groups. The observed chest girth values were non-significantly higher in T2 and T3 group as compared to T1 group lambs. This could be due to more weight gain along with bony growth as result of better digestibility of nutrients with efficient utilization of absorbed nitrogen in T2 and T3 group diets which received Moringa oliefera leaf meal in their concentrate mixture.

These findings are in agreement with reports of Dass (2007), Bharambe and Burte (2012) who found maximum gain for chest girth in stall fed systems. On contrast to these results Adegun and Aye (2011) found a significant increase in final chest girth when sheep was fed with Moringa based multi nutrient blocks.

5.1.2.5 Fortnightly Hip Width

The observed values for hip (HW) width were non-significant (P>0.05) in all fortnights. The overall mean was non-significantly higher in T2 group than T1 and T3 group while the final gain in hip width was significantly (P<0.05) higher in T2 group than T1 group and T2 group had a non-significant difference with T3 group. Sandeep Kumar and Dhiya (2017) reported the similar results in Deccani sheep in intensive farming system.

5.1.2.6 Fortnightly Tail Length

The observed values for tail length (TL) were non-significant in all fortnights but linerly increased in all treatment groups. The overall mean and final tail length were also non-significantly highest in Moringa supplemented groups compared to control group. The findings in the present study are in agreement with the findings of Sandeep

Kumar and Dhiya (2017) and Mahmud (2013). In contrast to the present findings Adegun and Aye (2011) found a significant (P<0.05) increase in final tail length when sheep was fed with Moringa based multi nutrient blocks.

5.1.3 BODY CONDITION SCORE

All the experimental groups have shown a gradual increment in their BCS during experimental period. There was a significant increase in BCS during all fortnights except in 1st and 2nd fortnights. The final mean of BCS had a significant difference (P<0.01) among the three treatment groups. The final BCS was significantly (P<0.01) higher in T2 group than T1 group but comparable with T3 groups in intensive farming system. From the results, it is evident that the overall BCS has improved at the end of the experiment, that indicated the ideal body fat reserves and muscle thickness. Similar results were reported by Moyo *et al.* (2012b) when cross-bred Xhosa lop eared goats fed with *Moringa oleifera Lam*. Similarly, Kochewad *et al.* (2018) reported the significant difference (P<0.05) in BCS in Deccani lambs reared in intensive farming system.

5.1.4 CORRELATION CO-EFFICIENT OF BODY WEIGHT WITH BODY MEASUREMENTS

The correlation coefficient (R^2) of body weight with body length, face length, chest girth, height at wither, hip width and tail length in intensive farming system were 0.084, 0.660, 0.856, 0.360, 0.835 and 0.518, respectively.There was a positive and highly significant correlation between body weight and all the body measurements except body length in three treatment groups. Significantly (P<0.05) higher coefficient of determination was found between body weight and chest girth compared to other body measurements.

The co-efficient of determination (R^2) was maximum for gain in chest girth when compared to gain in height at withers and body length, similar finding was observed by Singh and Mishra (2004) for Barbari goat.

5.1.5 PHYSIOLOGICAL PARAMETERS

The results of the influence of the feeding MLM based diet on physiological profile in relation to the intensive farming system are discussed below.

5.1.5.1 Fortnightly Changes in pulse rate

The mean fortnightly pulse rate was significant higher (P<0.01) in all fortnights except in 1st fortnight in the intensive farming system. The pulse rate was significantly higher in T2 group than T1 group and T1 and T3 groups were comparable in all fortnights. The overall mean pulse rate was significantly (P<0.01) higher in T2 group

than T3 and T1 groups. However, the pulse rate was within the normal physiological limits. This could be due to that MLM feeding increases thyroid hormones levels in the blood (Hassan *et al.*, 2016) and increased thyroid hormone levels result in higher basal metabolic rate and associated physiological activities. Similar findings were reported by Marai *et al.* (2007) and Seijan *et al.* (2010), Babeker and Bdalbagi (2015) and Venkata Raju *et al.* (2015) reported that the pulse rate values under three different system of management were within physiological limits and there was no significant difference between the groups.

5.1.5.2 Fortnightly Changes in respiratory rate

The recorded mean respiratory rates were significantly ($P<0.01$) different throughout the experiment. The respiration rate was significantly ($P<0.01$) higher in T2 and T3 group lambs when compared with T1 from 1 to 6 fortnights during experimentation. The overall mean respiratory rate was relatively higher in lambs fed with Moringa based diets (T2 and T3) than control (T1). This could be due to rise in thyroid hormone levels and associated increase in basal metabolic rate. The present findings are in concurrence with Babeker and Bdalbagi (2015) in Sudan Nubian goats when fed with three different levels of *Moringa oleifera* leaves. In contrast to these, Venkata Raju *et al.* (2015) reported a non-significant difference among three types of management systems.

5.1.5.3 Fortnightly Changes in Rectal Temperature

Mean rectal temperatures were relatively higher in T2 and T3 group lambs when compared to T1. It could be due to rise in basal metabolic rate as a result of increased thyroid hormone in Moringa leaf supplemented lambs. These observations are in agreement with Marai *et al*. (2007). In contrast to the present results. Babeker and Bdalbagi (2015) reported a significant difference ($P<0.05$) in rectal temperature when Sudan Nubian goats fed with three different levels of *Moringa oleifera* leaves.

5.1.6 HAEMATOLOGICAL PARAMETERS

The influence of various factors such as age, season, growth performance, reproductive status and farming systems upon blood parameters are necessary to understand in the evaluation of blood parameters to determine the nutritional status of animals for undertaking the prophylactic measures to counter the health disorders and to increase productivity (Antunovic *et al*., 2002).

5.1.6.1 WBC (10^3/mm^3)

The recorded mean W.B.C values were significantly (P<0.05) higher in T2 and T3 lambs fed with different levels of Moringa leaf meal in diets. However, WBC levels were within the normal range of 4.0 to 12.0 10^3/mm^3 (Swensen and Ithane1984). Konlan *et al.* (2012) reported that WBC offer explanation for defence mechanism of animal. Antimicrobial properties of *Moringa olifera* are well established and extracts from leaves reported to be potential antibacterial and antifungal functions (Oluduro, 2012). This could be the reason for higher WBC in supplemented lambs, however values are within physiological limits for sheep. These results are comparable with Asaolu *et al.* (2012b) and Babeker and Bdalbagi (2015) who reported significant difference in the values of WBC in goats due to inclusion of Moringa in diets.

5.1.6.2 RBC (millions/mm^3)

The RBC values were significantly (P<0.05) higher in lambs fed with diet containing 25% (T2 group) and 50% Moringa leaf supplemented lambs (T3 group) when compared to control (T1 group). The RBC values observed in lambs were within the normal range of 8.0 to10 ^{6}/cu mm (Swensen and Ithane1984). High content of iron in Moringa leaf meal helps in rapid multiplication of Red Blood Cells (RBC). RBC are responsible for the transportation of oxygen and carbon dioxide in the blood as well as manufacture of haemoglobin hence higher values indicate a greater potential for this function and a better state of health. Adegan and Aye (2011), Fadiyimu *et al.* (2010), Asaolu *et al.* (2012) and Babeker and Bdalbagi (2015) reported the similar results in goats fed with Moringa based diets.

5.1.6.3 Haemoglobin (g/dl)

Relatively higher haemoglobin (Hb) values were observed in lambs (T2 and T3) fed with diet containing moringa leaf when compare to control (T1). However, the haemoglobin values in intensive farming system among experimental groups were within the normal range of 8-16 (Dhanotiya, 2004). High content of iron in Moringa leaf meal helps in more synthesis of haemoglobin. The haemoglobin concentration was within the normal range and it is opined that dietary treatment seemed to be capable of supporting high oxygen carrying capacity of blood in growing lambs due to presence of high iron content in the Moringa leaves. The results are in agreement with the findings of Manmohan Kumar *et al.* (2018) in Black Bengal goats fed with different levels of *Moringa oleifera* leaf powder. In contrast to the findings, Asaolu *et al.* (2012b) and Babeker and Bdalbagi (2015) reported significantly higher values of Hb in goats fed with Moringa Multi Nutrient Block and Moringa leaves, respectively.

5.1.6.4 PCV (%)

The mean P.C.V values of all lambs across the three treatment groups ranged between 22.33 to 24.91% at the end of the experiment. The recorded PCV value in T2 group was significantly higher ($P<0.05$) and the values were comparable among the supplemented T3 and T2 group lambs. The PCV (%) values in intensive farming systems and were within normal range of 28-40 (Jain, 1986). PCV indicate the capability of RBC to deliver oxygen to the tissues and high PCV values have been regarded as sign of healthy and high productive animals. This result is comparable with the values obtained by Daramola *et al.* (2005), Asaolu *et al.* (2012b) and Babeker and Bdalbagi (2015) for West African Dwarf goats.

5.1.6.5 Erythrocytes and Leucocytes Indices

The Mean corpuscular volume (MCV) was significantly higher in Moringa based rations than the control group lambs. This could be due to beneficial effect of *M. olifera* on haematological parameters. The present findings are in agreement with Babeker and Bdalbagi (2015) who reported the significant difference in MCV values when Sudan Nubian goats fed with three different levels of *Moringa oleifera* leaves. In contrast to the present findings Syed Ali (2017) had recorded non-significant values in MCV.

The mean corpuscular haemoglobin (MCH) value was relatively higher in Moringa based diets than the control group lambs and this could be due to beneficial effect of *Moringa olifera* on haematological parameters. Similar findings were reported by Syed Ali (2017) in goats fed with two different levels of Moringa based concentrate mixture. Babeker and Bdalbagi (2015) reported significant difference in MCH values when Sudan Nubian goats fed with three different levels of Moringa leaves, hence, disagreement with the present findings.

The mean corpuscular haemoglobin concentration (MCHC) values were relatively high in Moringa based diets than the control group lambs. This could be due to beneficial effect of *Moringa olifera* on haematological parameters. The present findings are corroborated with the reports of Syed Ali *et al* (2017) but contrary to the findings of Babeker and Bdalbagi (2015).

The Erythrocyte indices of growing Deccani lambs fed with different levels of *Moringa oleifera* leaves shown normal values among the treatment groups when compared to control in intensive farming system.

All leucocyte indices were observed to be non-significantly higher in Moringa based diets than the control group lambs. This could be due to beneficial effect of *M. olifera* on haematological parameters. It suggests that immune system of lambs was in ideal state as apparent from normal concentration of Differential Leukocyte Count (DLC) in experimental lambs. The observations indicated that, *Moringa oleifera* based concentrate diets do not have any adverse effect on immune system of lambs. Similar findings were reported by Babeker and Bdalbagi (2015), Syed Ali (2017) and Manmohan Kumar *et al.* (2018).

5.1.7 BLOOD BIOCHEMICAL PARAMETERS

5.1.7.1 Total Protein (g/dl)

Total protein concentrates (g/dl) was statistically significant ($P<0.01$) among three treatment groups in intensive system. T2 group had significantly ($P<0.05$) higher total protein content which was comparable to T3 and lowest value was noticed in T1 group which also comparable with T3 (Table 25). The total protein values in intensive farming system among experimental groups were within the normal range of 6.0 to 7.9 (g/dl) (Dhanotiya, 2004).

Supplementation of Moringa resulted in increase in serum protein content as it contains several antioxidants, which increases blood total protein by decreasing corticosterone secretion and limiting protein catabolism. Further, presence of some phyto-chemicals in Moringa leaves are beneficial as they impact some qualities of rumen undegradable protein, thus improving protein availability and utilization (Garg *et al*., 1992). These results are comparable to the normal range of goats (6.4-7g/dl) reported by Dhanotiya (2004). In the present experiment, all the experimental diets had met the protein requirements of lambs, hence, it was reflected in their levels. Similar findings have been reported by Bebekar and Bdalbagi, (2015), Suliman *et al.* (2016) Damor *et al.* (2017b), Padama Meel (2018) in goats. The present findings are disagrrement with Kholif *et al.* (2016) and Syed Ali (2017), Ahmad *et al.* (2017) reported non-significant difference in total protein when different levels of *Moringa oleifera* leaves were fed to animals.

5.1.7.2 Serum Albumin (g/dl)

The mean serum albumin levels of Deccani lambs were numerically higher for T2 and T3 groups than control group in intensive farming system. Supplementation of Moringa resulted in increased serum albumin content as it contains several antioxidants which may results in better immune response. The serum albumin levels were within the normal range (Dhanotiya, 2004). Similarly results reported by Krishnamohan *et al*

(1984) and Haridas (2018). The present values are in disagreement with Bebekar and Bdalbagi, (2015) and Damor *et al.* (2017b) who reported significantly higher level of albumin with feeding moringa leaves at different levels in the diet of Sudan Nubian and Mehsana goats, respectively. The values for serum albumin in the present study were lower than the values reported by Karim and Varma (2000) in lambs.

5.1.7.3 Serum Glucose (mg/dl)

Concentration of serum glucose was non-significantly lower in T2 and T3 group lambs when compared with T1 group lambs. Similarly, moringa leaf meal supplementation lowered serum glucose concentration at the end of experiment when compared to the start of experiment, however the differences were non-significant. Lower serum glucose concentrations in T2 and T3 group lambs could be due presence of flavonoids present in the Moringa leaf which inhibits alpha-amlylase activity to regulate the amount of glucose in the blood. Further, higher thyroid hormones and associated increased basal metabolic rate and physiological activities also reduce serum glucose concentration. The observations in the present study were in concurrence with Damor *et al.* (2017), Syed Ali (2017) who stated non-significant differences in serum glucose values in goat kids fed with different levels of Moringa leaves. In contrast to the present findings, Kholif *et al* (2017) recorded significant increase in serum glucose.

5.1.7.4 Serum Glutamic Oxaloacetic Transaminase (IU/dl)

In the present study, no significant difference was observed in Serum Glutamic Oxaloacetic Transaminase (SGOT) when the growing lambs fed with experimental diets. The SGOT values are within the normal range of 32-84 IU/dl (Dhanotiya, 2004) which indicated that there is no adverse effect on liver function in lambs fed MLM based concentrate mixtures. Similar values were reported by Syed Ali (2017) and Ahmed *et al.* (2017). In contrast to the present findings, significantly ($P<0.05$) high values of SGOT have been reported by Kholif *et al.* (2016) and Yusuf *et al.* (2017) and Damor *et al.* (2017b) with *Moringa oleifera* leaves.

5.1.7.5 Serum Glutamic Pyruvate Transaminase (IU/dl)

No significant difference was recorded for Serum Glutamic Pyruvate Transaminase (SGPT) levels when the experimental diets were fed in intensive farming system and within the normal range of 2.0-7.5 IU/dl (Ramesh Kumar *et al*, 2003). However, slight increase was observed in *Moringa olefera* leaf meal supplemented lambs (T2 and T3) at the end of experiment when compared to the start of experiment. It could be due to hepato protective nature of *Morinaga oleifera*, as the liver supposed to release SGPT when it gets damaged. The normal range of these enzymes was also

indicative that the animals are free from disease and morbid condition. Similar results were reported by Ahmed *et al.* (2017).

5.1.8 NUTRIENT DIGESTIBILITY

5.1.8.1 Dry matter Digestibility

The dry matter digestibility coefficient (%) was non-significantly higher in T2 and T3 than T1 group lambs. Among the MLM supplemented lambs, T2 lambs showed relatively higher dry matter digestibility coefficient than T3. Higher digestibility of Moringa supplemented diets could be due to low structural carbohydrates and good quality protein. The results obtained in the present study are corroborated with the finding of Manh *et al.* (2005) and Sultana *et al.* (2015) who observed in the concentrate mixture the DM digestibility did not significant with increased Moringa levels. Similarly, Sarwatt *et al.* (2002) observed an inconsistent trend in the digestibility of nutrients with increasing levels of *Moringa oleifera* leaf as a substitute to sunflower seed cake in goats fed a basal diet of *Chlorias gayana* Whereas, Fadiyimu *et al.* (2010), Tona *et al.* (2014) and Kholif *et al.* (2017) had reported contrasting results to the present findings.

5.1.8.2 Organic Matter Digestibility

The organic matter digestibility coefficients (%) were non-significantly ($P>0.05$) higher in the T2 and T3 treatment groups when compared with the control (T1) group in intensive farming system. Sanchez *et al.* (2006a) reported that increasing level of moringa leaves supplementation in dairy cows fed low quality feed improved digestibility of all nutrients as it is rich in minerals, antioxidants and high-quality protein. The obtained value is in agreement with the finding of Naula *et al.* (2006), Asaolu *et al.* (2011), Tona *et al.* (2014) and Sultana *et al.* (2015) reported the non-significant effect of Moringa leaves inclusions in dietary treatments. Mahmud (2013), Tona *et al.* (2014), Fadiyimu *et al.* (2016) and Kholif *et al.* (2016) reported that OM digestibility was significant when different levels of Moringa leaves were included in the diets.

5.1.8.3 Crude Protein (CP) Digestibility

The CP digestibility was found to be numerically higher in T2 group as compared to T3 and control group, however, the differences are not significant. Among the Moringa leaf meal supplemented lambs, T2 lambs showed relatively higher CP digestibility coefficient than T3. Higher crude protein digestibility coefficient (%) in Moringa supplemented groups could be due to the presence of high-quality protein in the leaves. Similar results were reported by and Oyedem *et al.* (2016) and Syed Ali

(2017) and Soby *et al*. (2015). The present results are in disagreement with the observations of Tona *et al.* (2014), Fadiyimu *et al.* (2016) and Kholif *et al.* (2017).

5.1.8.4 Crude Fibre (CF) Digestibility

Relatively higher CF digestibility was observed in Moringa leaf meal supplemented group (T2 and T3) compared to control group (T1) lambs, however the differences were not significant. Among the supplemented lambs, T2 lambs showed relatively higher CF digestibility coefficient than T3. The higher CF digestibility in T2 and T3 equally suggests an increase in the activities of fibrolytic bacteria in the rumen probably as a result of the availability of essential nutrients especially protein, energy and minerals in balanced proportions. The obtained values are in line with the finding of Akinyemi *et al.* (2010) and Soby *et al*. (2015), Sultana *et al.* (2015), Oyedele *et al.* (2016), and Syed Ali (2107). While Fadiyimu *et al.* (2010), Tona *et al.* (2014) and Kholif *et al.* (2017) reported dis similar results.

5.1.8.5 Ether Extract (EE) digestibility

There was no significant difference in the ether extract digestibility among the three experimental diets. But the lambs fed with diets containing *Moringa oleifera* shown relatively higher ether extract digestibility coefficient (%). The higher EE digestibility in T2 and T3 could be due to increased ruminal microflora as a result of the availability of all the essential nutrients especially protein, energy and minerals in balanced proportions through Moringa leaf meal. A similar finding was earlier reported by Naula *et al.* (2006), Akinyemi *et al.* (2010) and Sultana *et al.* (2015*)* and Syed Ali (2017). Fadiyimu *et al.* (2010), Tona *et al.* (2014), Soby *et al* (2015) Ahmad *et al* (2016) and Kholif *et al.* (2017) reported dis similar result.

5.1.8.6 Nitrogen Free Extract (NFE) digestibility coefficients (%)

The Nitrogen free extract digestibility was significantly ($P<0.05$) higher in the T2 and T3 treatment groups when compared to the control (T1) group. T2 group had significant difference with T3 and T1 groups. The higher NFE digestibility in T2 and T3 could be due to supply of essential nutrients especially protein, energy and minerals in balanced proportions through Moringa leaf meal. Similar findings are reported by Akinyemi *et al.* (2010) and Syed Ali (2017) when sheep and goats respectively fed with *Moringa oleifera* as supplements to *Panicum maximum* and Cotton seed cake, respectively. Soby *et al*. (2015) reported dissimilar results when different levels of Moringa leaves fed to fattening lambs.

5.1.8.7 Neutral Detergent Fibre (NDF)

The observed neutral detergent fibre digestibility was non-significantly (P>0.05) higher in T2 and T3 group than T1 group lambs. The higher NDF digestibility in T2 and T3 equally suggests an increase in the activities of fibrolytic bacteria in the rumen probably as a result of the supply of essential nutrients especially protein, energy and minerals in balanced proportions through Moringa leaf meal. Similar findings were reported by Manh *et al.* (2005), Naula *et al.* (2006), Akinyemi *et al.* (2010) who reported higher value for NDF digestibility when animals fed with *Moringa oleifera* leaves.

5.1.8.8 Acid Detergent Fibre (ADF) digestibility

Acid Detergent Fibre digestibility was non-significantly higher in T2 and T3 group compared to T1 group lambs. It could be due to the higher rumen microbial activity and availability of digestible cellulose from ADF of Moringa foliage to the lambs. The values obtained for ADF digestibility are similar to those recorded by Manh *et al.* (2005) and Naula *et al.* (2006), Akinyemi *et al.* (2010) reported higher values for ADF digestibility when increasing inclusion level of *Moringa oleifera*. In contrast to the present findings Mahmud (2013) reported significant (P<0.05) difference between the Moringa supplement groups in growing lambs.

5.1.9 FEEDING BEHAVIOUR INTENSIVE FARMING SYSTEM.

Time spent and percentage of total time spent on eating and sleeping were significantly (P<0.01) higher in T2 group lambs than T3 and T1 group lambs and no significant difference was noticed between T1 and T3 group lambs. The percentage of time spent for ruminating was less than the time spent for eating in the present study. Time spent in eating and percentage of time spent in eating in T2 group indicates that the Moringa based diet (25%) was relatively more palatable. The literature on feeding behaviour with Moringa based diets are scanty in sheep. However, the present findings are disagreement with Abijoude *et al.* (2000) in sheep Nasrullah *et al*. (2013) in goats.

5.1.10 FAECAL CONSISTANCY SCORE

Faecal consistency is used as a tool to assess how a diet is digested and overall animal health. Faecal consistency score was, 1.35±0.64, 2.42±0.30 and 2.24±0.13 in T1, T2 and T3 groups, respectively. The fecal consistency score was significantly (P<0.01) higher in the T2 group when compared to the control (T1) group. T2 group had significant difference with T3 and T1 groups. This could be due to higher

digestibility and feed effiecncy in Moringa based groups. A scanty literature is available on the FCS when sheep are fed with *Moringa oleifera* leaf meal. Similar finding was observed by Bhavna Aharwal (2018) when buffalo calves were fed with *Moringa oleifera* leaf meal at 10% level in the concentrate mixture during the preweaning period.

5.1.11 CARCASS CHARACTERISTICS

T3 group had statistically non-significant (P>0.05) higher pre-slaughter, empty live and hot carcass weights than T2 and T1 groups. There was a non-significant difference (P>0.05) in dressing percentage on pre slaughter and empty live weights basis in all three treatment groups. However, the T2 group had numerically higher dressing percentage (63.3±4.48) on empty live weight compared to T1 (59.34±1.38), and T3 (61.8±3.23) group. Lower gut fill due to higher digestibility and higher empty live and hot carcass weights due to better feed efficiency with Moringa based rations in T2 and T3 resulted in better productivity.

A non-significant difference was observed among the treatment groups for weight of liver, kidney, heart, and testis. The weight of head, leg, skin, blood, lung, stomach was also non-significant among the treatment groups. However, relatively higher edible and non-edible offal weights were observed with Moringa based rations supplemented lambs (T2 and T3). It could be due to higher digestibility of nutrients and better feed efficiency of Moringa leaf meal supplemented diets.

Similar result was reported for hot carcass weight and edible organ weights by Busani Moyo *et al.* (2013) when crossbred Xhosa lop-eared goats were fed with *Moringa oleifera* leaves. In case of dressing percentage, a lower dressing percentage was reported by Busani Moyo *et al.* (2013). Similar result was reported by Kochewad *et al. (*2018) in Decani lambs when reared in intensive farming systems. Hence, the feeding of Moringa leaf meal-based diet in intensive farming system is considered as profitable economically in terms of meat production.

5.1.12 COST OF PRODUCTION

Feed cost accounts 60-70 percent of total cost of animal production. Hence it is necessary to incorporate cheaper and unconventional feed ingredients with high nutritive value for better results and profitability.

The total cost and cost of production per one kg of meat was lower in T2 and T3 group lambs which received concentrate mixture containing *Moringa oleifera* than control group lambs. It could be due to higher digestibility of nutrients and better feed efficiency of supplemented diets in addition to the lower cost of production of Moringa leaf meal in the present study. Thus, results indicated the improvement in profit on

replacement of GNC in concentrate mixture with *Moringa oleifera* leaf meal in lambs' rations. Adegun and Aye (2013) and Syed Ali (2017), Yosuf *et al.* (2018) reported significant reduction in cost per kg live metabolic body weight with increasing level of *Moringa oleifera* and cotton seed cake as protein supplements.

EXPERIMENT II SEMI- INTENSIVE FARMING SYSTEM

The results of feeding of Moringa (*Moringa oleifera*) leaf meal-based diets under semi- intensive farming system are discussed under following heads in order to have comprehensive information on the productive performance of growing Deccani lambs.

5.2 GROWTH PERFORMANCE

5.2.1 Fortnightly Body Weights

All groups exhibited similar trend of fortnightly increase in average live body weight throughout the experiment period which revealed linear growth in control and experimental groups (Table 31). The final weight gain (kg) of Deccani lambs in semi-intensive system farming was non-significantly higher in Moringa based diets (T2 and T3) than control. The numerically higher values in the group supplemented with moringa leaf meal showed that it could contribute towards better livestock performance in terms of bodyweight changes and high yield of good-quality products as it contains an appreciable level of essential nutrients. Nutrition is far the most important environment influence on animal growth and development before and after birth (Widdoson and Lister, 1991).

The results of the present study are in concurrence with the findings of Mahgoub *et al.* (2005), Jiwuba *et al.* (2016) and Syed Ali (2017) who reported non-significant increase in live body weight. Similarly, Porwal *et al.* (2005) and Bharambe and Burte (2012) also reported higher body weight gains for the lambs reared under semi intensive system of feeding when compared to extensive system. In contrast to this, Asaolu *et al.* (2012), Sultana *et al.* (2015) and Choudary *et al.* (2018) had reported significant increase in body weight changes when goats fed with different levels of Moringa leaves.

5.2.1.1 Total Weight Gain

There was no significant difference in total weight gain (kg) among the treatment group lambs, however total weight gain (kg) was relatively higher in Moringa supplemented group lambs (T2 and T3) when compared to T1. Higher live weight might be due to positive effect of Moringa on intake, digestibility and nitrogen balance. Similar results are reported by Babeker and Bdalbagi (2015) and Syed Ali (2017) in goats. Simiarly, Porwal *et al*. (2005) and Bharmabe and Burte (2012) also reported

higher body weight gain in lambs reared under semi- intensive system of feeding when compared to extensive system.

Tona *et al.* (2104), Sultana *et al.* (2015) and Damor *et al.* (2017) reported significant increase in total body weight gain in goats fed with different levels of *Moringa oleifera* leaves.

5.2.1.2 Average Daily Gain

The average daily gain was non-significantly higher in T2 group (92.60±5.07 g) followed by T3 (83.70±6.10 g) and T1 (80.20±6.47g) groups. Higher digestibility of nutrients with efficient utilization of absorbed nitrogen might be the reason for increased ADG in supplemented lambs. The present findings are in concurrence with findings of Syed Ali (2017), Bhavana Aharwal *et al.* (2018) who reported non-significant difference in average daily body weight gain among the treatment groups. Similarly, Krishna Mohan and Charyulu (1983) reported non-significant effect on ADG in goats reared under semi-intensive system.

The present results are disagreement with Moyo *et al.* (2012), Tona *et al.* (2014), Sultana *et al.* (2015) and Bebekar and Bdalbagi (2015), Damor *et al.* (2017) who reported that feeding of *Moringa oleifera* leaves significantly increased in average daily body weight gain in goats.

5.2.1.3 Dry Matter Intake

The acceptability of feed is probably one of the prime parameters for ascertaining utility of the non-conventional feed resource. The statistical analysis of the data revealed a significant effect ($P<0.01$) on the DMI (kg/100 kg body weight) among three treatment groups. T2 group lambs had a significantly higher DMI (kg/100 kg body weight) compared to T1 group and there was no significant difference between T2 and T3 groups. This could be due to lower fibre content of the Moringa leaves and thereby enhancing the palatability and consumption. The observations made in present study are in concurrent with Sarwatt *et al*. (2004), Tona *et al*. (2014), Kholif *et al*. (2016) and Padma Meel (2018) who reported significant difference in DM intake in animals supplemented with *Moringa oleifera* leaves.

In contarst to our findings, Asaolu *et al.* (2010), Syed Ali (2017), Damor *et al.* (2017) and Manmohan Kumar *et al.* (2018) reported non-significant effect in dry matter intake on *Moringa oleifera* leaves supplementation. Similarly, Kochewad *et al*. (2017) reported significantly ($P<0.05$) higher DMI in lambs reared in intensive system than semi-intensive system.

5.2.1.4 Feed Conversion Ratio

The feed conversion ratio was relatively lower in Moringa based groups (T2 and T3) compared to T1 groups. Further, T2 diet recorded better FCR compared to diet T3. This could be due to lower feed intake and better digestibility of nutrients with efficient utilization of absorbed nitrogen when compared with control diet. Similar results are reported by Krishna Mohan *et al.* (2018) in goats reared under semi-intensive system.

The present results are in disagreement with the findings of Adegun and Aye (2011), Babeker and Bdalbagi (2015), Jiwuba *et al.* (2016) and Padma Meel (2018) who reported significantly increased feed efficiency with feeding of Moringa leaves in goats in semi-intensive system.

5.2.2 BIOMETRICAL MEASUREMENTS

5.2.2.1 Fortnightly Body Length

The fortnightly recorded body length was significantly affected by feeding *Moringa oleifera* based diets from 1st to 6th fortnights in semi-intensive system. Lambs fed with 50% Moringa leaf meal in T3 group had a significantly higher body length from 1st to 5th fortnights while there was no significant difference in overall mean of body length. The statistical analysis of the data shown in Table 34 for final gain in body length was non-significantly higher in lambs fed with 25% Moringa leaf meal-based ration (T2 group) followed by T3 and T1 groups. This might be due to high and better nutritive value of *Moringa oleifera* leaves fed to the lambs. Similar results were reported by Adegun and Aye (2011) and Padma Meel (2018) in sheep and goats, respectively.

5.2.2.2 Fortnightly Height at Wither

The average height at wither was significantly ($P<0.01$) higher in T2 lambs at final fortnight among three treatment groups, however height at wither was relatively higher in Moringa based groups (T2 and T3) than control group. It reflects the beneficial effect of feeding Moringa based diets to lambs in semi-intensive farming system. This could be due to more weight gain along with bony growth as result of better digestibility of nutrients with efficient utilization of absorbed nitrogen in T2 and T3 lambs fed with moringa leaf supplementation.The present results are in accordance with Adegun and Aye (2011) and Padma Meel (2018) who reported a significant difference in height at withers in sheep and goats, respectively.

5.2.2.3 Fortnightly Face Length

Statistical analysis of fortnightly recorded face length revealed a significantly ($P<0.05$) higher in T2 at 1st fortnight and was non- significant from 2nd to final fortnights among three treatment groups. The overall mean and final gain in face length was non-significantly higher in Moringa based diets than control diet in semi-intensive system. This could be due to more weight gain along with bony growth as a result of better digestibility and efficient utilization of nutrients in *Moringa oleifera* based diets. Iqbal *et al.* (2013) reported dissimilar results in Deccani sheep reared in semi-intensive system.

5.2.2.4 Fortnightly Chest Girth

The growth of chest girth was much pronounced from fourth to sixth fortnights in all the experimental groups. The observed chest girth values were non-significantly higher in T2 and T3 group as compared to T1 group lambs. This could be due to more weight gain along with bony growth as a result of better digestibility of nutrients with efficient utilization of absorbed nitrogen in T2 and T3 group diets which received *Moringa oliefera* leaf meal in their concentrate mixture (Table 37). Adegun and Aye (2011) and Padma Meel (2018) had reported similar results.

5.2.2.5 Fortnightly Hip Width

The observed values for hip (HW) width of T2 group lambs were non-significantly higher from 1st to 4th fortnights and were significant ($P<0.05$, 0.01) later. The overall mean and gain in hip width were non-significantly higher in T2 and T3 groups than T1 group. Present findings are in contrary to Sandeep Kumar and Dahiya (2017) reported the significantly higher hip width in Deccani sheep reared in intensive farming system.

5.2.2.6 Fortnightly Tail Length

The observed values for tail length (TL) were significantly ($P<0.05$) higher in T2 lambs at final fortnight but increased linearly in all treatment group lambs. The overall mean and final tail length were also non-significantly highest in Moringa supplemented groups compared to control group. The present findings are in line with Mahmud *et al.* (2013) and Sandeep Kumar and Dahiya (2017) in Deccani sheep reared in semi-intensive system.

5.2.3 BODY CONDITION SCORE

All the experimental groups have shown a gradual increment in their BCS during experimental period. The body condition score was significantly ($P<0.01$) affected in lambs in 3rd, 4th 5th and final fortnights whereas it was non-significant in 1st

and 2nd fortnights among three treatment groups. The final body condition score was significantly (P<0.01) higher in T2 group than T1 while there was no difference between T1 and T3 groups. The overall mean BCS was numerically higher in Moringa based groups than control group. From this result, it is evident that the overall BCS has improved in lambs at the end of the experiment, that indicated the ideal body fat reserves and muscle thickness. Similar results were reported by Busani Moyo *et al.* (2013) when cross-bred Xhosa lop eared goats fed with *Moringa oleifera Lam*. Similarly, Kochewad *et al.* (2017) reported a significant difference (P<0.05) in BCS in Deccani lambs reared in semi-intensive farming system.

5.2.4 CORRELATION CO-EFFICIENT OF BODY WEIGHT WITH BODY MEASUREMENTS

The correlation coefficients of body weight with chest girth, height at withers and tail length had significant (P<0.01) positive correlation in lambs fed with three treatment groups. Among body measurements, body length, hip width, height at withers and tail length had highly positive correlation (P<0.01). Perusal of the results showed that height at withers had higher correlation with body weight. Similar finding was observed by Singh and Mishra (2004) for Barbari goat.

5.2.5 PHYSIOLOGICAL PARAMETERS

5.2.5.1 Fortnightly Changes in Pulse Rate (Beats/Min)

The mean fortnightly pulse rate was significantly (P<0.01) higher in T2 lambs during the experimental period in all fortnights under the semi-intensive farming system. The mean pulse rate was significantly (P<0.01) higher in T2 and T3 than T1 group lambs, however it was in within the physiological limits. Moringa leaf meal feeding increases thyroid hormones levels in the blood (Hassan *et al.*, 2016). Increased thyroid hormone levels result in higher basal metabolic rate and associated physiological activities. Similar findings were reported by Marai *et al.* (2007) and Babeker and Bdalbagi (2015). In contrast to present finding Venkata Raju *et al.* (2015) reported no significant difference between the groups under three different system of management.

5.2.5.2 Fortnightly Changes in Respiratory Rate (Breaths/Min)

The observed respiratory rate was significant (P<0.01) higher in T2 lambs during the experimental period in all fortnights under the semi-intensive farming system. Except in 5th fortnight. Higher mean respiratory rate was noticed in T2 and T3 dietary groups compared to T1 group throughout the experiment. The overall mean respiratory rate was relatively higher in lambs fed with Moringa based diets (T2 &T3)

than control (T1), however it was within the normal physiological limits. This could be due to rise in thyroid hormone levels and associated increase in basal metabolic rate. The present findings were in concurrence with Babeker and Bdalbagi (2015) in Sudan Nubian goats fed with three different levels of *Moringa oleifera* leaves. In contrary to these findings Venkata Raju *et al.* (2015) reported non-significant difference between the groups in three types of management systems.

5.2.5.3 Fortnightly Changes in Rectal Temperature (^{0}F)

The observed mean rectal temperature was relatively higher in T2 and T3 groups compared with T1 group, however, it was within the normal physiological limits in all the three treatment groups in semi-intensive farming system. It could be due to rise in basal metabolic rate as a result of increased thyroid hormone in Moringa leaf supplemented lambs. These observations are in agreement with Marai *et al*. (2007) and Venkata Raju *et al.* (2015). In contrast to this, Babeker and Bdalbagi (2015) reported a significant difference ($P<0.05$) in rectal temperature when Sudan Nubian goats fed with three different levels of *Moringa oleifera* leaves.

5.2.6 HAEMATOLOGICAL PARAMETERS

The evaluation of blood parmenters are essential to know the nutrional staus of the animals for undertaking the prophylactic measures to counter the health disorders and to increase productivity (Antunovic *et al.,* 2002)

5.2.6.1 WBC (10^3/mm^3)

Statistical analysis of the data revealed a significant difference ($P<0.01$) in the WBC levels among experimental diets. Significantly ($P<0.01$) higher WBC values were observed in T2 dietary group which was comparable with T3 dietary group and lowest values were observed in T1 dietary group. The recorded WBC values in the present study were within the normal range of 4.0 to 12.0 (Swensen and Ithane, 1984). Konlan *et al.,* (2012) reported that WBC offer explanation for defence mechanism of animal. Antimicrobial properties of *Moringa olifera* are well established and extracts from leaves reported to be potential antibacterial and antifungal functions (Oluduro *et al.,* 2012). This could be reason for higher WBC in supplemented lambs, however values are within physiological limits for sheep. These results are corroborated with the findings of Fadiyimu (2010), Babeker and Bdlabagi (2015), Jiwuba *et al.* (2016) and Syed Ali (2017) who reported significant difference in the values of WBC in goats due to inclusion of Moringa in diets. The present results are in disagreement with the values obtained by Adegun and Aye (2011) and Padma Meel (2018).

5.2.6.2 RBC (millions/mm^3)

The observed R.B.C values were significant (P<0.01) at the end of the experiment among three treatment groups. RBC values were significantly higher in T2 group than T1 dietary group. This could be due to high content of iron in Moringa leaf meal helps in rapid multiplication of Red Blood Cells (RBC). RBC are responsible for the transportation of oxygen and carbon dioxide in the blood as well as manufacture of haemoglobin hence higher values indicate a greater potential for this function and a better state of health. The recorded RBC values in the present study were within the normal range of 8-10^6/cumm (Swensen and Ithane, 1984). Similar results were reported by Asaolu *et al.* (2012b), Babeker and Bdalbagi *et al.* (2015) and Jiwuba *et al.* (2016) when goats are fed with Moringa based diets. The results obtained in the present investigation are in disagreement with Syed Ali (2017) who reported a non-significant increase in RBC when goats are fed with Moringa leaves.

5.2.6.3 PCV (%)

The observed PCV values were relatively higher in T2 and T3 groups when compared to T1 group and the same was ranged between 21.83 to 24.16 % across the treatment groups. The PCV values were with the normal range of 20-40% (Jain, 1986). PCV indicate the capability of RBC to deliver oxygen to the tissues and high PCV values have been regarded assign of healthy and high productive animals. This result is comparable with the values obtained by Syed Ali (2017) and Padma Meel (2108) whereas Damor *et al.* (2017b), Fadiyimu (2010) and Asaolu *et al.* (2012b) reported significantly higher PCV values when different levels of Moringa fed to the animals.

5.2.6.4 Haemoglobin (%)

The hemoglobin values were significantly (P<0.05) higher in lambs fed with diet containing 25% (T2 group) when compared to control (T1 group) and T3 group was comparable with 50% moringa leaf supplemented lambs (T3 group). This could be due to high content of iron in Moringa leaf meal helps in more synthesis of haemoglobin. The haemoglobin concentration was within the normal range of 8-16 (Dhanotiya, 2004) it is opined that dietary treatment seemed to be capable of supporting high oxygen carrying capacity of blood in growing lambs due to presence of high iron content in the Moringa leaves.

These results are in agreement with the findings of Asaolu *et al.* (2012b) and Babeker and Bdalbagi (2015) who reported significant difference in Hb levels when goats were fed with MMNB and different levels of Moringa leaves, respectively. In

contrast to these findings, Fadiyimu (2010), Jiwuba *et al.* (2016), Syed Ali (2017) and Padma Meel (2108) had reported a non-significant increase in Hb level.

5.2.6.5 Erythrocytes and Leucocytes Indices

The Mean corpuscular volume (MCV) was significantly higher in Moringa based ration (T1) than the control group lambs. This could be due to beneficial effect of *M. olifera* on haematological parameters. The present findings are in agreement with Fadiyimu (2010), Babeker and Bdalbagi (2015) who reported the significant difference in MCV values when rams and Sudan Nubian goats, respectively fed with three different levels of *Moringa oleifera* leaves. In contrary to the present findings Syed Ali (2017) had recorded non-significant values in MCV.

The mean values recorded for MCH was relatively higher in Moringa based rations than the control group lambs and this could be due to beneficial effect of M. olifera on haematological parameters. Similar findings were reported by Fadiyimu (2010) and Syed Ali (2017). In contrast to the present results, Babeker and Bdalbagi (2015) reported significant difference in MCH values when Sudan Nubian goats fed with three different levels of *Moringa oleifera* leaves.

The mean corpuscular haemoglobin concentration (MCHC) values were also relatively high in Moringa based rations than the control group lambs. This could be due to beneficial effect of *M. olifera* on haematological parameters. The present findings were corroborated with findings of Fadiyimu (2010) and Syed Ali (2017). Incontrast to the present results, Babeker and Bdalbagi (2015) reported significant difference in MCHC values when Sudan Nubian goats fed with three different levels of *Moringa oleifera* leaves.

Feeding of Moringa based rations in semi-intensive system had no significant effect on all leucocyte indices except lymphocytes ($P<0.05$) in lambs at the end of the experiment. This could be due to beneficial effect of *Moringa olifera* on haematological parameters. It suggests that immune system of lambs was in ideal state as apparent from normal concentration of Differential Leukocyte Count (DLC) in experimental lambs. The observations indicated that, *Moringa oleifera* based concentrate rations boosts immune system of lambs. Similar findings were reported by Babeker and Bdalbagi (2015), Syed Ali (2017) and Manmohan Kumar *et al.* (2018).

5.2.7 BLOOD BIOCHEMICAL PARAMETERS

5.2.7.1 Total Protein (g/dl)

The total protein concentration increased during the experimental period in all the experimental group lambs. The observed total protein concentration was

significantly (P<0.05) higher in T2 group than control group (T1) and no difference was observed between T2 and T3 groups, however, it was within the normal range of 6.0 to 7.9 (g/dl) (Dhanotiya, 2004). This could be due to that Moringa contains several antioxidants, which increases blood total protein by decreasing corticosterone secretion and limiting protein catabolism. Further, presence of some phyto-chemicals in Moringa leaves are beneficial as they impact some qualities of rumenun degradable protein, thus improving protein availability and utilization (Garg *et al.*,1992). These results are comparable to the normal range of goats (6.4-7g/dl) reported by Dhanotiya (2004). In the present experiment, all the experimental diets had met the protein requirements of lambs, hence, it was reflected in their levels. Similar results were reported by Azzaz *et al.* (2016), Damor *et al.* (2017) and Kholif *et al.* (2017) and Padma Meel (2018). In contrast to the present findings, Ahmad *et al.* (2017), Syed Ali (2017) and Yusuf *et al.* (2017) reported non significant difference on total protein level. Similarly, Manmohan Kumar *et al.* (2018) reported non-significant effect of feeding Moringa based ration in goats reared under semi-intensive system.

5.2.7.2 Serum Albumin (g/dl)

The analysis of the data presented in Table 47 indicated that, the mean serum albumin levels of Deccani lambs were numerically higher for T2 and T3 groups than control group in intensive farming system. Supplementation of Moringa resulted in increased serum albumin content as it contains several antioxidants which may results in better immune response. Similar results were reported by Manmohan Kumar *et al.* (2018) in an experiment where in female black Bengal goats fed with different levels of Moringa leaves in semi intensive system. Babeker and Bdalbagi (2015) Damor *et al.* (2017) observed significant difference in serum albumin levels when goats fed with different levels of Moringa leaves, with the present results.

5.2.7.3 Serum Glucose (mg/dl)

Feeding of Moringa based rations lowered the serum glucose concentration at the end of experiment when compared to the start of experiment, however the differences were non-significant. The concentration of serum glucose was non-significantly lower in T2 and T3 group lambs when compared with T1 group lambs. This could be due to presence of flavonoids in the Moringa leaf which inhibits alpha-amlylase activity to regulate the amount of glucose in the blood. Further, higher thyroid hormones and associated increased basal metabolic rate and physiological activities also reduce serum glucose concentration. The observed glucose concentration in the present study was within the normal range of 50-75mg/dl (Dhanotiya, 2004).

The present results are in agreement with Damor *et al.* (2017), Syed Ali (2017) and Padma Meel (2018) who reported non significant effect feeding different levels of Moringa leaves in goats. Similarly, Manmohan Kumar *et al.* (2018) also reported same result when female black Bengal goats were fed with different levels of Moringa leaves in semi-intensive system. In contrary to present findigs, Azzaz *et al.* (2016) and Kholif *et al.* (2017) reported a significant effect of feeding Moringa based diets on serum glucose concentration.

5.2.7.4 Serum Glutamic Oxaloacetic Transaminase (IU/dl)

No significant difference was observed in Serum Glutamic Oxaloacetic Transaminase (SGOT) when the growing lambs fed with experimental rations in semi-intensive farming system. The SGOT values are within the normal range of 32-84IU/dl (Dhanotiya, 2004) which indicated that there was no adverse effect on liver function in lambs fed MLM based concentrate mixtures. Similar values were reported by Azzaz *et al.* (2016), Syed Ali. (2017) Kholif *et al.* (2017) and Yosuf *et al.* (2018). In contrary to the present findings Ahmad *et al.* (2017) and Damor *et al.* (2017) reported a significant effect with *Moringa oleifera* leaves. Similarly, Manmohan Kumar *et al.* (2018) reported a significant effect ($P<0.05$) of feeding Moringa based ration in goats reared under semi-intensive system.

5.2.7.5 Serum Glutamic Pyruvate Transaminase (IU/dl)

Statistical analysis of the data shown in Table 47 revealed no significant difference in Serum Glutamic Pyruvate Transaminase (SGPT) concentration when the experimental diets were fed to lambs in semi-intensive farming system and within the normal range of 2.0-7.5 IU/dl (Ramesh Kumar *et al.*, 2003). However, slight increase was observed in *Morinaga oleifera* leaf meal supplemented lambs (T2 and T3) at the end of experiment when compared to the start of experiment. It could be due to hepato protective nature of *Morinaga oleifera*, as the liver supposed to release SGPT when it get damaged. The normal range of these enzymes was also indicative that the animals are free from disease and morbid condition.

The present results are in agreement with Syed Ali (2017) and Damor *et al.* (2017) and disagreement with Kholif *et al.* (2016) and Yusuf *et al.* (2017). Manmohan Kumar *et al.* (2018)) reported a significant effect ($P<0.05$) of feeding Moringa based ration in goats reared under semi-intensive system.

5.2.8 NUTRIENT DIGESTIBILITY

5.2.8.1 Dry Matter Digestibility

The dry matter digestibility coefficient (%) was non-significantly higher in T2and T3 than T1 group. Among the Moringa leaf meal supplemented lambs, T2 lambs showed relatively higher (62.61±1.05) dry matter digestibility coefficient than T3 (61.23±1.32). Higher digestibility of Moringa supplemented diets could be due to low structural carbohydrates and good quality protein. The results obtained in the present study are corroborated with the finding of Manh *et al.* (2005), Sultana *et al.* (2015), Zinder *et al.* (2016) Syed Ali (2017) who observed that the DM digestibility is did not significant with increased levels of Moringa leaves in concentrate mixture. Similarly, Sarwatt *et al.* (2002) observed an inconsistent trend in the digestibility of nutrients with increasing levels of *Moringa oleifera* leaf as a substitute to sunflower seed cake in goats fed a basal diet of *Chlorias gayana*. Fadiyim *et al.* (2010), Tona *et al.* (2014) and Kholif *et al.* (2017) had reported contrasting results to the present findings.

5.2.8.2 Organic Matter Digestibility

Feeding of *Moringa oleifera* based diets had no significant effect on the organic matter digestibility in the semi-intensively reared lambs. Organic matter digestibility coefficients (%) were numerically higher in T2 and T3 groups than T1 group. Sánchez et al. (2006a) reported that increasing level of moringa leaves supplementation in dairy cows fed low quality feed improved digestibility of all nutrients as it is rich in minerals, antioxidants and high-quality protein. The obtained values were in agreement with the finding of Gebregiorgis *et al.* (2011), Tona *et al.* (2014) and Sultana *et al.* (2015) who reported non-significant effect of Moringa leaves inclusions in dietary treatments. In contrary to the present results Fadiyimu *et al.* (2010), Mahmoud (2013), Azzaz *et al.* (2016) and Kholif *et al.* (2017) reported that OM digestibility was significant when different levels of Moringa leaves were included in the rations.

5.2.8.3 Crude Protein (CP) Digestibility

The CP digestibility was numerically higher in T2 and T3 groups when compared to control group, however, no significant difference was found among treatment groups. Among the *Moringa oleifera* leaf meal supplemented lambs, T2 lambs showed relatively higher CP digestibility coefficient than T3. Higher crude protein digestibility coefficient (%) in Moringa supplemented groups could be due to the presence of high-quality protein in the Moringa Leaves. Similar results were reported by Sultana *et al.* (2015), Zinder *et al.* (2016) and Syed Ali (2107). The present

results are disagreement with the observations of Fadiyim *et al.* (2010), Tona *et al.* (2014), Ahmad *et al.* (2017) and Kholif *et al.* (2017).

5.2.8.4 Crude Fibre (CF) Digestibility

The observed crude fibre digestibility was numerically higher in T2 and T3 groups than control group, however, no significant difference was found in between treatment groups. Among the Moringa supplemented lambs, T2 lambs showed relatively higher CF digestibility coefficient than T3 lambs. The higher CF digestibility in T2 and T3 equally suggests an increase in the activities of fibrolytic bacteria in the rumen probably as a result of the availability of essential nutrients especially protein, energy and minerals in balanced proportions. The obtained value is in line with the finding of Akinyemi *et al.* (2010) Sultana *et al.* (2015), Oyedele *et al.* (2016) and Syed Ali (2107). Fadiyim *et al.* (2010), Tona *et al.* (2014) and Kholif *et al.* (2017) reported dissimilar results.

5.2.8.5 Ether Extract (EE) Digestibility

There was no significant difference in the ether extract digestibility among the three experimental diets. But the lambs fed with diets containing MLM in concentrate mixture shown higher ether extract digestibility coefficient. The higher EE digestibility in T2 and T3 could be due to increased ruminal microflora as a result of the availability of all the essential nutrients especially protein, energy and minerals in balanced proportions through Moringa leaf meal. Similar results were reported by Akinyemi *et al.* (2010), Naula *et al*. (2006), Azzaz *et al.* (2016) and Syed Ali (2017), Fadiyim *et al.* (2010), Tona *et al.* (2014), Ahmad *et al.* (2017) and Kholif *et al.* (2017) reported contrast results.

5.2.8.6 Nitrogen Free Extract (NFE) Digestibility

The Nitrogen free extract digestibility coefficient (%) found to be non-significantly higher in the T2 group and lowest in T1 group. The higher NFE digestibility in Moringa based groups could be due to supply of essential nutrients especially protein, energy and minerals in balanced proportions through Moringa leaf meal. The present result is in accordance with Kholif *et al.* (2015), Syed Ali (2017) and Jagritisrivastav (2019). Fadiyimu (2010), Azzaz *et al.* (2016), and Kholif *et al.* (2017) reported a significant effect of feeding Moringa based diets on NFE digestibility.

5.2.8.7 Neutral Detergent Fibre (NDF) Digestibility

The observed neutral detergent fibre digestibility was statistically significant ($P<0.05$) among the treatment groups. Higher NDF digestibility was observed in T2 group lambs which was comparable with T3 group and lower NDF digestibility was

noticed in T1 group lambs which also comparable with T3 group (Table 48). The higher NDF digestibility in T2 and T3 could be due to an increase in the activities of fibrolytic bacteria in the rumen probably as a result of the supply of essential nutrients especially protein, energy and minerals in balanced proportions through Moringa leaf meal. These results are corroborated with the findings of Kholif *et al.* (2017) and dissimilar with Naula *et al.* (2006), Akinyemi *et al.* (2010) and Kholif *et al.* (2016).

5.2.8.8 Acid Detergent Fibre (ADF) Digestibility

Acid Detergent Fibre digestibility coefficient (%) was significant (P<0.05) among the treatment groups. Higher ADF digestibility was observed in T2 group lambs which was comparable with T3 group and lower ADF digestibility was noticed in T1 group lambs which also comparable with T3 group (Table 48). It could be due to the higher rumen microbial activity and availability of digestible cellulose from ADF of moringa foliage to the lambs. Similar result was reported by Mahmoud (2013) who found a significant (P<0.05) difference in ADF between the Moringa supplemented groups in growing lambs. In contrast to this Manh *et al.* (2005), Naula *et al.* (2006) and Akinyemi *et al.* (2010) reported higher values for ADF digestibility when increasing inclusion level *Moringa oleifera*.

5.2.9 FAECAL CONSISTANCY SCORE (FCS)

Faecal consistency is used as a tool to assess how a diet is digested and overall animal health. Statistical analysis of the data in Table 49 revealed that faecal consistency score was significantly (P<0.01) effected by feeding three treatment rations. FCS is significantly higher in supplemented groups (T2 and T3) compared to T1 group sheep in semi-intensive farming system. Among the supplemented, T2 has relatively higher FCS indicating more supplementation has some negative effect due to present of tannins and poly phenals. Similar finding was observed by Bhavna Aharval *et al.* (2018) when buffalo calves were fed with *Moringa oleifera* leaf meal at 10 % level in the concentrate mixture during the preweaning period.

5.2.10 CARCASS CHARACTERISTICS

5.10.1 Live weight carcass weight and dressing percentage

Pre-slaughter weight and empty live weight were non-significantly (P>0.05) higher in lambs fed with 25% Moringa group (T1) than T3 and T1 groups while hot carcass weight was numerically higher in T3 groups when compared with T2 and T1 groups. There was a non-significant difference (P>0.05) in dressing percentage on pre slaughter weight and empty live weight basis in all three treatment groups. However,

the T2 group had numerically higher dressing percentage (67.5 ±1.39) on empty live weight compared to T1 (60.0±1.40) and T3 (62.46 ±8.09) groups (Table 50). Lower gut fill resulted in higher empty live weight and hot carcass weights in Moringa based rations.

A non-significant difference was observed among the treatment groups for weights of liver, kidney, heart, and testis. The weight of head, leg, skin, blood, lung, stomach was non-significant in all the treatment groups. However, relatively higher edible and non-edible offal weights were observed with Moringa based rations supplemented lambs (T2 and T3). It could be due to higher digestibility of nutrients and better feed efficiency of Moringa leaf meal supplemented diets. Similar result was reported for hot carcass weight and edible organ weights by Busani Moyo *et al.* (2011) when crossbred Xhosa lop-eared goats were fed with Moringa Oleifera leaves. In contrary to the present findings, Kochewad *et al. (*2017) reported significant ($P<0.05$) difference in preslaughter weight, empty live weight, hot carcass weight, dressing percentage on pre slaughter weight and empty live weight, edible and non-edible weights in Decani lambs when reared in three different farming systems.

5.2.11 COST OF PRODUCTION

The total cost and cost of production per one kg of meat was lower in T2 and T3 group lambs which received concentrate mixture containing *Moringa oleifera* than control group lambs. It could be due to higher digestibility of nutrients and better feed efficiency of supplemented diets in addition to the lower cost of production of Moringa leaf meal in the present study. Thus, results indicated the improvement in profit on replacement of GNC in concentrate mixture with *Moringa oleifera* leaf meal in lambs' rations. Adegun and Aye (2013), Syed Ali (2017) and Haridas (2018) reported significant reduction in cost per kg live weight gain with increasing level of *Moringa oleifera.*

CHAPTER-VI

SUMMARY

The research work was designed to assess the effect of feeding Moringa (*Moringa oleifera*) leaf meal-based diets on productive performance, body condition score, haemato, biochemical parameters, feeding behaviour, faecal consistency score, carcass study and cost economics of growing Deccani lambs in two experiments i.e., in intensive and semi-intensive farming systems. Three experimental diets were prepared using 100 percent groundnut cake (T1), 75% groundnut cake+ 25% *Moringa oliefera* leaf meal (T2) and 50% groundnut cake+ 50 % *M. oliefera* leaf meal (T3) as protein source in the concentrate mixture and offered @ 1% of body weight along with *ad libitum* green fodder. In experiment 1, eighteen growing Deccani sheep of uniform body weight (14.22 ± 1.5 kg) were selected and randomly allotted to three treatment groups with six lambs in each group (6 x 3) and reared under intensive farming system at LFC, Rajendranagar for 90 days. Similarly, in experiment 2, eighteen growing Deccani lambs of uniform body weight (18.83 ± 0.97 kg) were selected from Animal Experiment Farm of ICAR-CRIDA and randomly allotted to three treatment groups with six lambs in each group (6 x 3) and reared under semi-intensive farming system at Animal experimental farm, CRIDA campus, Hayathnagar, Hyderabad for 90 days.

In intensive system, the growth trial was conducted for a period of 90 days and the body weights were recorded at fortnightly intervals. Statistical analysis of the data revealed that there was no significant difference in the fortnightly body weights of the lambs from 1st to 6th fortnights among three treatment groups. The observed average total weight gain of growing Deccani lambs was was 7.7 ±0.26, 9.13 ±0.24 and 8.67 ±0.25 kg in T1, T2, T3 groups, respectively. Highest body weight was observed in T2 (M25%) group and lowest in T1 (M0%) group throughout the experiment. The average ADG was 85.55±2.98, 101.50 ±3.01 and 96.29 ±2.83 g for groups T1, T2 and T3, respectively. Total weight gain and average daily gain were significantly ($P<0.01$) higher in T2 group lambs fed with 25% MLM based diet which was comparable to that of T1 and T3 groups. The mean values for daily DMI (kg/day and kg/100 kg body weight) are found to be 0.82±0.044, 0.88±0.069 and 0.86±0.081, 3.77±0.031, 3.82 ±0.045and 3.78, ±0.078 respectively in T1, T2 and T3 groups. The daily average dry matter intake (DMI) per 100 kg body weight was comparatively higher in Deccani lambs fed with T2 and T3 diets. The FCR ranged from 8.67 to 9.58 in intensive farming

system. There was no significant difference in FCR among the three dietary groups. The highest FCR (lower value) was observed in T2 (25% ML) and lowest FCR (higher values) was observed in T1 (0% ML).

The fortnightly biometric measurement findings in intensive farming systems indicated that the mean fortnight body length, face length and hip width of growing Deccani lambs increased linearly throughout the experimental period and had a significant difference ($P<0.05$) among the treatments while the height at wither, chest girth and tail length showed non-significance difference between the groups. However, the final gain height at wither, chest girth and tail length were higher in Moringa based groups (T2 &T3) than T1 treatment groups.

The body condition score was significantly ($P<0.05$) affected in lambs by feeding three experimental diets from 3rd to 6th fortnights whereas in 1st and 2nd fortnight there was no significant difference among the treatment groups in intensive system. The final body condition score was significant ($P<0.05$) among the three treatment groups. Significantly ($P<0.05$) higher BCS was observed in T2 group lambs than T1 group lambs from 3rd to 6th fortnight. Positive and highly significant correlation was observed between body weight and all the body measurements in three treatment groups. Significantly ($P<0.05$) higher coefficient of determination was found between body weight and chest girth compared to other body measurements in intensive farming system.

T2 group lambs had shown high pulse rate throughout the experiment than T1 group lambs and there was no significant difference between T2 and T3 all fortnights. Similarly, feeding of three treatment diets also significantly ($P<0.01$) effected the overall mean pulse rate in lambs. The pulse rate was significantly higher in T2 than T3 and T1 group lambs, however it is in within the physiological limits. The observed mean final respiration rate (bpm) was 28.5 ±0.42, 32.33 ±0.71 and 30.16 ±0.40 and the overall mean reparation rate (bpm) was 25.87 ±0.67, 29.78 ±0.64 and 29.18 ±0.39 for T1, T2 and T3 treatment groups, respectively. The overall mean respiratory rate was relatively higher in lambs fed with Moringa based diets (T2 &T3) than control (T1), however it was within the normal physiological limits in both farming systems.

The observed mean rectal temperature was relatively higher in T2 and T3 groups compared with T1 group, however, it was within the normal physiological limits in all the three treatment groups in both intensive and semi-intensive farming system.

The WBC and RBC levels observed to be significant ($P<0.01$) among three treatment groups. The WBC and RBC values were significantly ($P<0.01$) higher in

T2 dietary group, whose values were comparable to T3 group. The lowest RBC values were noticed in T1 dietary group and the values were also comparable with T3 group. Haemoglobin levels among experimental diets was non-significant (P>0.01) and the mean P C V values ranged between 22.33 to 24.99% at the end of the experiment. The recorded PCV value in T2 group was significantly higher (P<0.05) and the values were comparable among the supplemented T3 and T2 group lambs. The observed PCV values were relatively higher in T2 and T3 groups when compared to T1 group.

The values of all leucocyte indices were statistically non-significant (P>0.05) among the three treatment groups after the end of experiment. Highest lymphocytes were found in T3 group than T2 group and comparable with T1 dietary group.

The total protein concentration was 7.04±0.15, 7.85±0.13 and 7.41±0.10 at the end of the experiment. The observed total protein concentration was significantly (P<0.0, 0.05) higher in Moringa based groups (T2 &T3) than control group (T1). The observed serum albumin, globulin and glucose values were numerically higher in T2 group. The mean values for Serum Glutamic Oxaloacetic Transaminase and Serum Glutamic Pyruvate Transaminase were non-significant, it indicates that feeding of Moringa based diets in lambs did not cause any effect on liver functions.

At the end of growth trial, a digestibility trial was conducted in the same experimental group of growing Deccani lambs to study the nutrient utilization of test and control diets in intensive farming systems. The digestibility coefficients (%) of DM, OM, C.P, C.F and E.E were non-significant (P>0.05) among different treatments. NFE digestibility coefficient (%) was statistically significant (P<0.01) in intensive farming system. The ADF and NDF digestibility coefficients (%) were non-significant among the three treatment diets.

Time spent and percentage of total time spent on eating and sleeping were significantly (P<0.01) higher in T2 group lambs than T3 and T1 group lambs and no significant difference was noticed between T1 and T3 group lambs. More time spent in eating in T2 group indicate that the Moringa based diet (25%) was relatively more palatable than the other two groups.

The fecal consistency score was significantly (P<0.01) higher in the T2 groups when compared to the control (T1) group. T3 group had no significant difference with T1and T2 groups. This indicated that feeding of Moringa based diets significantly affected the faecal consistency of Deccani lambs in the present study.

At the end of growth trial, three growing male lambs from each test group slaughtered to study carcass characteristics. No significant difference was

observed for the pre slaughter weight, empty body weight, hot carcass weights and dressing percent among the three groups. T2 group lambs had numerically higher dressing percentage (63.3±4.48) on empty live weight compared to T1 (59.34±1.38), and T3 (61.8±3.23) group in intensive farming system. A non-significant difference was observed for edible and non-edible offals. The carcass characteristics were superior in lambs fed with MLM 25% based diet compared with MLM50% and MLM0% diets in intensive farming systems.

The average feed cost per kg body weight gain in growing Deccani lambs Rs 128.18/-, 108.83/- and 119.41/ in intensive farming system. The average feed cost per kg body weight gain in growing Deccani lambs fed with MLM 25% diet was found to be more economical than MLM 0% diet in the intensive farming systems.

In semi-intensive system the growth trial was conducted for a period of 90 days and the body weights were recorded at fortnightly intervals as well.

The fortnightly body weights and average daily gain were showed non - significant difference in the lambs from 1st to 6th fortnights among three treatment groups. The total gain in body weight (kg) was 7.22 ±0.58, 8.33 ±0.48 and 7.66±0.54 in lambs fed with T1, T2 and T3 diets, respectively. There was no significant difference in total weight gain (kg) among the treatment group lambs, however total weight gain (kg) was higher in Moringa supplemented group lambs (T2 and T3) when compared to T1. The ADG (g) was 80.20 ±6.47, 92.60 ±5.07 and 85.11±6.10 g in T1, T2 and T3 groups, respectively. The average DMI per 100 kg body weight were 3.95±0.03, 4.21±0.06 and 4.01±0.05 kg, respectively for T1, T2 and T3 group lambs. T2 group lambs had a significantly higher DMI (kg/100 kg body weight) compared to T1 and T3 groups and there was no significant difference between T1 and T3 groups

The FCR ranged from 12.31 to 12.71 in semi-intensive farming system. There was no significant different in FCR among the lambs fed on three experimental diets. The highest FCR (lower value) was observed in T2 (25% MLM) and lowest FCR (higher values) was observed in T1 (0% MLM) in semi-intensive system.

The fortnightly biometric measurement findings indicated that the mean fortnight body length, face length and hip width of growing Deccani lambs increased linearly throughout the experimental period and had significance difference ($P<0.05$) among the treatments while the height at wither, chest girth and tail length showed non-significance difference between the groups. However, the final gain in height at wither, chest girth and tail length were higher in Moringa based groups (T2 and T3) than T1

treatment groups. From 1st to 5th fortnightly mean biometric measurements of growing Deccani lambs increased linearly throughout the experimental period.

The body condition score was significantly (P<0.05) affected in 5th fortnight and final BCS while it was non-significant from 1st and 4th fortnights among the treatment groups. The final body condition score was significant (P<0.01) among the three treatment groups. Significantly (P<0.01) higher BCS was observed in T2 and T3 group lambs when compared to T1. Positive and highly significant correlation was observed between body weight and all the body measurements in three treatment groups. Significantly (P<0.05) higher coefficient of determination was found between body weight and height at withers compared to other body measurements in semi-intensive farming system.

Pulse rate was significantly (P<0.01, 0.05) different during the experimental period in all fortnights under the semi-intensive farming system. The pulse rate was significantly higher in T2 and T3 than T1 group lambs, however it was in within the physiological limits.

The observed mean final respiration rate (bpm) was 32.66 ±0.33, 34.16 ±0.51 and 33.16 and the overall mean reparation rate (bpm) was 28.04 ±0.69, 30.54 ±0.78 and 29.59 ±0.62 for T1, T2 and T3 treatment groups, respectively in semi-intensive system. The overall mean respiratory rate was relatively higher in lambs fed with Moringa based diets (T2 &T3) than control (T1), however it was within the normal physiological limits in both farming systems.

The observed mean rectal temperature was relatively higher in T2 and T3 groups compared with T1 group, however, it was within the normal physiological limits in all the three treatment groups semi-intensive farming system.

The WBC and RBC levels observed to be significant (P<0.01) among three treatment groups. The WBC and RBC values were significantly (P<0.01) higher in T2 dietary group, whose values were comparable to T3 group. The lowest RBC values were noticed in T1 dietary group and the values were also comparable with T3 group. Haemoglobin levels was significant (P<0.01) among the treatment groups in semi-intensive system. The observed PCV values were relatively higher in T2 and T3 groups when compared to T1 group and the same was ranged between 21.83 to 24.16% in semi-intensive system.

The mean lymphocytes (%) values at the end of the experiment were 60.66±0.42, 63.00±0.68 and 61.83±0.60 in T1, T2 and T3 groups, respectively. The lymphocyte values were significant (P<0.05) among the three treatment groups at the

end of the experiment. The other leucocyte indices were statistically non-significant among the three treatment groups after end of the experiment.

The total protein concentration was 6.97 ±0.29, 7.09 ±0.32 and 6.98 ±0.19 for T1, T2 and T3 test diets, respectively in semi-intensive system. The observed total protein concentration was significantly ($P<0.05$) higher in T2 group than control group (T1) and no difference was observed between T2 and T3 groups. The observed serum albumin, globulin and glucose values were numerically higher in T2 group. The mean values for Serum Glutamic Oxaloacetic Transaminase and Serum Glutamic Pyruvate Transaminase were non-significant, it indicates that feeding of Moringa based diets in lambs did not cause any effect on liver functions.

At the end of growth trial, a digestibility trial was conducted in the same experimental group of growing Deccani lambs to study the nutrient utilization of test and control diets in intensive and semi-intensive farming systems. The digestibility coefficients (%) of DM, OM, C.P, C.F and E.E were non-significant among different treatments semi-intensive farming system. NFE digestibility was non-significant. The ADF and NDF digestibility coefficients (%) were significant ($P<0.05$) among the three treatment diets. The NDF and ADF digestibility ranged from 69.05 to 71.34 and 64.77 to 68.39 in T1, T2 and T3 groups, respectively in semi-intensive system.

Faecal consistency score value was significantly ($P<0.05$) higher in T2 group than T1 group. This indicates that feeding of Moringa based diets significantly affected the faecal consistency of Deccani lambs in the present study.

At the end of growth trial, three growing male lambs from each test group slaughtered to study carcass characteristics. No significant difference was observed for the pre slaughter weight, empty body weight, hot carcass weights and dressing percent among the three groups. T2 group had numerically higher dressing percentage (67.5 ±1.39) on empty live weight compared to T1 (60.0±1.40), and T3 (62.46 ±8.09) groups in semi-intensive farming system. A non-significant difference was observed for edible and non-edible offals. The carcass characteristics were superior in lambs fed with MLM 25% based diet compared with MLM50% and MLM0% diets in semi-intensive systems.

The average feed cost per kg body weight gain in growing Deccani lambs was Rs 110.55/-, 95.00/- and 105.00/- for T1, T2 and T3 dietary groups, respectively in semi-intensive farming system. The average feed cost per kg body weight gain in growing Deccani lambs fed with MLM 25% diet was found to be more economical.

Keeping in view of the present findings the following conclusions can be drawn

1. *Moringa oliefera* had a crude protein content of 24.39% on DB basis. Hence, it could be considered as an alternative proetein source for sheep feeding.
2. Body weight and average daily gains were higher in lambs fed with 25% of *Moringa oliefera* leaf meal under both farming systems while, the observed FCR was non-significantly higher with 25% of *Moringa oliefera* leaf meal in both farming systems.
3. The dry matter intake was significantly higher in lambs fed with 25% of *Moringa oliefera* leaf meal under both farming systems.
4. Biometric measurements, body condition score and fecal consistency scores were non-significantly higher in lambs fed with 25% of *Moringa oliefera* leaf meal compared with other two diets under both farming systems.
5. Feeding of *Moringa oliefera* leaf meal didn't affect the albumin, glucose SGOPT and SGPT levels in lambs reared in both farming systems. This indicate that feeding of *Moringa oliefera* leaf meal had no effect on the health of the lambs.
6. Digestibility co-eeficients (%) of DM, OM, CP, CF and EE were non-significantly increased in *Moringa oliefera* leaf meal-based diets in both farming systems.
7. The carcass tarits observed to be relatively higher in the lambs fed with 25% of *Moringa oliefera* leaf meal-based diet.
8. The average feed cost per kg body weight gain in growing Deccani lambs fed with MLM 25% diet was found to be more economical in both farming systems. Hence, it is recommended that ground nut cake in the concentrate mixture of sheep could be replaced with 25% *Moringa oliefera* leaf meal to reduce the cost of sheep rearuing.

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