EFFECT OF *MORINGA OLEIFERA* FEEDING ON PERFORMANCE OF SAHIWAL CALVES

Thesis

Submitted to the

Bihar Animal Sciences University, Patna

in partial fulfillment of the requirements for the degree of

MASTER OF VETERINARY SCIENCE

IN

LIVESTOCK PRODUCTION MANAGEMENT

By

Dr. Arjun Kumar Mandal

(VM0009/2018-2019)

BIHAR VETERINARY COLLEGE, PATNA-800014

2021

DEPARTMENT OF LIVESTOCK PRODUCTION MANAGEMENT

Bihar Veterinary College, Patna-800014
(Bihar Animal Sciences University Patna, Bihar)

CERTIFICATE- I

This is to certify that the thesis entitled, "**EFFECT OF *MORINGA OLEIFERA* FEEDING ON PERFOMANCE OF SAHIWAL CALVES"** submitted in partial fulfilment of the requirements for the award of the degree of Master of Veterinary Science in the discipline of **Livestock Production Management** of the faculty of Post-Graduate Studies, Bihar Animal Sciences University, Patna, Bihar is the bonafide research work carried out by **Dr. ARJUN KUMAR MANDAL, Registration No-VM0009/2018-19,** son of Shri. **CHANDESHWAR MANDAL**under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been fully acknowledged.

Place: Patna

Date:

Dr. Ravi Ranjan Kumar Sinha

Assistant Professor cum Jr. Scientist

Dep. of Livestock Production Management

(Major Advisor)

CERTIFICATE- II

This is to certify that the thesis entitled, "**EFFECT OF *MORINGA OLEIFERA* FEEDING ON PERFORMANCE OF SAHIWAL CALVES"** submitted by **Dr. ARJUN KUMAR MANDAL, Registration No-VM0009/2018-19,** son of **Shri CHANDESHWAR MANDAL** to the Bihar Animal Sciences University, Patna, Bihar in partial fulfilment of the requirements for the degree of Master of Veterinary Science in the discipline of **Livestock Production Management** has been approved by the Advisory Committee after an oral examination of the student in collaboration with an External Examiner.

Dr. R.R.K. Sinha **External Examiner**

Major Advisor

Asst. Prof. Dept. of LPM _____

Members of the advisory Committee

1. **Dr. S.P. Sahu**
   Assistant Professor,
   Department of LPM _____
2. **Dr. Kaushalendra Kumar**
   Assistant Professor,
   Dept. of Animal Nutrition, _____
3. **Dr. Saroj Kumar Rajak**
   Assistant Professor,
   Dept. of Veterinary Extension Education _____
4. **Dr. Pankaj Kumar Singh**
   Assistant Professor,
   Dept. of Animal Nutrition _____
   (Nominee of Dean, PGS)

Dr. S.P.Sahu **Dean Post-Graduate Studies**

Assistant Professor and Head Bihar Animal Sciences University

Department of LPM, BVC, Patna Patna-14

ACKNOWLEDGEMENT

I would like to express my deep sense of gratitude and indebtedness to my guide and major advisor, ***Dr. Ravi Ranjan Kumar Sinha,*** *Assistant Professor-cum Jr. Scientist Department of Livestock Production Management, Bihar Veterinary College, Patna, for valuable guidance, keen interest, close supervision, constant encouragement and healthy criticisms during the course of investigation. His painstaking supervision of the manuscript warrants special mention, without which this research undertaking would not have completed.*

I am highly obliged to ***Dr. S. P. Sahu,*** *Head, and Dept. of Livestock Production Management, for his useful suggestions and needful facilitation of contrivance during the course of investigation.*

I am also highly obliged to ***Dr. R. K Nirala, Dr. Amrendra Kumar, Dr. Sanjay Kumar,*** *and Assistant Professor-cum Jr. Scientist Department of Livestock Production Management.* ***Dr. Suchit Kumar, Dr. Parmod Kumar,*** *Assistant Professor-cum Jr. Scientist Livestock Farm complex and.* ***Rohit Kumar Jaiswal*** *Assistant Professor-cum Jr. Scientist Department of Livestock Products Technology for his co-operative behaviour, valuable suggestions during the research work.*

I am grateful to the other members of my advisory committee, ***Dr. S. P. Sahu*** *Assistant Professor-cum Jr. Scientist Department of Livestock Production Management,* ***Dr. Kaushalendra Kumar*** *Assistant Professor-cum Jr. Scientist Department of Animal nutrition,* ***Dr. Pankaj Kumar Singh*** *Assistant Professor-cum Jr. Scientist Department of Animal nutrition,* ***Dr. Saroj Kumar Rajak,*** *Assistant Professor-cum Jr. Scientist Deptt. of Veterinary Animal Husbandry and Extension, and* ***Dr. Ajeet kumar*** *Assistant Professor-cum Jr. Scientist Deptt. of Veterinary Biochemistry, Bihar Veterinary College, Patna, for their valuable guidance, constructive suggestions and timely help during the entire period of investigation.*

My sincere thanks are also to all Assistant Professor-cum Jr. Scientist of Bihar Veterinary college, Patna for his co-operative behaviour, valuable suggestions and moral support during the research work.

I, with great pleasure, acknowledge my thanks to ***Dr. J. K, Prasad,*** *Dean Bihar Veterinary college, Patna-14, for providing the necessary facilities during the tenure of this investigation.*

A deep sense of gratitude is expressed to Bihar Animal Sciences University, Patna, Bihar, for providing facilities to conduct this investigation.

My thanks are also extended to all the respected seniors ***Dr. Shudhanshu Pratap Singh, Dr. Sushil Kumar,*** *many colleagues like,* ***Dr. Brajesh Kumar, Dr. Dheeraj Kumar, Dr. Agyey Pusp, Dr.***

Vishnu Prabhakar, Dr. Ravi Kumar, Dr. Sudheer Kumar, Dr. Sourabh Swami, Dr. Praveen Kumar, Dr. Prakash Kr. Chaudhari, Dr. Sunil Kr. Tuddu, Dr. Pravin Kr. Sinha, Dr. Sumit Kumar, Dr. Anil Kr. Kushwaha, Dr. Shishir Kumar Thakur, Dr. Pranav Kumar, Dr. Sanjeev Kumar, Dr. D.K, Sinha, Dr. Menaka, Dr. Nitu Sourya, Dr. Richa Khushboo, Dr. Rakhi Bharti, Dr. Komal, Dr. Sangeeta, most loving junior *Dr. Nitin Kumar, Dr. Priti Ranjan, Dr. Arun kumar, Dr. Kumar, Dr. Kumari Prashansa Sinha, Dr. Sweta Kumari, Dr. Manoj Kumar, Dr. Vijay Kumar, Priynka Roy, Pankesh Kumar, Rana Pratap Singh, Ajeet Kumar, Rahul Raj, Vivek Kumar, Ranjan Kumar Singh, Pravin Kumar, Neha Ranjan* and all *other friends* who helped me directly or indirectly during my research work with a company of whom helped me to overcome the stressful moment of investigation and physically help from time to time during the course of study.

I am also thankful to the Librarian and the staff-members of the university library of the Bihar Animal Sciences University, Patna-14 for rendering their cooperation.

Thanks, are also to the non-teaching staff members Mr. Shiv jee, Mr. Mungari Lal, Mr. Binod Kumar, department of Livestock Production Management for their kind help during the research work.

Gratitude alone fails to convey my feelings which cannot be expressed in words for the affectionate care, thought fullness, moral support and encouragement constantly received from all members of my family specially My Elder father Shri Bindeshwar Mandal, my mother Smt. Ram Day Devi, my father Sri. Chandeshwar Mandal, Elder brother Arun Kumar Mandal, Laxmi Kumar Mandal, Youngest brother Kumar Sarwan, Anuj Kumar, Bhabhi Laxmi Devi, Savita Devi, Sister Babita Devi, Savita Devi and Asha Devi, nephew Jai Kumar, Alok Kumar, Aryan, Anurag for their divine support and source of inspiration during the study.

Last but not the least, I thank God for giving me patience and strength to overcome the difficulties which crossed my way in accomplishment of this endeavour.

Place _____

Date _____ **(*Arjun Kumar Mandal*)**

TABLE OF CONTENTS

LIST OF TABLES

4.4.5	Serum Creatinine (mg/dl)	
4.4.6	Blood Urea Nitrogen (mg/dl)	
4.4.7	Serum Albumin (g/dl)	
4.4.8	Total Serum protein (g/dl)	
4.4.9	Serum Globulin (g/dl)	
4.4.10	Serum Albumin: Globulin ratio	
4.5	Economics of *Moringa oleifera* feeding	
4.5.1	Feed consumption detail of Sahiwal calves	
4.5.2	Economics of feeding	

LIST OF FIGURES

4.3.4	Mean Packed cell volume (%) in Sahiwal calves	
4.4.1	Mean Serum Calcium (mmol/lit) in Sahiwal calves	
4.4.2	Mean Serum Potassium (mmol/lit) in Sahiwal calves	
4.4.3	Mean Serum Sodium (mmol/lit) in Sahiwal calves	
4.4.4	Mean Serum Glucose (mg/dl) in Sahiwal calves	
4.4.5	Mean Serum Creatinine (mg/dl) in Sahiwal calves	
4.4.6	Mean Blood Urea Nitrogen (mg/dl) in Sahiwal calves	
4.4.7	Mean Serum Albumin (g/dl) in Sahiwal calves	
4.4.8	Mean Total Serum protein (g/dl)in Sahiwal calves	
4.4.9	Mean Serum Globulin (g/dl) in Sahiwal calves	
4.4.10	Mean Serum Albumin: Globulin ratio in Sahiwal calves	

LIST OF ABBREVIATIONS AND SYMBOLS

ABBREVIATIONS	FULL FORM
ADF	Acid Detergent Fibre
ADG	Average Daily Gain
ADL	Acid Detergent Lignin
AHD	Alfalfa hay diet
AOAC	Association of Official Analytical Chemists
BUN	Blood Urea Nitrogen
C	Concentrate
CF	Crude Fibre
CFM	Concentrate feed mixture
CP	Crude Protein
CPI	Crude Protein Intake
CSC	Cotton seed cake
CPL	Cassava peels
CSR	Corn starch residues
Cu.mm.	cubic millimeter
DCP	Digestible Crude Proteins
DM	Dry Matter
DMI	Dry Matter Intake
DMOL	Dry *Moringa oleifera* leaves
EDTA	Ethylene diamine tetra acetic acid
EE	Ether Extract
et al.,	Co-workers

FAO	Food and Agriculture Organization
FCR	Feed Conversion ratio
fL	Femtoliter
g	Gram
G	Gliricidia
g/dl	gram per decilitre
GMNB	*Gmelina arborea* multi nutrient blocks
GGT	Gama glutamyle transferase
GH	Grass hay
GNH	Groundnut hay
GLI	*Gliricidia sepium*
GOI	Government of India
Hb	Hemoglobin
HM	High *Moringa oleifera*
I.C.A.R	Indian Council of Agriculture Research
ICMR	Indian Council of Medical Research
Kg	Kilogram
L	Litre
LW	Live weight
LEU	*Leucaena leucocephala*
LM	Low *Moringa oleifera*
M	Moringa
MF	Moringa forage
mg/dl	Milligrams per decilitre
ml	Millilitre

MLM	*Moringa oleifera* leaf meal
MMNB	Moringa multi nutrient block
MOD	Moringa leaves diet
MOH	*Moringa oleifera* hay
MOLM	*Moringa oleifera* leaf meal
MOLP	*Moringa oleifera* leaf powder
M. oleifera	*Moringa oleifera*
MOLSTL	*Moringa oleifera soft twigs and leaves*
MPSL	*Moringa oleifera* pods, stems and leaves
MSH	*Medicago* sativa hay
n	No of sample
NM	No *Moringa oleifera*
NS	Non-Significant
NDF	Neutral Detergent Fibre
NFE	Nitrogen Free Extract
OM	Organic Matter
PCV	Packed Cell Volume
Pg	Picogram
PI	Performance index
RBC	Red Blood Cell
RP	Range plant
S.E.	Standard Error
SC	Sunflower cake
SSC	Sunflower seed cake

SNF	Solid Not Fat
TA	Total Ash
TDN	Total Digestible Nutrients
TEC	Total Erythrocyte Count
TLC	Total Leukocyte Count
TMNB	*Tithonia diversifolia multi-nutrient blocks*
TMR	Total Mix Ration
T_0	Control Group
U/L	Unit per Liter
Viz	Namely
WAD	West African Dwarf
WBC	White Blood Cell
Wt.	Weight
<	less than
>	more than
%	Percentage
($p<0.05$)	Significant at 5 % level
($p<0.01$)	Significant at 1 % level
($p<0.10$)	Significant at 10% level
@	At the rate
°C	Degree centigrade
@	At the rate

1 INTRODUCTION

Livestock sector is the major areas, which contribute significantly in agriculture and allied sectors. It plays a vital role with an annual contribution in total GDP of 4.1% at current prices during 2019-2020. In 20th Livestock Census, Cattle and Buffalo contributes 35.94% and 20.45%; respectively in total livestock population in India. Total livestock population in India is 535.78 million among that Cattle population is 192.49 million and buffalo population is 109.85 million in 2019, showing increase of 0.8% and 1%; respectively over previous census (20th Livestock Census, GoI, 2019).The milk production which is envisaged to be 254.55 Million MT by 2021-22 and 300 Million MT by 2023-24 from existing 163.7 Million MT will be requiring an annual growth rate of 9.2%. This would lead to increase in per capita availability of milk from current level of 352 grams per day to 515 and 592 grams per day in 2021-22 and 2023-24; respectively (adjusted for population growth) addressing the substantial nutritional requirement of growing population. To achieve the desired milk production targets, average in-milk animal productivity would also be required to grow annually at the rate of 4.7% to 6.14 Kg/day by 2021-22 and 6.7 Kg/day by 2023-24 from existing 4.65 Kg/day in 2015-16 (National Action Plan for Dairy Development, Vision-2022).

Bihar stands 9th position with annual production of 9.81 million MT milk among states in India with per capita availability of 251 gm per day (NDDB, 2019). Furthermore, Bihar is having 15.3 million Cattle and 7.7 million buffalo in total livestock basket (20th Livestock Census, GoI, 2019). With the shrinking cultivable land and further lesser interest on fodder production, country is not sufficient to meet the fodder requirement for livestock and also the forages offered are mostly of poor quality. India is deficient in the supply of fodder, resulting in very low levels of productivity that limit marketable surplus of milk. In Bihar State, over 50% of the land area is planted to rice and rice straw along with wheat straw and some pulse residues form the main animal feeds. Recent studies in the Indo-Genetic Plain have highlighted the problem of insufficient fodder and the poor nutritive value of fodder, a problem which becomes more acute in the more Eastern parts of the region where agricultural resources, particularly arable land and water, become scarcer. This fodder scarcity affects most farmers but is particularly acute for landless and those with access to only small area of land (Singh *et al*., 2013).

The working group on Animal Husbandry and Dairying foresees that at national level there would be a gap of about 65% between the demand and supply of green fodder and 25%

for dry fodder by the year 2025. These gaps are even more alarming in Bihar. The estimated annual requirements of concentrates, dry fodder and green fodder for the livestock in Bihar are 5.9 million tonnes, 24.8 million tonnes and 38.2 million tonnes; respectively. In contrary the state is able to meet only 85% of its requirements of dry fodder and 4.4% of green fodder (Singh *et al*., 2013).

The average chemical composition of *Moringa oleifera* leaves is 95.57% DM, 26.74% CP, 8.06% EE, 11.03% CF, 26.35% NDF, 40.40% ADF, 89.83% OM, 39.53% NFE (Asaolu *et al*., 2011). With regard to nutritional composition, *Moringa oleifera* leaves have been reported to contain higher amount of vitamin C than orange, higher vitamin A than carrot, more amount of calcium than milk, higher potassium than banana and higher Iron than spinach (Gopalakrishnan *et al*., 2016). Apart from its nutritional value, Moringa oleifera tree is well known for its medicinal properties such as anticancer, anti-inflammatory, anti-diabetic, anti-microbial and antioxidant. In addition, Moringa oleifera leaf has been reported to contain about 16-19 amino acids, of which 10 are classified as essential amino acid viz. Threonine, tyrosine, methionine, valine, phenylalanine, isoleucine, histidine, leucine, lysine and tryptophan. Moringa, as a supplement feedstuff possesses numerous advantages. It is a perineal plant can be harvested several times in a single growing season and also can potentially reduce feed cost of livestock ration. Moringa can easily be grown in field, crops up well, and has a good potential for forage production. It grows to a height of 12 m at maturity and when planted very densely can yield up to 120 tonnes of fodder per hectare per year (Makkar and Becker, 1996). Additionally, the occurrence of any disease on the plant is rare (Parrotta, 1993). Due to all these advantages, it is popularly known as "Miracle Tree".

The leaves of *Moringa oleifera* are willingly eaten by cattle, sheep, goats, pigs, chickens and rabbits as ingredient in their diet. The plant has been used to improve the health status, growth performance, milk production meat quality of several livestock species. Many researchers investigated the effect of *Moringa oleifera* leaves on productive performance of dairy cow, sheep, goats and laying hen and the growth and carcass characteristics of rabbits, broilers etc (Sanchez *et al*., 2006, Khalel *et al.,* 2014, Oyedele *et al*., 2016). However, the researches on use of Moringa oleifera leaf and stem in ruminants are scanty and requires further experimentation to evaluate its use as replacement for protein source in concentrate mixture.

Feed and fodder deficiencies are major limiting factors in raising livestock productivity. Fodder markets are important for communities, which have limited ability to produce their own fodder, but need quality fodder at reasonable prices to produce milk at competitive cost. *Moringa*

oleifera tree, native to India, is fast growing drought resistance and widely cultivated in tropical and sub-tropical areas which can easily be propagated by seeds to cover extensive area within a limited time. Its different parts are sources of proteins, vitamins and minerals and present different pharmacological and biotechnological potential. The leaves of moringa are good source of antioxidant compounds such as ascorbic acid, flavonoids, phenolics and carotenoids and also possess medicinal properties. The moringa species having high crude protein with higher nutritive value in term of energy content and organic matter digestibility. Moreover, *M. oleifera* seeds are widely used in water and effluent treatment, for their coagulation, flocculation and sedimentation properties, their ability of improving water quality, by reducing organic matter and microbial load, with special applicability in intensive animal production systems (Sobhy, *et al.*, 2015). The nutrient profile of Moringa reflects that it has potential for alternative animal feed resources in tropical countries during scarcity. Considering the above facts, the present study has been designed with following objectives:

OBJECTIVE: -

1. To study the effect of feeding *Moringa oleifera* on feed intake and growth performances in Sahiwal calves.
2. To study the effect of feeding *Moringa oleifera* on haemato-biochemical changes in Sahiwal calves.
3. To study the economics of *Moringa oleifera* feeding in Sahiwal calves.

Moringa oleifera belongs to the family Moringaceae and order Brassica is a highly valuable plant distributed in many tropical and subtropical countries. Basically, the native place of *Moringa oleifera* is the Sub- Himalayan region of the North West India. This plant exhibits massive range of health benefits with high nutritional and impressive medicinal qualities. *Moringa oleifera* come under non-conventional feed resource which can be used as a high protein feed for ruminants. Results from different experiments with different classes of animal indicate that *Moringa oleifera* can satisfactorily be fed without any harmful effect. However, the scientific literature on inclusion of *Moringa oleifera* in ration of Sahiwal calves and its effects on growth performances and haemato-*biochemical* changes are scanty. In this chapter various aspects of feeding *Moringa oleifera* feeding and their effects have been reviewed in separate headings as mentioned below:

1. Proximate Composition of *Moringa oleifera* fodder
2. Effect of feeding *Moringa oleifera* on feed intake and growth performances
3. Effect of feeding *Moringa oleifera* on haemato-biochemical changes.
4. Economics of *Moringa oleifera* feeding.

1. Proximate Composition of *Moringa oleifera* fodder

Aregheore (2002) reported that proximate composition of *Moringa oleifera* leaves as dry matter 46.1%, crude protein 19.3%.and organic matter 88.5%.

Sarwatt *et al*. (2002) found that, *Moringa oleifera* dried grinded leaves contain DM933g/kg dried leaves, OM 801g/kg DM and CP 253 g/kg DM.

Sanchez et al. (2006) evaluated that chemical composition of Moringa forage as; DM 164 g/kg, CP 178 g/kg DM, NDF 506 g/kg DM, ADF 376 g/kg DM and Ash 107.6 g/kg DM.

Asaolu *et al*. (2010) found that chemical composition of freshly harvested Moringa leaves has DM 25%, CP 22.2%, EE 6.68%, NFE 41.3%, Ash 13.2%, NDF 28% and ADF 28.9%.

Anjorin *et al*. (2010) in their study at Nigeria confirmed that there are variations in macro and trace minerals in Moringa leaves, pods and seeds from different locations. They further concluded that some organ of Moringa are good source of important minerals and this

plant might be explored as a viable supplement and ready source of dietary minerals in animal and human food. The mineral composition of the lamina, petiole, seed pod shell, seed kernel powder and seed kernel oil of *Moringa oleifera* leaves from two region, Sheda and Kuje, Abuja, Nigeria were investigated. The results indicated that Ca, Mg, Fe, and Cu in *Moringa oleifera* leaves, pods and seeds from Sheda were relatively higher than Kuje. Relatively high contents Ca and Fe were found in the lamina and seed shell of the plant respectively from both regions. The Mg content (0.185 mg/ml) in the seed kernel oil of Moringa from Sheda was significantly lower ($p<0.05$) than that in the other part of leaf and seed. The Fe content in the seed shell from Sheda was 0.2436 mg/gm more than those from Kuje.

Mahmood *et al*. (2010) reported that Moringa used as meditional and nutritional purpose. It is one of the richest plant sources of vitamins A, B, C, D, E and K. The vital minerals present in Moringa include Ca, Cu, Fe, K, Mg, Mn and Zn. It has more than 40 naturals anti-oxidants. Moringa has been used since 150B.C. by ancient kings and queens in their diet for mental alertness and healthy and healthy skin. The leaves, pods, seed, gums, bark and flowers of Moringa are used in more than 80 countries to relieve minerals and vitamins deficiencies, support a healthy cardiovascular system, promote normal blood-glucose levels, neutralize free radicals, provide excellent support of the body anti-inflammatory mechanisms, enrich anemic blood and support immune system. It also improves eyesight, mental alertness and bone strength. It has potential benefit in malnutrition, general weakness, lactating mothers, menopause depression and osteoporosis. It is also used to make an efficient fuel, fertilizer and livestock feed.

Newton's *et al*. (2010) reported that Moringa leaves are rich in nutrients like Fe, K, Ca, and multi-vitamins, which are essential for livestock weight gaining and milk production.

Asaolu *et al*. (2011) reported that chemical composition of air dried *Moringa oleifera* leaves shows DM 95.57%, CP 26.74%, EE 8.06%, CF 11.03%, NDF 26.35%, ADF 40.40%, OM 89.83% and NFE 39.57%.

Mendieta *et al.* (2011) in their study at Sweden found that Moringa can be fed to dairy cow in large quantities without any negative effect on nutrient intake or digestibility. Cows fed large quantities of Moringa produce milk in as much quantity and as high in quality as cows fed conventional Elephant grass diets. Whereas a fresh Moringa diet can lead to an off-flavour and aroma in milk, a Moringa silage diet leads to good organoleptic milk characteristics. Equal

intake of metabolizable energy the intake of protein and fiber differed (P<0.001) between all diets where fresh Moringa had highest and elephant grass diets had the lowest intake. Compared with control diets, ensiled Moringa had higher digestibility (p<0.05) of both protein and fiber.

Moyo *et al.* (2012) evaluated the proximate composition as moisture - 9.53%, crude protein - 30.29%, fat- 6.50% and ash 7.64% in dried powdered leaves of Moringa oleifera.

Nouman *et al.* (2014) in their study at Pakistan, reported that *Moringa oleifera* is one of those plant that has been neglected for several year but now is being investigated its fast growth, higher nutritional attributes, and utilization as a livestock fodder crop. It can be grown as a crop on marginal lands with high temperature and low water availability, where it is difficult to cultivate other agriculture crop.

Divya *et al*. (2014) observed that proximate composition of shade dried grounded *Moringa oleifera* leaves with considerable amounts of percent crude protein (24.01), crude fiber (9.15), ash (14.11), crude fat (2.3).

Babeker and Bdalbagi (2015) reported proximate composition (on % DM basis) of air dried *Moringa oleifera* leaves as dry matter, crude protein, crude fibre, ether extract and ash 42.7%, 20.9%, 18.5%, 3.8% and 10.5%respectively.

Oyedele *et al.* (2016) evaluated proximate composition on % DM basis with dry matter 28.11%, crude protein 29.14%, crude fibre 10.34%, ether extract 28.40%, ash 8.27% and nitrogen free extract 23.80% in *Moringa oleifera* fodder.

Williams *et al*. (2016) in their study at Nigeria concluded that protein, fat and carbohydrates were abundantly found in *Moringa oleifera*. Also, various phytochemical such as tannins, terpenoids, alkaloids, flavonoids and steroids were found in *Moringa oleifera*.

Tope *et al*. (2017) reported protein 18.61%, fat 2.87%, ash 2.37%, crude fibre 31%, nitrogen free extract 64.41% and dry matter 91.57%. In *Moringa oleifera* leaves extracts (aqueous and ethanolic 3. extract)

Damor *et al*. (2017a) reported proximate composition of shed dried *Moringa oleifera* leaves (DM basis) as DM 77.4%, CP 26.3 %, CF 8.8 %, EE 5.7% and Total Ash 14.1 %.

Sun *et al.* (2017) in their study at China; *Moringa oleifera* is a remarkable species with high nutritional value and good biomass production, which can be used as livestock fodder.

Rajput et al. (2019) in their study at U.P observed that it could be practically to utilize Moringa leaves in producing very important and palatable economic products such as Moringa powder and Moringa juice. Dried Moringa leaf powder exhibited moisture levels 72.83% ether extract 9.53%, crude fiber 22.03%, total minerals 9.53%, crude protein 20.42% and carbohydrate 50.16%. The predominant mineral element in the dried Moringa leaf powder were Ca, Mg, K, Fe, Cu, 20.32, 387.83, 154.33, 26.69, 0.83 mg/100g respectively.

2. Effect of feeding *Moringa oleifera* on feed intake and growth performances

Aregheore (2002) studied the intake and digestibility of *Moringa oleifera*–batiki grass mixtures on growing goats. Animals was allotted in four dietary treatments control group was fed with batiki grass alone (M0) and in 2^{nd} 3^{rd} and 4^{th} group batiki grass were replaced with three levels of *Moringa oleifera* leaves @ 20% (M20), 50% (M50) and 80% (M80) respectively. The DMI of the goats on M0, M20, M50 and M80 diets was reported 50.6, 50.9, 51.0 and 46.8 g/($W^{0.75}$kg), respectively. Study revealed that DMI was significantly lower ($P < 0.05$) in M80 group.

Sarwatt *et al.* (2002) in their study at Tanzania, used *Moringa oleifera* leaves as a supplemental feed in East African goat by substituting sunflower seed cake with *Moringa oleifera* leaves at 0%, 25%, 75% and 100% levels. All animals were fed with low quality *chloris gayana* hay as a basal ration. Study evaluated that, there was significantly more dry matter intake (DMI) at 75 and 100% *Moringa oleifera* leaves supplemented group than other groups.

Kakengi *et al.* (2005) in their study at Japan concluded from that high crude protein content in Moringa *oleifera* leaf (MOL) and *Moringa oleifera* soft twings and leaves (MOLST) could be well utilized by ruminant animals and increase animal performance, however, due to negligible tannin content render it a relatively poor protein supplement for ruminants which reflects through high proportion of unavailable protein to the lower gut of animal and high rumen degradable protein *Moringa oleifera* seed cake (MOC) can be a best alternative protein supplement to leaves and soft twigs for ruminants.

Sanchez *et al.*(2006) in their study at Sweden revealed that *Moringa oleifera* fed at 2 kg or 3 kg DM/day can significantly improve dry matter intake, nutrient digestibility and milk yields of dairy cattle fed a basal diet of *Brachiaria brizantha* hay in the dry topics without affecting milk composition (fat crude protein and total solid) or organoleptic characteristics of milk (smell, taste and colour), and has thus a great potential to contribute protein rich forage , particularly in dual purpose production systems during the dry season. Apparent digestibility coefficients of DM, OM, CP, NDF and ADF increased ($p<0.05$) in the diets supplemented with Moringa compared with Brachiaria brizantha hay alone. The results showed that inclusion of Moringa as a protein supplement to low quality diets improved DM intake digestibility.

Akinyemi *et al.* (2010) carried out the experiment to observe the effect on nutrient intake, digestibility and nitrogen balance in West African Dwarf (WAD) sheep fed *Moringa oleifera* as supplements to *Panicum maximum*. Twenty West African Dwarf ram were divided in five treatment groups with 0, 25, 50, 75 and 100 % *M. oleifera* inclusion levels as treatment 1,2,3,4 and 5 respectively. DM intake was highest ($P<0.05$) in treatment 1 but it is similar with values for treatments 2 and 3 while lower values were obtained in treatments 4 and 5. The CP (Crude Protein) intake increased with increasing the level of *M. oleifera* inclusion.

Asaolu *et al.* (2010) evaluated the effects of feeding Moringa and bamboo leaves on groundnut hay utilization by West African Dwarf goats. They used a sole groundnut hay diet (100 GNH) as the reference diet and equal combinations of Moringa (MOR) and bamboo (BAM) leaves respectively with groundnut hay (50 MOR: 50GNH;50 BAM:50 GNH). The study noticeable that, there were no significant ($P>0.05$) differences in total DM intake values which ranged from 291 to 315 and 316g DM/animal/day respectively. The CP intake was significantly higher in group's bamboo (BAM) and Moringa (MOR) supplemented with groundnut hay i.e. 44.4 and 56.8 g/d respectively as compare to sole groundnut hay diet 39.3 to g/day.

Asaolu *et al.* (2011) carried out the experiment on West African Dwarf goats (WAD) to study the utilization of Moringa oleifera fodder (MO) in combination with Leucaena leucocephala (LEU) and Gliricidia sepium (GLI) Fodders. Three experimental diets; 50 MO: 50 LEU, 50 MO: 50 GLI and 100 MO were fed to different groups. They observed that there was no significant ($P>0.05$) differences in DM intake between different treatment group.

Asaolu *et al*. (2012) used the Moringa multi nutrient block supplementation to

concluded the performance of grazing West African Dwarf goats. Goats was divided in three different treatments fed cassava peels (CPL), corn starch residues (CSR) and Moringa multi nutrient block (MMNB) respectively. The study revealed significant difference in supplement intakes, viz., 11.08, 23.61 and 34.53 g-1 kg0.75 in MMNB, CPL and CSR, respectively. Though fewer intakes were observed in MMNB in comparison to CPL and CSR groups, it is suggested that MMNB has high nutrient contents.

Adigun and Aye (2013) in their study at Nigeria concluded that Moringa leaf meal can completely replace cotton seed cake as protein source in a concentrate mix fed to West African Dwarf sheep as supplement to basal *Panicum maximum* diet. Reduced cost of production is an advantage to the resource's poor farmers. It replaces cotton seed cake (CSC) with *Moringa oleifera* leaf meal (MOLM) @ 0, 25, 50, 75, and 100% level in concentrate mixture and denoted as group 1, 2, 3, 4 and 5 respectively. All animal was fed with basal diet of Panicum maximum. Results revealed that the body weight gain did not differ between the groups. They evaluated that, the cost of feeding diet 1 was higher as compared to diet 2, 3, 4 and 5 and the minimum cost of feeding was observed in diet 5 that replaced 100% of CSC with Moringa leaf meal. Additionally, the cost per metabolic weight gain was observed to be significantly low in group 2, 3, 4 and 5 diets with as compared to group 1. They also found that significant reduction in cost per kg live metabolic body weight with increasing level of supplementation of Moringa oleifera leaves. They concluded that MLM can completely replace CSC as protein source in a concentrate mix fed to WAD sheep fed basal Panicum maximum.

Mahmoud. (2013) in their study at Egypt found that *Moringa oleifera* stems are suitable for feeding sheep and can be used to replace a part of clover hay or concentrate feed mixture without any adverse effect on performance on Rahmani lambs. Twenty-seven of Rahamni lambs with average initial weight 30±1.84 kg were divided into three groups (9 each). Lambs in the control group were fed R1 contained clover hay (CH) (1% from live body weight) +concentrate feed mixture CFM (3% from live body weight), while the experimental lambs fed clover hay+ 25% Moringa oleifera stem from CFM (R2) and 25% *Moringa oleifera* stem from clover hay + concentrate feed mixture (R3). Result indicated that the highest ($P<0.05$) of most nutrients digestibility and nutritive values was recorded for control ration (R1), while R2 showed the lowest values and R3 had intermediate values. Total protein, globulin, urea and creatinine concentration in plasma insignificant differences.

Moyo *et al.* (2014) in their study at South Africa concluded that supplementing crossbred Xhosa lop-eared goats with a *Moringa oleifera* leaf meal diet produced chevon with the highest physico-chemical characteristics and consumer sensory scores. They studied about the effect of supplementary Moringa oleifera leaves (MOL) on growth performance, carcus and non-carcus characteristics of crossbred Xhosa lop-eared goats. All goats were offered basal diets of grass hay (GH) ad-libitum and wheat bran (200 g/day each). The *Moringa oleifera* leaves and sunflower cake (SC) group were provided additional 200g of dried Moringa oleifera leaves and 170g Sunflower cake respectively. The third group did not receive any additional ration. They evaluated that, average daily weight gain increases significantly ($p<0.05$) in animal provided *Moringa oleifera* leaves or sunflower cake as compared to animal fed on third group. They observed that feeding *Moringa oleifera* leaves or sunflower cake have almost similar effect on the growth performance of goats.

Babeker and Bdalbagi (2015) in their study at Sudan concluded that *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. They divided the goats in three treatments at three different level of inclusion of Moringa oleifera viz., 0%, 20%, and 50%. They found that improvement in body weight at the end of experiment was significant ($p<0.05$) in group B than another group. In addition, they found that total gain and ADG (Average daily gain) increased significantly in group B as compared to group A and C.

Sophy *et al.* (2015) studied the effect of *Moringa oleifera* leaves on fattening lambs. Soybean meal was replaced with *Moringa oleifera* leaves @ 0, 7.5, 15 and 30% in 1 to 4 groups respectively. The control ration consisted of 75% concentrate feed mixture and 25% wheat straw. Result showed that DM intake increase as the level of Moringa leaves increased in the ration.

Ahmad *et al*. (2017) In their study at Egypt concluded that replacing up to 15% of calf starter by dry *Moringa oleifera* leaves improved growth performance of suckling buffalo calves, if compared with replacing 20% and control group. Total body weight gain and average daily gain of buffalo calves fed 5, 10 and 15% dry *Moringa oleifera* leaves (DMOL) supplemented ration were ($p<0.05$) higher than those fed control (0%) or 20% DMOL ration. It was observed that R2, R3 and R4with highest TDN, DCP and DE intake produced the highest weaning weight, total body weight gain and Average Daily Gain (ADG) while, calves fed

control and R5 consumed the lowest intake of TDN, DCP and DE achieved the lowest weaning weight, total weight gain and ADG. The better weaning body weight and weight gain attained by feeding R2, R3 and R4 could be attributed to higher TDN, DCP and DE contents and consumed compared with those fed control and R5 ration which were efficient metabolized for growth. Feed conversion and economic efficiency was significantly ($p<0.05$) increased with increasing the level of DMOL in the ration up to 15% and decreased afterwards at 20% level, which was nearly similar to control ration.

Fadiyimu *et al.* (2016) observed the research on the feed intake, growth performance and carcass characteristics of West African Dwarf sheep fed Moringa oleifera, Gliricidia sepium Cassava fodder as supplements to Panicum maximum. Twenty-four growing WAD sheep were allotted to four dietary treatment groups as 100% P. maximum (control), 75% P. maximum + 25% M. oleifera, 75% P. maximum + 25% G. sepium and 75% P. maximum + 25% Cassava leaves. Total DM intake was comparable for all the groups except group 4 which was significantly lower ($P<0.05$) than group 3.

Aye, (2016) studied the feed intake, performance and nutrient utilization of West African Dwarf (WAD) sheep fed Panicum maximum and cassava peels. Sixteen yearly West African Dwarf (WAD) sheep were divided into four treatment groups as Moringa multi-nutrient blocks (MMNB), Gmelina arborea multi nutrient blocks (GMNB), Tithonia diversifolia multi-nutrient blocks (TMNB) and the control (Panicum+Cassavapeels) respectively. The feed intake was higher in TMNB (1.8±0.02kg) followed by MMNB (1.7±0.05kg) and GMNB (1.6±0.03kg) as compared to control group (1.5±0.03kg) showing that feed intake is better in MMNB than control group.

Oyedele *et al.* (2016) conducted experiment on nutrient digestibility and growth performance of West African Dwarf (WAD) goats fed combinations of *Moringa oleifera* foliage and Gliricidia sepium with equal proportions of a low-cost concentrate. A total Forty West African Dwarf (WAD) goats were divided into five groups, each group consisted eight animals. These groups provided concentrate with 100 % Gliricidia and 100 % Moringa respectively (LC: G 100 M 0, LC: G 0 M 100), concentrate with Gliricidia and Moringa combinations at 75 to 25 %, 50 to 50 % and 25 to 75%respectively (LC: G 75 M 25, LC: G 50 M 50, LC: G 25 M 75). Total DM intake was significantly ($P<0.05$) higher in LC: G 0M 100 (85.80 g/kg0.75) as compare to LC: G100 M0 (74.80 g/kg0.75). The forage combinations showed significantly

(P<0.05) higher total DM intakes in LC: G 50 M 50 (92.10g/kg0.75) than other groups. CP intake was significantly (P<0.05) higher in Moringa supplemented groups than non-Moringa group.

Kholif *et al.* (2017) in their study at Egypt considered the effect of *Moringa oleifera* (MO) foliage in replacement of Berseem clover (BC) on feed utilization and lactational performance in Nubian goats. A total of 16 lactating Nubian does, weighting 36 ± 0.8 kg, were randomly assigned to four experimental treatment containing 0, 125, 250 and 375 g of MO per kg diet to replace 0 (M0), 25 (M25), 50 (M50) and 75% (M75) of berseem clover (on dry matter basis) in a quadruplicated 4±4Latin square design. The MO diets increased (P<0.01) feed intake and nutrient digestibility. Moringa diets increased (P<0.01) serum total protein, albumin and glucose.

Damor *et al.* (2017a) conducted the experiment on growth performance of grazing Mehsana goat kids fed different levels of *Moringa oleifera* leaves with concentrate mixture. 18 numbers of Mehsana goat kids were divided into three groups, each group having six kids. They observed that 100% *Moringa oleifera* leaves supplemented group showed higher overall body weight changes and average daily body weight gain followed by 50% *Moringa oleifera* group and 100% concentrate group.

Damor *et al.* (2017b) conducted the experiment on blood biochemical profile of grazing Mehsana goat kids fed different levels of *Moringa oleifera* leaves. Three experimental groups diet contain, T1 (100% concentrate mixture), T2 (50% concentrate mixture + 50 % *Moringa oleifera* leaves) and T3 (100% *Moringa oleifera* leaves). They observed that the group fed with Moringa had higher (P<0.05) serum total protein, and albumin levels as compared to control group. The glucose concentrations were reported to be similar (P>0.05) between the different groups.

Korsor *et al* (2017) evaluated the indirect effects of feeding *Moringa oleifera* supplemented diet on growth rates in pre-weaning kids .at Namibia being a semi-arid and driest country in Africa south of Sahel, lactating does are challenged with acquiring the required amount of forage in the rangelands to meet milk production and nutritional need for their kids. This scarcity of forage along with the low nutritional quality of the available grasses or browses creates the need for supplementing lactating does with nutritional- rich fodders. A completely randomized block design (CRBD) was used with four inclusion levels of *Moringa oleifera*

supplemented diets and four replicates of does in each level to determine if growth parameters differ with level of *Moringa oleifera*. The present study found that there were significant differences ($p<0.05$) in heart girth, body length and weight of kids which was measured as growth rate parameters along with body condition scores (BCS). Although Boer goats are known for their fast growth under favourable condition, feed supplementation of pregnant and lactating does could be advantageous for milk production to supports their kids' healthy early growth and development especially under un-favourable condition such as during winter and drought.

Soltan *et al.* (2017) in their study at Egypt, concluded that Moringa leaves have high quality of protein balanced with its amino acid, thus the leaves are the most suitable part used as source of protein, however; it is well known for high ruminal degradability of protein and organic matter. Moreover, in comparison with leaves of other shrubs like Leucaena, Moringa leaves containing around 200g/kg DM crude protein (CP), thus can not consider as a potent source of high protein supplement. Despite the CP content, every part of Moringa plant is containing several bioactive components and found to have specific nutritional characteristics. Many studies have shown that the leaf, seeds, root, flower, bark and gum exhibit several activities including antimicrobial, antioxidant, and anthelmintic. Thus, it can suggest that Moringa has more nutritional mode of action; there by improve the ruminal degradability, digestion, health and production performance of the animals.

Zinder *et al.* (2017) in their study at Israel reported that cow fed Moringa silage had higher milk yield and antioxidant capacity and lower somatic cell count compared with controls, during some stage of lactation. These finding imply that ensiling *Moringa oleifera* in an appropriate practice by which health and production of dairy cow can be improved.

Babiker *et al.* (2017) in their study at Saudi Arabia on goats concluded that partial replacement of alfalfa hay with *Moringa oleifera* in the diet of ewe and goats positively affected their milk yield and their composition. Total body weight gain (BWG) and average daily gain (ADG) of ewe's lambs and goat kids fed with alfalfa hay (AHD) and Moringa oleifera leave diet (MOD). Partial replacement of the diets of lambs with MOD increased significantly ($p<0.01$) total BWG (13.44 kg) of the animals compared to AHD (9.66 kg), but no significant variation in total BWG was observed in goat kid fed with diets. The ADG of the lambs and kids fed with MOD was significantly ($p<0.01$) higher than those fed with AHD. Feed

conversion ratio was increased significantly ($p<0.05$) in group B and group C compared with group A.

Aharwal *et al.* (2018) in their study on effect of *Moringa oleifera* leaf meal feeding at Jabalpur, India on buffalo calves revealed that the body weight change, average daily gain, dry matter intake, average daily dry matter intake (% Body weight), protein efficiency was significantly varied among the group. It can be concluded that Moringa leaf meal can replace upto 10% of calf starter and concentrate mixture to attend body weight gain of Murrah buffalo calves.

Choudhary *et al.* (2018) in their study at Bihar revealed that 50:50 replacement of concentrate feed with Moringa leaf had greater effect on the milk yield of does and growth performance. The initial and final average body weight were 10.74, 9.14, 9.64 kg and 12.04, 10.58, 11.58 kg in T1, T2 and T3 groups respectively. The final body weight of experimental does had progressively increased with the increasing level of Moringa leaves supplementation in the diet. Consequently, daily growth rate was progressively increased in does on the T1, T2 and T3 groups. The highest growth rate of doe in T3 group may be due to high protein in the diet.

Sultana *et al.* (2018) in their study at Bangladesh concluded that Moringa foliage may be included to the diet of goat up to 67.2% or 3.4% of Live weight which will produce more lean than fat without affecting dietary intake and daily gain. The five dietary treatment group contain various level of Moringa foliage (MF) and concentrate (C) viz. T1 (100 MF: 0 C), T2 (75 MF: 25 C), T3 (50 MF: 50 C), T4 (25 MF: 75 C) and T5 (0 MF: 100 C). Highest average daily live weight gain was found in goats fed with T2 diet while the lowest ($p<0.05$) was found in goats fed with T5 diet. They found that, final live weight of goats fed on T5 diet was significantly lower ($p<0.05$) than goats on T1, T2, T3 and T4 diet.

Ayandiran *et al.* (2019) in their study at Nigeria concluded that inclusion of bread waste and *Moringa oleifera* in the diet of goats led to improved performance characteristics.

Kumar et al. (2019) in their study at Jharkhand concluded that inclusion of *Moringa oleifera* leaf powder at 10%, 15% and 20% in goat's diet improves the growth performance than control diet however, the overall result on growth performance was shown by the goats fed with 15% *Moringa oleifera* leaf powder (MOLP).

3. Effect of feeding *Moringa oleifera* on haemato-biochemical changes.

Khalel *et al.* (2014) in their study at Egypt concluded that *Moringa oleifera* is palatable and highly nutritious fodder with antioxidant properties which was reflected on the improvement of milk yield and composition. Therefore, the partial or complete replacement of berseem with Moringa is highly recommended in the feeding practices of dairy cows. It included Moringa oleifera as a supplement feedstuff in lactating cow into two group R2 (60% concentrate + 40% Moringa) and R3 (60% concentrate +20% berseem and +20% Moringa) in comparison with R1 group (60% concentrate + 40% Berseem). Group feeding Moringa ration had higher blood glucose concentration lower urea content than fed all berseem ration (R1). However, the effect was more observed in 40% Moringa ration. Total protein, albumin and globulin increase in R2 and R3 group, however significantly ($P<0.05$) higher values were obtained in R2 group than R1 group. Feed intake, feed conversion and economic reported that dry matter intake was nearly comparable among groups being, 11.61kg, 11.95kg and 11.73 kg for R1, R2 and R3 respectively. The significance difference between group in terms of TDN intake is regarded to the higher nutrient's digestibility of Moringa containing rations R2 (40% Moringa) and R3 (20% Moringa) than R1 (40% berseem). Feed conversion (kg DM/kg 4% feed concentrate mixture) was improved ($p<0.05$) by nearly 18% and 13% with 40% and 20% Moringa rations comparison to that with R1 (40% berseem).

Jiwuba *et al.* (2016) in their study at Nigeria concluded that incorporation of 15% Moringa *oleifera* leaf meal (MOLM) in diets of West African Dwarf (WAD) does enhanced their performance and haematological profile. *Moringa oleifera* leaf meal supplementation level at 15% was recommended for optimum West African Dwarf goat production. Four diets were formulated such that diets T1, T2, T3, and T4 contained MOLM at 0%, 5%, 10%, and 15% respectively. The diets were offered to the goats, which were randomly divided into four groups of nine goats each in a complectly randomized design. Average daily feed intake (ADFI) differed significantly ($p<0.05$) among the treatment groups. Value for the animals fed control diets (T1) compared ($p>0.05$) with those of T2 and T3, but however differed ($p<0.05$) significantly from that group fed T4 diets. FCR was however best for does fed T4 diets. PCV, RBC and WBC differed ($p<0.05$) significantly among treatments. Packed cell volume (29.50-32.75%) was higher ($P<0.05$) and better than control.

Ali (2017) carried out a 90 days' study evaluate the effect of Moringa oleifera leaves on haemato-biochemical profile in growing goats. The study of biochemical parameters at monthly interval indicated non-significant difference at monthly interval and also in overall mean of experiment period with respect to serum albumin, serum globulin, serum total protein, serum glucose, similarly non- significant effect of dietary treatment on RBC and WBC was observed among the groups except the overall mean of WBC, which was significantly higher in T1 as compared to T0 group. Further, the mean for various biochemical and haematological parameters observed in the present study were in the physiological range.

Meel *et al*. (2018) in their study at Bikaner, Rajasthan concluded that feeding of Moringa oleifera leaves replacing concentrate feed improved body weights and average daily body weight gain as well as feed intake and overall health of sirohi goat kids. In group T1 provided 60% methi straw and 40% commercially available readymade concentrate and in groups T2, T3, T4 and T5, the commercially available readymade concentrate was replaced by Moringa oleifera leaves at 25%, 50%, 75% and 100% level, respectively. Results indicated that the RBC were increased significantly ($p<0.05$) in T5 where as WBC were lowest in T5 and highest in T1. Haemoglobin lowest in T1 and highest in T5, PCV lowest in T1 and highest in T5 group. Serum total protein and serum albumin were increased significantly ($p<0.05$) in T5 group. Serum globulin level was highest in T5 group and in T1 group. Serum glucose level decreased by feeding *Moringa oleifera* leaves diets.

Yusuf *et al*. (2018) reported that PCV, RBC, HB and total protein not significantly influence by MOLM inclusion.

4. Economics of *Moringa oleifera* feeding.

Adegun and Aye (2013) replaced cotton seed cake (CSC) with *Moringa oleifera* leaf meal (MLM) @ 0, 25, 50, 75 and 100% level in a concentrate mixture and denoted as group 1, 2, 3, 4 and 5 respectively. All animals were fed with basal diet of *Panicum maximum.* Results revealed that the body weight gain did not differ between the groups. They reported that, the cost of feeding diet 1 was higher as compared to diet 2, 3, 4 and 5 and the minimum cost of feeding was observed in diet 5 that replaced 100% of CSC with Moringa leaf meal. Additionally, the cost per metabolic weight gain was observed to be significantly low in group 2, 3, 4 and 5 diets with as compared to group 1. They also observed significant reduction in cost per kg live metabolic body weight with increasing level of supplementation of *Moringa*

oleifera leaves. They concluded that MLM can completely replace CSC as protein source in a concentrate mix fed to WAD sheep fed basal *Panicum maximum* diet.

Ali (2017) conducted the experiment to study the effect of inclusion of *Moringa oleifera* leaf meal (MOLM) in the concentrate mixture of growing goats on different parameters. Goats were divided into two groups the control (T0) group provided with standard concentrate mixture containing 25% Cotton seed cake (CSC), while the treatment (T1) group 50% of CSC in concentrate mixture was replaced by MOLM. They found that in T1 group feeding cost per kg weight gain was lower as compared to control group. Reducing feed cost in T1 leads to higher profit per kg body weight gain.

Yusuf *et al.* (2018) in their study at South Africa concluded that diluting the commercial supplement with Moringa oleifera leaf meal up to 100 g/kg DM (Dry Matter) does not impair the nutritional status, growth performance and health status of the goat while reducing the feed cost per gain.

Dong *et al.* (2019) in their study at China demonstrated that different supplementation levels of *Moringa oleifera* in the diet achieved similar feed intake, milk production, but adding 6 % of Moringa oleifera improved milk fat content.

Ayandiran *et al*. (2019) in their study at Nigeria, it could be concluded that inclusion of bread waste and Moringa oleifera in the diet of goats led to improved performance characteristics. In a twenty- week trial, twenty West African Dwarf (WAD) goats (7-8 kg) were randomly allotted into four treatments in a complectly randomized design to observe the growth performance and nutrient digestibility of WAD goats fed bread waste and *Moringa oleifera* leaf. Four diets (T1, T2, T3, and T4) were compounded by inclusion of bread waste and Moringa oleifera leaf at 0, 25, 50 and 100% levels. The goats were fed at 3% of their body weight. Performance parameters such as feed conversion ratio were evaluated. The CP content of diets containing bread waste and Moringa oleifera (T2, T3 and T4) were higher than T1 diets. There was no significant difference ($p>0.05$) in the feed intake of animal across the treatments. Animals fed diets T4 (34.38) had significantly highest ($p<0.05$) daily weight gain compared to T3 (26.67), T2 (21.88) and T1 (20.84). The diets T2, T3 and T4 were significantly higher ($p<0.05$) in digestible energy (59.23, 62.54 and 62.84% respectively) and crude protein (63.34, 69.39 and 72.39% respectively) compared to the control diets.

Aharwal *et al.* (2019a) in their study at Jabalpur; upto 15% concentrate mixture replacement can be done with *Moringa oleifera* leaf meal to improve the body weight gain. The result clearly indicated that Moringa leaf meal addition to the diet of calves not only improves the growth rate but also improve the economic efficiency of rearing of Murrah buffalo calves.

Aharwal *et al.* (2019b) in their study at Jabalpur concluded that Moringa leaf meal can replace upto 15% of calf starter to attain body weight gain and improve economic efficiency in Murrah buffalo calf rearing. A total of 18 Murrah buffalo calves with six calves in each group having similar body weight of either sex at 5^{th} day were randomly distributed into three different groups (control, M5 andM15). Calf starter was replaced by *Moringa oleifera* leaf meal @5% and 15% for M5 and M15 group, respectively. Economic analysis indicated that recurring cost of rearing Murrah buffalo calves was reduced in M5 and M15 groups in comparison to the control group. Recurring expenditure of body weight gain (rupess/kg) were 322.27, 269.35 and 262.15 in control, M5 and M15, respectively. Reduction of recurring expenditure on body weight gain (rupess/kg) in comparison to control group was 52.93 and 60.13 for the M5 and M15, respectively. Percent decrease of total recurring expenditure in comparison to control group/kg BW gain were 16.42 and 18.66 in M5 and M15 groups, respectively.

The present study was conducted at Livestock farm complex (LFC) of the Bihar veterinary college Patna. The materials and methods employed in the present investigation, with the objective to study the effect of Moringa oleifera feeding on performance of Sahiwal calves are described under following sub headings.

3.1 Geographical location of Bihar veterinary college Patna

The present study was on the effect of Moringa oleifera feeding on Sahiwal calves was conducted at Livestock farm complex (LFC) of the Bihar veterinary college Patna, Bihar animal science university. The BASU, Patna is situated at coordinates of 25''36' 00''N 85'05'06''.

3.2 Duration of experiment work

The total duration of experiment work was of 90 days. The experiment was started in the month of February 2020 and lasted up to July 2020.

3.3 Selection of animals

A total of 12 Sahiwal calves was selected of similar age group between 6-10 month of either sex for the experiment. All the calves were divided into two group Control (T1) and Treatment (T2); both control and treatment group were of approximate same weight.

3.4. Housing and Management

Standard management practices were adopted during the research work**.** All the animals selected were dewormed with Albendazole @ 7.5 % of the body weight before starting the experiment. The animals were kept in well ventilated, pucca floored house and fed individually in mangers. They were provided with fresh, clean water *ad libitum* thrice a day. Sheds were kept clean and in hygienic condition.

3.5. Feeding strategies

All the calves of T_1 group, standard diet practiced at farm were offered and in T2 group dry fodder as well as green fodder feeding was remain same as practiced at farm but concentrate (100%) was replaced with ad. lib. Moringa leaves along with stem feeding after chaffing.

3.6. Experimental Design:

12 (Twelve) Sahiwal calves were selected of similar age group between 6-10 month of either sex for the experiment. Six calves were kept as control group (T1) with Standard diet

practiced at farm and Six calves were kept as treatment group(T2). Diet offered for treatment group(T2); Dry fodder as well as green fodder feeding was remain same as practiced at farm but concentrate (100%) was replaced with ad lib. Moringa leaves along with stem feeding after chaffing.

S, No.	Group	No. of Calves	Treatment
1.	Control(T1)	6	Standard diet practiced at farm
2.	Treatment group(T2)	6	Dry fodder as well as green fodder feeding was remain same as practiced at farm but concentrate (100%) was replaced with *ad lib*. Moringa leaves along with stem feeding.

3.7. Proximate Analysis

The feed and fodder offered were analyzed for various proximate principles viz., moisture, crude protein (CP), crude fibre (CF), total ash (TA), ether extract (EE), according to methods of Association of Official Analytical Chemists (AOAC,2000).

3.7.1. Moisture

The method involves drying a sample in an oven and determining moisture content by the weight difference between dry and wet material. About 50-100 g samples of feed and fodder offered were taken in pre-weighed metallic trays and kept in a hot air oven at 100 ± 0.5^0C for overnight. The loss in weight of samples due to evaporation is the moisture content of sample.

3.7.2. Crude Protein (CP)

Nitrogen present in the samples of feed was estimated by Micro-Kjeldahl's method of AOAC (2000). The nitrogen content was multiplied by factor 6.25 to calculate the crude protein content.

3.7.3. Crude Fiber (CF)

About 5-8 g fat free dried sample was taken in a spoutless tall beaker. It was boiled with 200 ml 1.25% sulphuric acid for 30 minutes. Thereafter it was filtered through a muslin cloth and repeatedly washed with hot water till it becomes acid free. Then it was transferred into the same beaker containing 200 ml of 1.25% NaOH solution and boiled for 30 minutes. It

was then made alkali free through continuous washing with hot water. The residue left was transferred to the previously weighed silica crucible. Then it was dried at 100±0.5^{0}C in hot air oven for 12 hrs. The dried material was ignited in the muffle furnace at 600^{0}C for 2 hours. The loss in the weight was considered as crude fiber content of sample.

3.7.4. Ether Extract (EE)

About 5-10g dried powdered samples were taken in a readymade thimble. The samples were extracted continuously for 4-6 hours with petroleum ether (40^{0}C-60^{0}C boiling point) in a modified Soxhlet extraction apparatus (Socsplus- Pelican India Ltd., Chennai). The ether extract was calculated by difference in the weight of oil flask before and after extraction.

3.9.1 Body weight Gain

Initial body weight of individual animals was recorded by electronic weighing machine at the start of the experiment. Similarly, body weight of individual animal was recorded at Fortnightly intervals (0, 15th, 30th, 45th, 60th, 75th90thday) by electronic weighing machine in morning hour before offering feed and water.

3.9.2Change in body weight

It was estimated as a difference between initial and final body weight divided by total numbers of days in trial.

3.9.3 Feed conversion ratio (FCR)=Feed consumption(kg)/Body weight gain (kg)

3.9.4 Performance index (PI) =Body weight gain/FCR

3.10 Hematological parameters

Blood samples were collected through jugular vein from each individual animal at0, 30, 60, and 90 days of experiment. For hematological parameters blood sample were collected in EDTA (ethylene diamine tetra acetic) vial and by using hematology analyzer (mindray) following parameters were studied.

3.10.1Hemoglobin (Hb)

Hemoglobin concentration was estimated following method described by (Sharma and Singh 2000) using Sahil's haemoglobinometer with acid haematin method. The brown color was matched with glass standard and hemoglobin concentration (g/dl) was recorded.

3.10.2Total erythrocyte count (TEC)

The blood specimen was diluted with 1:200 with the RBC diluting fluid cells and counted under high 40Xby using Neubauer's chamber. The number of cells in undiluted blood were

calculated and reported as the total number of cells per cubic mm of whole blood. The total count equal to total number of RBC in all five squares (upper left, upper right, lower right, lower left and central) multiplied by 10000.

3.10.3 Packed cell volume (PCV)

In wintrobe haematocrit tube blood was filled upto 10 mark, then centrifuge at 3000 rpm for 10 minutes. Plasma were settled in upper surface and Red blood cells settled in bottom. The height of red blood cell was then measured. Then PCV was found by the formula.

PCV (%) = (10 x 100)/red blood cell height

3.10.4 Total leucocyte count (TLC)

Total leucocyte count was done manually by using hemocytometer (Neubauer's chamber).

3.11 Biochemical parameters

For Biochemical parameters blood was collected in EDTA vial and serum was separated by using centrifuge machine at 2500 rpm for 15 minutes. Separated serum samples were analyzed for following parameters.

3.11.1 Total serum protein

Total serum protein was estimated as per the standard method of Doumas (1975) by using semi-automatic biochemical analyzer (microlab 300) by using diagnostic kits Coral Clinical Systems and result were expressed in g/dl.

3.11.2 Serum albumin

Serum albumin was estimated as per the standard method of Doumas (1975) by using semi-automatic biochemical analyzer (microlab 300) by using diagnostic kits Coral Clinical Systems and result were expressed in g/dl.

3.11.3 Serum globulin

Serum globulin was calculated by subtracting the albumin values from the total serum protein and result were expressed in mg/dl.

Globulin (g/dl) = Total protein (g/dl) – Albumin (g/dl)

3.11.4 Serum Blood urea nitrogen (BUN)

Blood urea nitrogen was estimated as per the standard method of Chaey (1962) by using semi-automatic biochemical analyzer (microlab 300) by using diagnostic kits Coral Clinical Systems and results were expressed in mg/dl.

3.11.5 Serum glucose

Serum glucose was estimated as per the standard method of Trinder (1969) by using semi-automatic biochemical analyzer (microlab 300) by using diagnostic kits Coral Clinical Systems and results were expressed in mg/dl.

3.14.6 A: G ratio (Serum albumin: Serum globulin ratio)

The albumin-globulin ratio was calculated by using following formula:

Albumin- globulin ratio = Serum albumin (g/dl)/ Serum globulin

3.14.7 Serum creatinine

Creatinine in serum was estimated following a standard method (Bonses and Tausskay, 1945) using a commercial kit (Span Diagnostic Ltd) were expressed in mg/dl.

3.14.8 Serum sodium

Sodium was estimated by Na^+ Colorimetric method by using commercial kit coral clinical system as per manufacture's protocol.

3.14.9 Serum potassium

Potassium was estimated by K^+ Colorimetric method by using commercial kit coral clinical system as per manufacture's protocol.

3.14.10 Serum calcium

Serum calcium was estimated by the O-cresolpthaleincomplex one method (Baginski, 1973) using Span diagnostic kit. Calcium in alkaline medium reacts with O-Cerolphaleincomplax one to form purple coloured complex whose absorbance sample was measured against blank on spectrophotometer and result were expressed in mmol/lit.

Fig.3.1. Chaffing of *Moringa Oleifera*

Fig.3.3. Weighing of *Moringa oleifera*

Fig.3.2. Drying of *Moringa Oleifera*

Fig.3.4.*Moringa Feeding on Sahiwal Calves*

Fig.3.5.*Body weight measure in Sahiwal Calves*

Fig.3.6.. Blood collection from Jugular Vein

Fig.3.8. Biochemical estimation using semi auto analyser

The present study was carried out to evaluate the effect of *Moringa oleifera* feeding on performance of Sahiwal Calves with regard to various parameters such as body weight, gain in body weight, change in body weight, feed conversion ratio and performance index. In addition to this, effect of dietary treatment on haematological profile of Sahiwal calves including total Erythrocyte Count, total leucocyte count, haemoglobin, Packed cell volume and bio-chemical profile like Serum Glucose, Serum Albumin, Serum Globulin, Total Serum Protein, A.G. ratio, Blood Urea Nitrogen, Serum Creatinine, Serum Sodium, Serum potassium, serum Calcium were evaluated. Economics of incorporating *Moringa oleifera* as a dietary source in the concentrate feed of Sahiwal calves was also calculated. The data obtained during the study was statistically analysed for interpretation of the results. The findings of the present study have been presented and discussed in this chapter under the following major headings.

4.1 Proximate Composition of *Moringa oleifera* fodder
4.2 Effect of feeding *Moringa oleifera* on feed intake and growth performance of Sahiwal calves
4.3 Effect of feeding *Moringa oleifera* on haematological parameters of Sahiwal calves
4.4Effect of feeding *Moringa oleifera* on biochemical parameters of Sahiwal calves
4.5Economics of *Moringa oleifera* feeding of Sahiwal calves

4.1 Proximate composition of *Moringa oleifera* fodder

The chemical composition of Moringa leaves and in combination with premature and mature stem has been presented in Table 4.1.

The proximate analysis of *Moringa Oleifera* fodder had been done at laboratory of Animal Nutrition, Bihar Veterinary College, Patna, & found that Moringa mature leaves contains (in%), moisture, dry matter, CP, EE & CF was 77, 23, 22.92, 5.9 & 20.8 respectively. Similarly, premature Moringa leaves contains 80.5% moisture, 19.5% dry matter, 25.23% CP, 6.33% EE & 18.74% CF. Whereas, proximate composition of Moringa leaves with mature stem was 76% moisture, 22% DM, 16.62% CP, 4.38% EE & 25.73 CF. Similarly, Moringa leaves with premature stem proximate composition had 82% moisture, 18% DM, 19.46% CP, 5.84% EE & 23.02% CF.

Similar results were also observed by (Asaolu *et al*., 2011, Tope *et al*., 2017 and Damor *et al*., 2017) but Divya *et al*., 2014 observed very less Crude Fibre (9.15 %) in shed dried grounded *Moringa oleifera* leaves.

The difference in proximate analysis in *Moringa oleifera* of different areas might due to different stage of harvest, soil type, and season of harvesting, post harvesting treatment and agro climatic condition.

Table: 4.1 Proximate analysis of *Moringa oleifera* fodder

Proximate analysis of Moringa available at Livestock Farm Complex				
Particulars	**Sample 1. Moringa leaves with mature stem**	**Sample 2. Moringa leaves with pre-mature stem**	**Sample 3. Moringa Mature leaves**	**Sample 4. Moringa Pre-mature leaves**
Moisture%	76	82	77	80.5
Dry Matter %	24	18	23	19.5
CP %	16.62	19.46	22.92	25.23
EE %	4.38	5.84	5.9	6.33
CF %	25.73	23.02	20.8	18.74

4.2 Effect of feeding *Moringa oleifera* on feed intake and growth performance of Sahiwal calves

4.2.1 Body weight

Perusal of the table 4.2.1. reveals that average body weight at start of the experiment was 93.50±12.94 kg and 104.83±12.48 kg for control and experimental group respectively. After 15 days of experiment average body weight was 93.58±12.80 kg for control group whereas, it was 107.33±12.04 kg in case of experimental group of animal. Similarly, at 45 days of experiment average body weight in control group was 97.00±11.55kg whereas it was 116.92±10.99 kg in experimental group of animals. Further, at 90 days of experiment in control group average body weight was 102.83±12.10kg and in experimental group was 128.92±11.36 kg. Although average body weight was found Non-significant, however an increasing trend can be clearly evident in case of experimental group of animal. This might due to high and

better nutritional value of Moringa *Oleifera* which contains higher amount of protein, fat, minerals like Mg, Ca, K, P, Fe, Cu, S, Vitamins likes Vitamin A, Vitamin B, Vitamin C, Vitamin D, Vitamin E and various amino acids (Rockwood *et al*., 2013 & Fuglie, 2005).

Table: 4.2.1 Average Body Weight (kg) of Sahiwal calves at different intervals during the experiment

Days	Control	Experimental	Significant
0 Days	93.50±12.94	104.83 ±12.48	NS
15 Days	93.58±12.80	107.33±12.04	NS
30 Days	93.33±11.58	110.33±11.34	NS
45 Days	97.00±11.55	116.92±10.99	NS
60 Days	99.33±11.97	121.17± 11.36	NS
75 Days	101.08±12.06	124.92±11.26	NS
90 Days	102.83±12.10	128.92±11.36	NS

NS: Non-Significant

Note: **** is significant at 1%, ** is significant at 5% and * is significant at 10%*

The result obtained in present studies is in consonance with (Adigun *et al*., 2011) who reported in sheep that feeding of Moringa leaf meal significantly increased body weight. Moringa oleifera have no deteriorating effect on weight gain, however higher body weight observed in experimental group could be attributed to good quality rumen by pass protein available in Moringa (Makkar and Becker).

The finding of the present investigation are in agreement with the earlier workers Zinder *et al.*, (2016) and Yusuf *et al*., (2018). Zinder *et al*., (2016) reported that *Moringa oleifera* silage inclusion in dairy cow ration do not affected the body weight gain. Yusuf *et al*., (2018) included Moringa oleifera leaf meal in the commercial feed supplement at the level of 0, 50, and 100g/kg dry matter. They reported non-significant difference in body weight gain among Moringa supplemented and non supplemented groups.

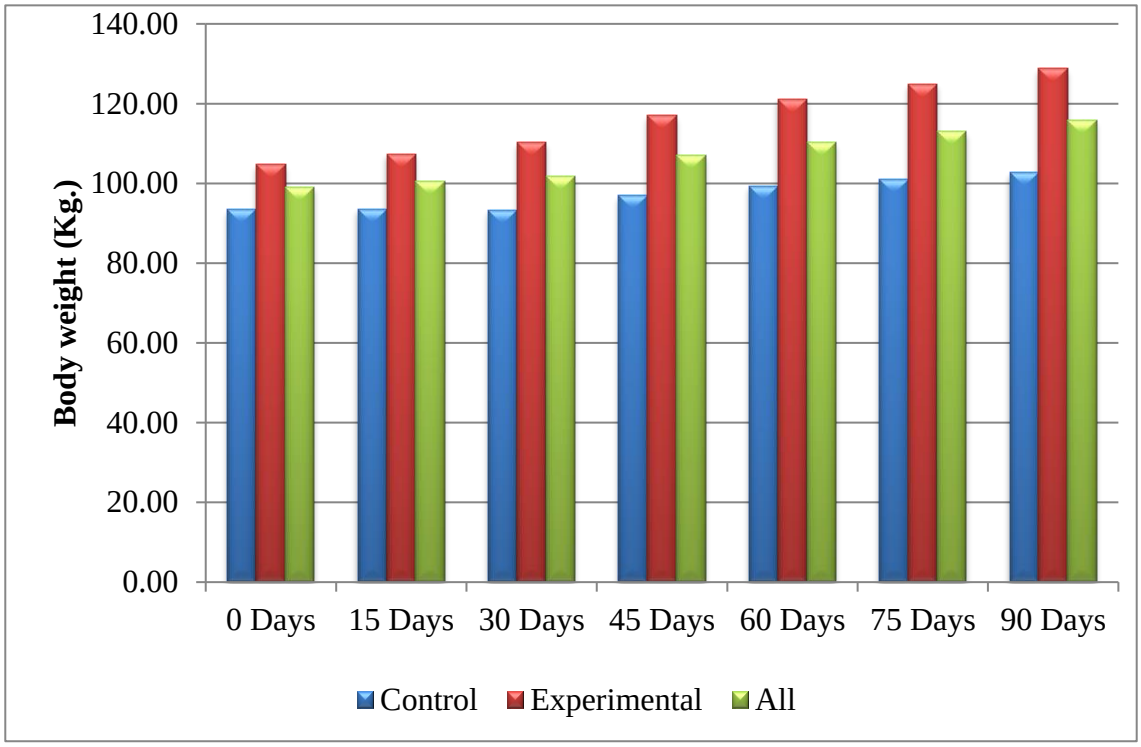

Fig 4.2.1: Average Body Weight (kg) of Sahiwal calves

4.2.2 Body weight gain (kg)

The average body weight gain (kg) in Sahiwal calves was 1.42±0.30 kg and 2.50±0.79 kg at 15 day of starts of experiment for control (T1) and experiment (T2) group of calves respectively (Table 4.2.2). Perusal of the table further reveals that at 3rd and 4th fortnight the change in average body weight was significant at (P<0.10). Level of significance was increased further from 5th fortnight which means as calves grows; the effect of Moringa feeding was very much significant. At 4th fortnight average body weight gain was 2.67±0.66 kg and 4.25±0.40 kg for T1 and T2group of calves respectively which was1.75±0.11 kg and kg and 4.00±0.44 kg in T1 and T2 group respectively at 6thfortnight (90 days).

This study is in agreement with Moyo *et al*., (2014), Aharwal *et al*., (2018), Ahmad *et al*., (2016), Babeker and Bdalbagi (2015), and Sultana *et al*., (2018).

Table: 4.2.2 Average body weight gain (kg) in Sahiwal calves during the experiment

Days	Control	Experiment	Significant
1st Fortnight	1.42±0.30	2.50±0.79	NS
2nd Fortnight	2.92±1.09	4.33±1.16	NS
3rd Fortnight	4.33±0.91	6.58±0.68	*
4th Fortnight	2.67±.66	4.25±0.40	*
5th Fortnight	1.75±0.17	3.75±0.30	***
6th Fortnight	1.75±0.11	4.00±0.44	***
All	2.47±0.30	4.24±0.33	***

NS: Non-Significant

Note: **** is significant at 1%, ** is significant at 5% and * is significant at 10%*

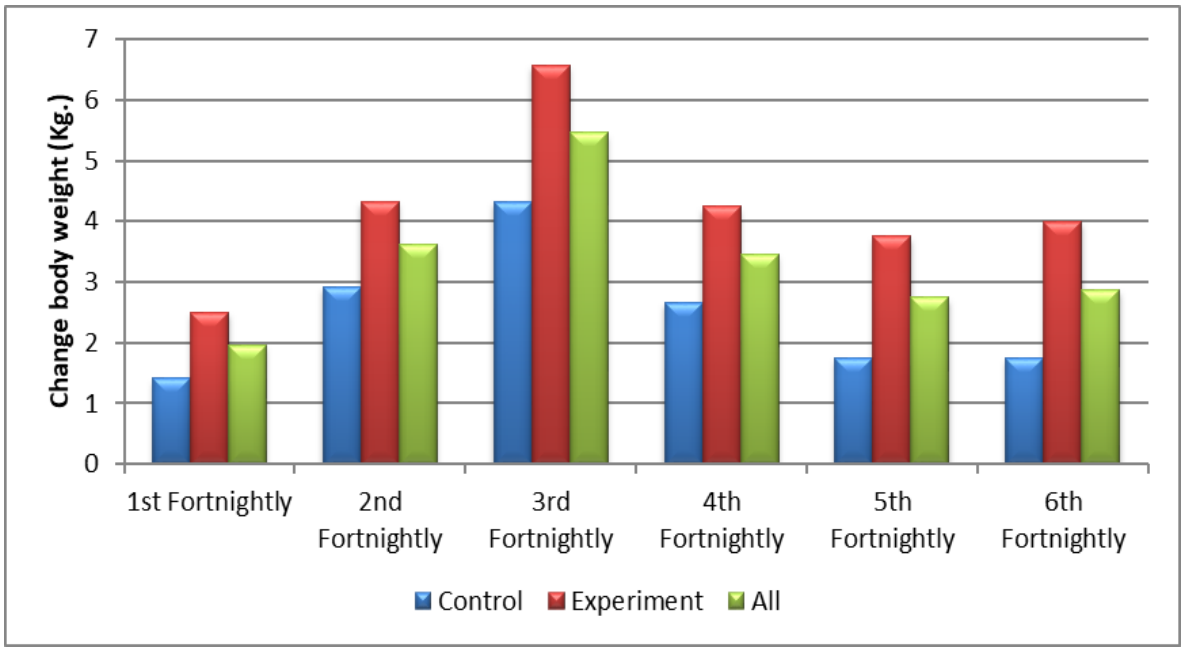

Fig 4.2.2: Average body weight gain (kg) in Sahiwal calves

4.2.3Average Daily Body Weight Gain (Kg/day)

Average daily body weight is calculated and presented in Table 4.2.3. Perusal of table 4.2.3 revels that average daily body weight gain at 1st fortnight was0.10±0.02 kg and 0.17±0.05 kg respectively in T1 and T2 groups, although this was non-significant between the T1 and T2 groups. Similarly, at 4thfortnight this was 0.18±0.04 kg and 0.29±0.02 kg for T1 and T2 groups respectively. This was 0.11± 0.01 kg and 0.26±0.02 at 6th fortnight respectively in T1 and T2 group.

Table: 4.2.3 Average Daily Weight Gain (Kg/day) in Sahiwal calves during the experiment

Days	Control	Experiment	Significant
1st Fortnight	0.10±0.02	0.17±0.05	NS
2nd Fortnight	0.19±0.07	0.30±0.08	NS
3rd Fortnight	0.29±0.06	0.44±0.05	NS
4th Fortnight	0.18±0.04	0.29±0.02	*
5th Fortnight	0.12±0.01	0.25±0.02	***
6th Fortnight	0.11± 0.01	0.26±0.02	***
All	0.16±0.01	0.28±0.02	***

NS: Non-Significant

Note: **** is significant at 1%, ** is significant at 5% and * is significant at 10%*

The statistical analysis of data as shown in Table 4.2.3 reveals that during 4th (P<0.10), 5th (P<0.01) and 6th fortnight (P<0.01) significant difference among the groups T1 and T2 were observed. Similar findings were also observed by Aharwal et al., (2018), Choudhary et al., (2018), Sultana et al., (2018), Babiker et al., (2017), Ahmad et al., (2016), and Aye, (2016).

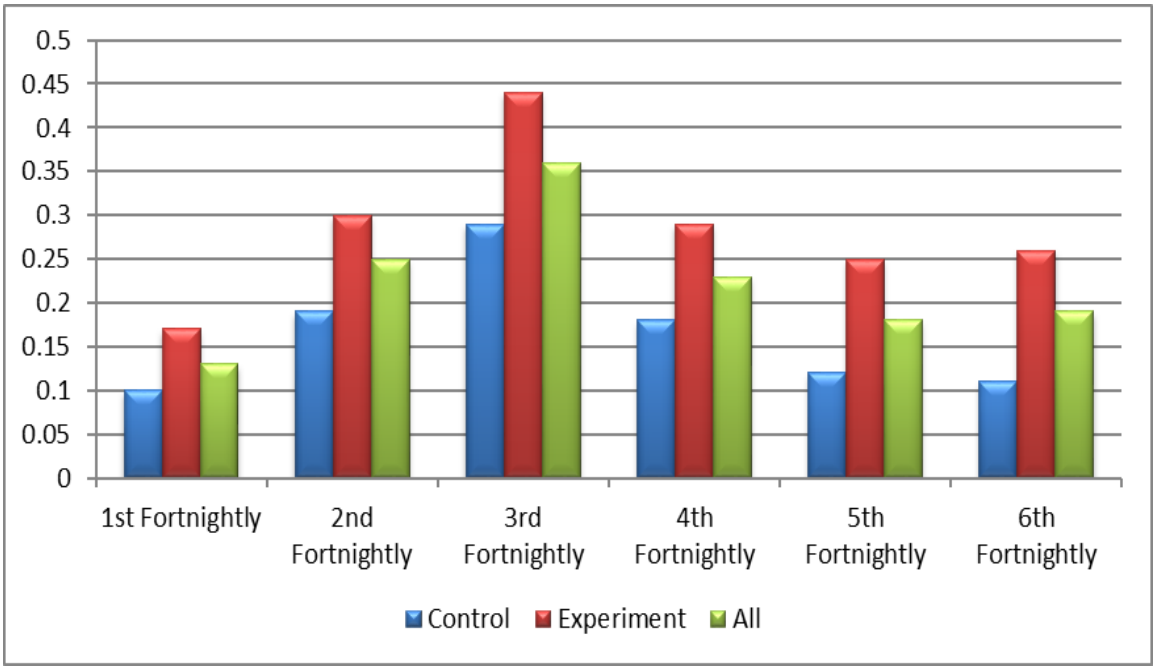

Fig4.2.3: Average Daily Weight Gain (Kg/day) in Sahiwal calves

4.2.4 Feed Intake

Feed intake is key process which determines the quality of feed stuff which is ingested over a period of time usually a per day (Mc Donald *et al*, 1993). The average daily dry matter intake per calves in both the treatment group T1 and T2 was calculated and presented in Table 4.2.4. This revels that (table 4.2.4) during 1st fortnight, dry matter intake (kg/day) in Sahiwal calves was2.26±0.08 kg in T1 groups and 2.43±0.04 kg in T2 groups. It also to note that animals in both the groups were consuming maximum at 6th fortnight (2.62±0.04 kg in T1 and 2.63±0.04 kg in T2) as their animal increase their size.

Table 4.2.4 also indicates that average feed intake in both the treatment groups were not significant. However, over all mean of average feed intake in both the treatment group T1 and T2 were differ significantly (P<0.10). Results obtained in present study is in concurrence with, Aregheore (2002), Asaolu *et al.,* (2010), Ali (2017), Damor *et al.,* (2017a) and in contrary to our finding, Sanchez *et al*., (2006), Babeker and Bdalbagi (2015), and Kholif *et al.,* (2017) reported significant dry matter intake.

Table: 4.2.4 Average Feed Intake on the basis of Dry matter (kg/day) in Sahiwal calves

Days	Control	Experiment	Significant
1st Fortnight	2.26±0.08	2.43±0.04	NS
2nd Fortnight	2.36±0.08	2.44±0.04	NS
3rd Fortnight	2.41±0.06	2.46±0.03	NS
4th Fortnight	2.45±0.05	2.47±0.03	NS
5th Fortnight	2.49±0.04	2.53±0.04	NS
6th Fortnight	2.62±0.04	2.63±0.04	NS
All	2.43±0.03	2.49±0.02	*

NS: Non-Significant

Note: **** is significant at 1%, ** is significant at 5% and * is significant at 10%*

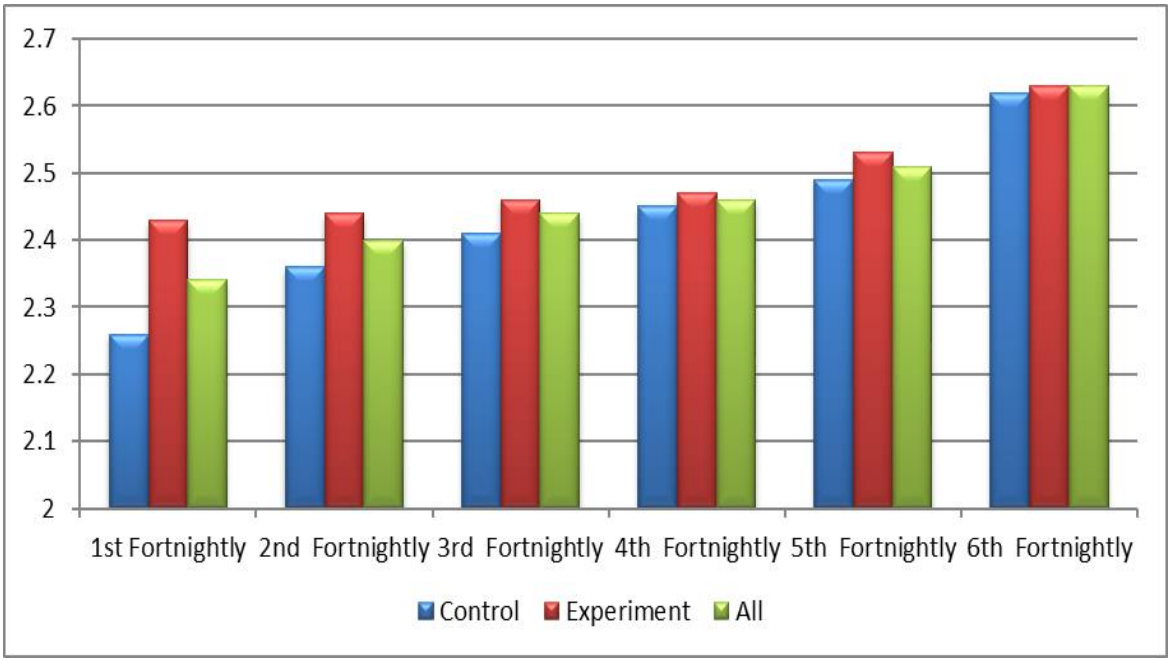

Fig 4.2.4: Average Feed Intake on the basis of Dry matter (kg/day) in Sahiwal calves

4.2.5Total dry matter intake (TDMI)

Fortnightly average total dry matter intake (kg) in Sahiwal calves has been depicted in Table 4.2.5. At 1st fortnight average total dry matter intake was 33.85±1.24 kg in T1 group and 36.38±0.69 kg in T2 group which was increase to 36.75±0.73 kg and 37.04±0.59 kg in T1 and T2 group respectively at 4th fortnight. It was at maximum (39.75±0.64 kg) in T1 and T2 (39.50±0.74 kg) groups at 6th fortnight. As far as statistical analysis is concerned, there was no significant difference was found between T1 and T2 groups during 1st to 6th fortnight in DMI but overall average total dry matter intake (kg) in Sahiwal calves were found significant difference at (P<0.10) during the experiment period.

Dry matter intake is very important in the utilization of feed by ruminants and is a critical determinant of energy intake and performance (Devendra, 1997). In present study dry matter intake was highest during the 6th fortnight period. This might be due to better adaptation, utilization of feed and increase in age of calves. Results obtained in present study was in concurrence with, Aregheore (2002), Asaolu *et al.*, (2010), Ali (2017), and Damor *et al.*, (2017a).

Table: 4.2.5 Average total dry matter intake (Kg) in Sahiwal calves

Days	Control	Experiment	Significant
1st Fortnight	33.85±1.24	36.38±0.69	NS
2nd Fortnight	35.42±1.22	36.66±0.63	NS
3rd Fortnight	35.79±1.01	36.94±0.59	NS
4th Fortnight	36.75±0.73	37.04±0.59	NS
5th Fortnight	37.30±0.72	38.25±0.64	NS
6th Fortnight	39.75±0.64	39.50±0.74	NS
All	36.48±0.47	37.46±0.30	*

NS: Non-Significant

Note: **** is significant at 1%, ** is significant at 5% and * is significant at 10%*

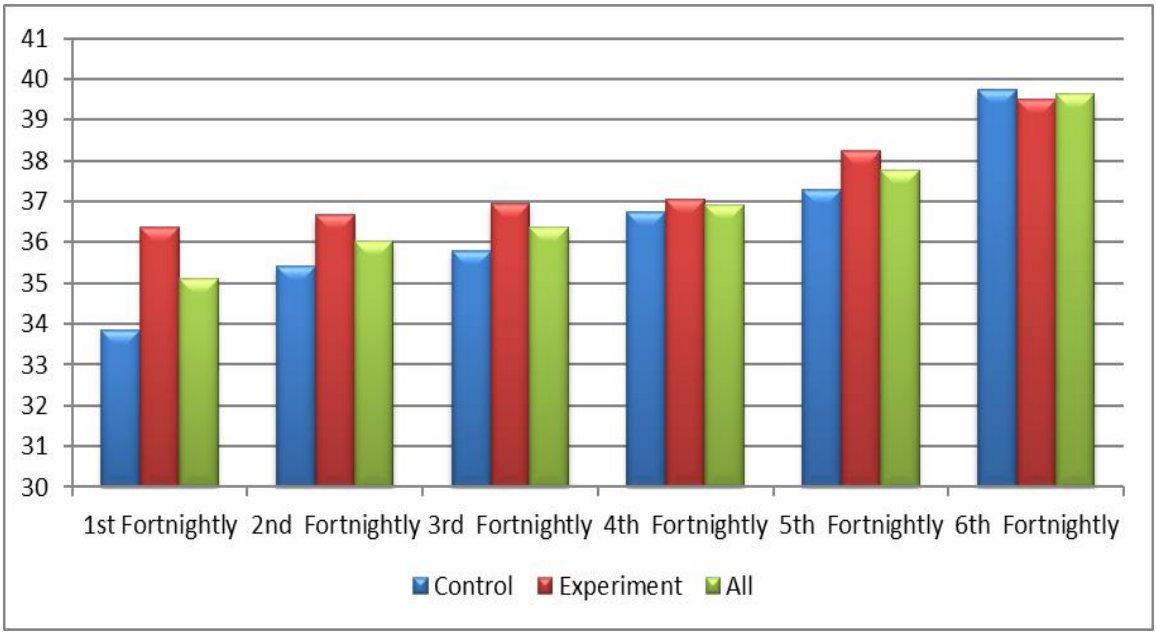

Fig 4.2.5: Average total dry matter intake (Kg) in Sahiwal calves

4.2.6 Feed Conversion Ratio (FCR)

The detail study has been presented in Table 4.2.6. Perusal of table 4.2.6 reveals that feed conversion ratio showed higher trend at all the fortnight in case of T1 group as compared to T2 group. This was 17.45±0.81 kg and15.87±2.68 kg in T1 and T2 groups respectively at 1stfortnight. At 4th fortnight, it was 15.87±2.68 kg and 8.90±0.87 kg in T1 and T2 group respectively. This was further higher at 6th fortnight in T1 (17.38±0.91 kg) and T2 (10.44±1.02kg) group.

Statistical analysis of data revealed significant changes among the T1 and T2 group from 3rd fortnight onward. At 5th and 6th fortnight feed conversion ratio difference were highly significant ($P<0.01$). Moringa has many important vitamins, minerals along with protein, amino acids which help calves to build muscle. It also packed with antioxidant that protect cell from damage and may boost immune system of calves.

Present study is also showing the similar trend of significant difference as shown by, Khalel *et al*., (2014), Babiker *et al*., (2017), and Ahmad *et al*., (2016).

Table: 4.2.6 Feed Conversion Ratio of Sahiwal calves

Days	Control	Experiment	Significant
1st Fortnight	17.45±0.81	15.87±2.68	NS
2nd Fortnight	13.23±2.06	12.43±2.90	NS
3rd Fortnight	10.53±2.27	5.89±0.55	**
4th Fortnight	15.87±2.68	8.90±0.87	**
5th Fortnight	17.46±1.03	10.59±0.96	***
6th Fortnight	17.38±0.91	10.44±1.02	***
All	14.98±0.75	10.69±0.84	***

NS: Non-Significant

***Note**: *** is significant at 1%, ** is significant at 5% and * is significant at 10%*

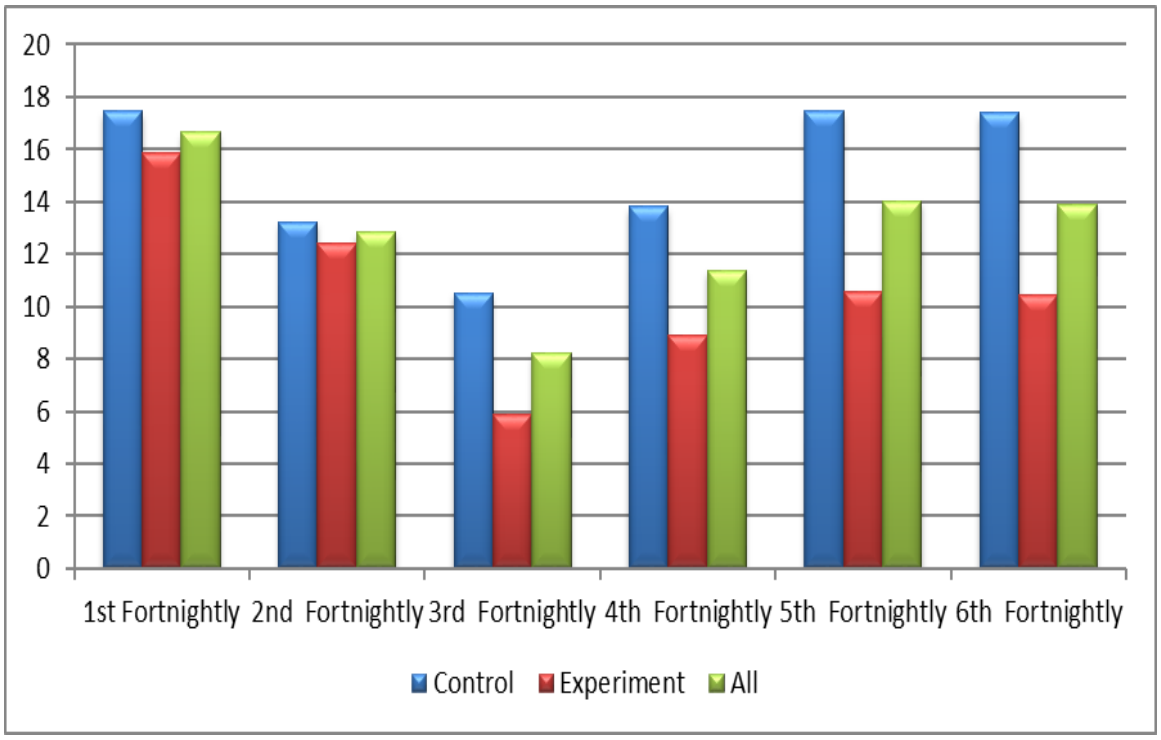

Fig 4.2.6: Feed Conversion Ratio of Sahiwal calves

4.2.7 Performance index (PI)

Average performance index of Sahiwal calves at different fortnight has been presented in Table 4.2.7. The performance index calculated at 1st fortnight was 0.11±0.01 kg in T1 and 0.29±0.14 kg in T2 group. It was maximum during 3rd fortnight in T1 (0.69±0.23 kg) and T2 (1.23±0.24 kg). Similarly, at 5th fortnight it was 0.13±0.01 kg in T1 and 0.38±0.06 kg in T2 groups. At 90-day study *i.e.* during 6th fortnight it was 0.14±0.01 kg and 0.44±0.11 kg in T1 and T2 group respectively.

There was significant difference found in performance index between the control and experiment group from 4th fortnight to 6th fortnight. Although in early days (1st to 3rd fortnight), there was no significant difference found between control and experiment group. This might be due to growing stage of animal. Growth rate may be higher in later stage of experiment. Further Moringa feeding might help in better feed utilization, nutrient absorption and nutrient supplementation.

Table: 4.2.7 Performance index of Sahiwal calves during the experiment

Days	Control	Experiment	Significant
1st Fortnightly	0.11±0.01	0.29±0.14	NS
2nd Fortnightly	0.22±0.05	0.74±0.39	NS
3rd Fortnightly	0.69±0.23	1.23±0.24	NS
4th Fortnightly	0.27±0.08	0.52±0.08	*
5th Fortnightly	0.13±0.01	0.38±0.06	**
6th Fortnightly	0.14±0.01	0.44±0.11	**
All	0.26±0.05	0.60±0.09	***

NS: Non-Significant

***Note**: *** is significant at 1%, ** is significant at 5% and * is significant at 10%*

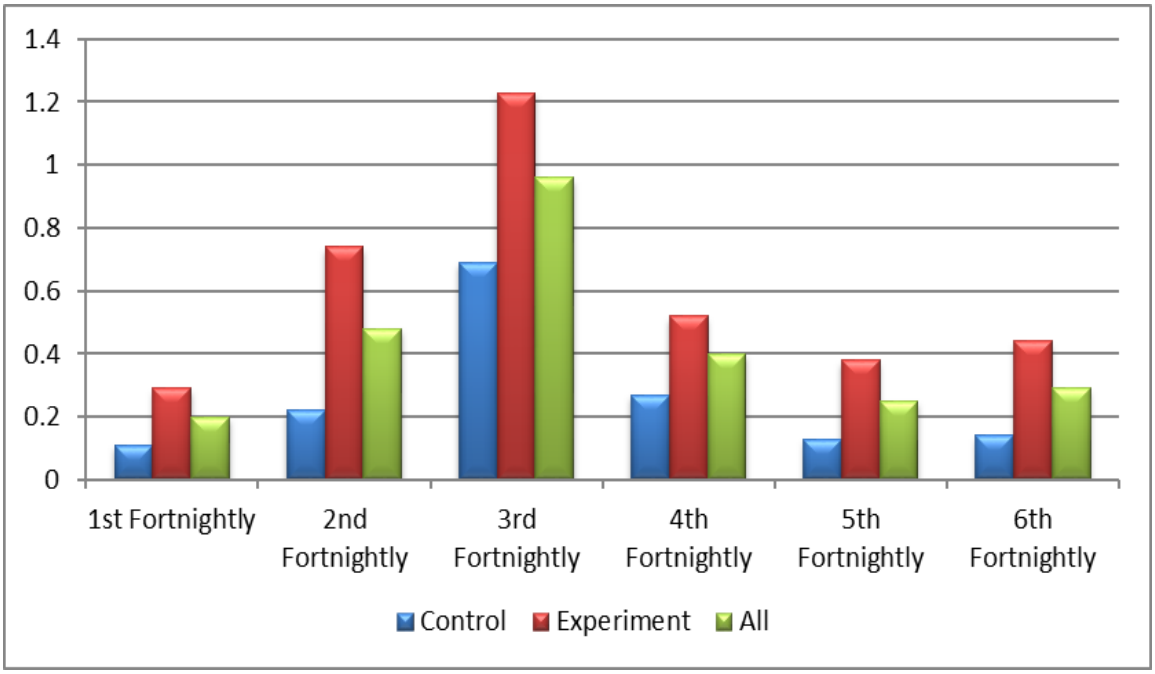

Fig 4.2.7: Performance index of Sahiwal calves

4.3 Effect of feeding *Moringa oleifera* on haemato-biochemical changes in Sahiwal calves

4.3.1 Total Erythrocyte count

According to Church et al 1984, evalution of blood profile of animals may give some potential of a dietary treatment to meet the metabolic needs of animal. Dietary component has measurable effect on blood constituent such that significant changes their value can be used to draw inference on the nutritive value offered to the animals. The various function of blood is made possible by individual and collective action of its consistent *i.e.* biochemical and haematological, which are influence by the quantity and quality of feed and level of anti-nutritional factor present in the feed including toxicity (Akinbamijo *et al.*, 2004).

Blood samples were collected through jugular vein of calves at 0, 30, 60, 90th day of experiment. These collected samples were analysed using haematological analyser for the study of haematological parameters. The findings of total erythrocyte count presented in Table 4.3.1. It reveals that at the start of experiment, total erythrocyte count was 4.93±0.28(x10^{6}/mm^{3}) in T1 and 5.58±0.27(x10^{6}/mm^{3}) inT2 groups. As study progress total erythrocyte count was increased in both the groups at 30th day of experiment, it was 5.17±0.31(x10^{6}/mm^{3}) and 5.90±0.19(x10^{6}/mm^{3}) respectively in T1 and T2 group. Further it

was found highest in both the group at 90th day of experiment, which is5.93±0.11(x10^6/mm^3) and6.45±0.15 (x10^6/mm^3) in T1 and T2 groups respectively. The statistical analysis of data as shown in table 4.3.1. reveal that there was significant difference found between the treatment groups at 5 % to 10% level which might be due to important nutritional attributes in the forms of minerals, vitamins, found in Moringa.

This study is in concurrence with Babeker and Bdalbagi (2015) and Jiwuba *et al.*, (2016) who reported significantly increase in total erythrocyte count value in goat fed Moringa leaves. However, the present study findings are in contrary to Ali, (2017).

Table: 4.3.1 Total Erythrocyte count (x10^6/mm^3) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	4.93±0.28	5.58±0.27	NS
30 Days	5.1 ±0.31	5.90±0.19	*
60 Days	5.70±0.14	6.12±0.14	*
90 Days	5.93±0.11	6.45±0.15	**
All	5.43±0.13	6.01±0.11	***

NS: Non-Significant

Note: **** is significant at 1%, ** is significant at 5% and * is significant at 10%*

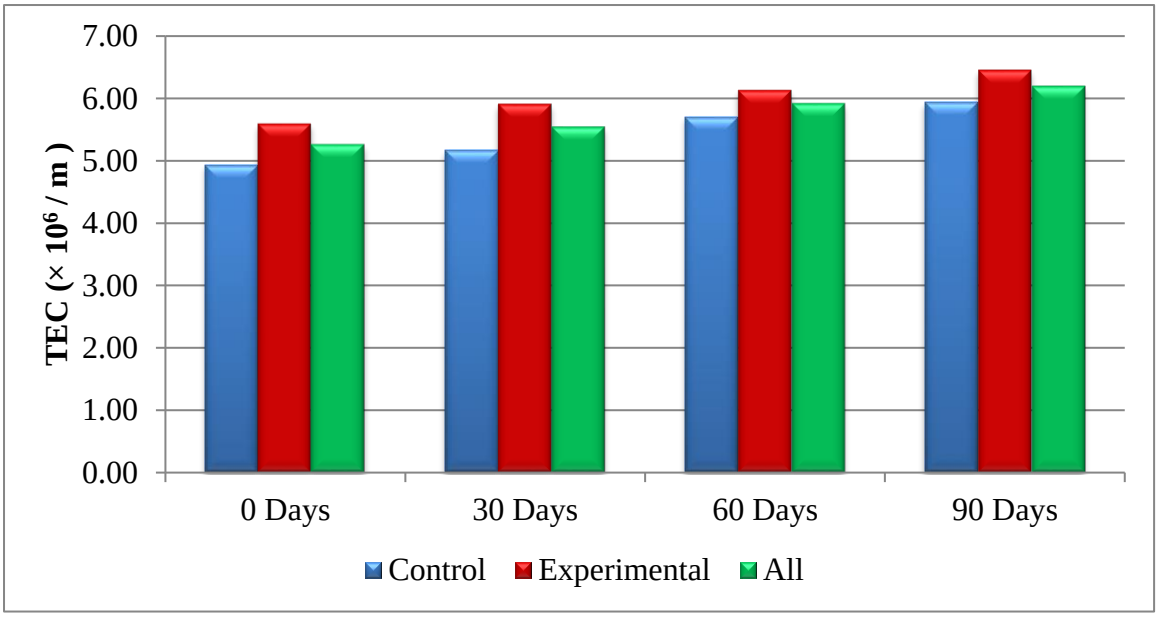

Fig 4.3.1: Mean Total Erythrocyte count (x10^6/mm^3) in Sahiwal calves

4.3.2 Total Leucocyte count

Leucocytes are involved in protecting the body from infection and are usually raised in acute infection (Saladin *et al*., 2007).

Blood examination on Sahiwal calves were done at 0, 30, 60, 90 days of experiment by using hematological analyzer. The findings oftotal leucocyte countvalue have been presented in Table 4.3.2. which is also depicted in fig 4.3.2. Overall mean total leucocyte count value were8.33±0.18 ($\times10^3/mm^3$) and 8.39±0.07 ($\times10^3/mm^3$) for T1 and T2 group respectively which was statistically non-significant. This is in agreement to Meel *et al.,* 2018 and Adegun *et al.,* 2011 in sirohi goat kid. Highest total leucocyte count in Sahiwal calves were found at 90^{th} days of experiment and this was 8.43±0.28 ($\times10^3/mm^3$) and 8.39 ±0.07($\times10^3/mm^3$) in T1 and T2 groups respectively. The trend of total leucocyte count was on higher side from start of experiment to the end of the experiment, however there was no significant difference found between Moringa fed (T2) and concentrate fed (T1) groups. Total leucocyte count in T2 group were in normal range which confirms that *Moringa oleifera* have antimicrobial, antifungal, antioxidant and anticancer property, which leads to keep animal healthy and free from infection.

Results of the present investigation are in accordance with Yusuf *et al*. (2018*),* who found non-significant difference in total leucocyte count among Moringa fed and concentrate fed goats.

Table: 4.3.2 Total Leucocyte count ($\times10^3/mm^3$) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	8.18±0.12	8.12±0.21	NS
30 Days	8.28±0.21	8.2 ±0.11	NS
60 Days	8.42±0.19	8.57±0.10	NS
90 Days	8.43±0.28	8.61±0.10	NS
All	8.33±0.18	8.39±0.07	NS

NS: Non-Significant

***Note**: *** is significant at 1%, ** is significant at 5% and * is significant at 10%*

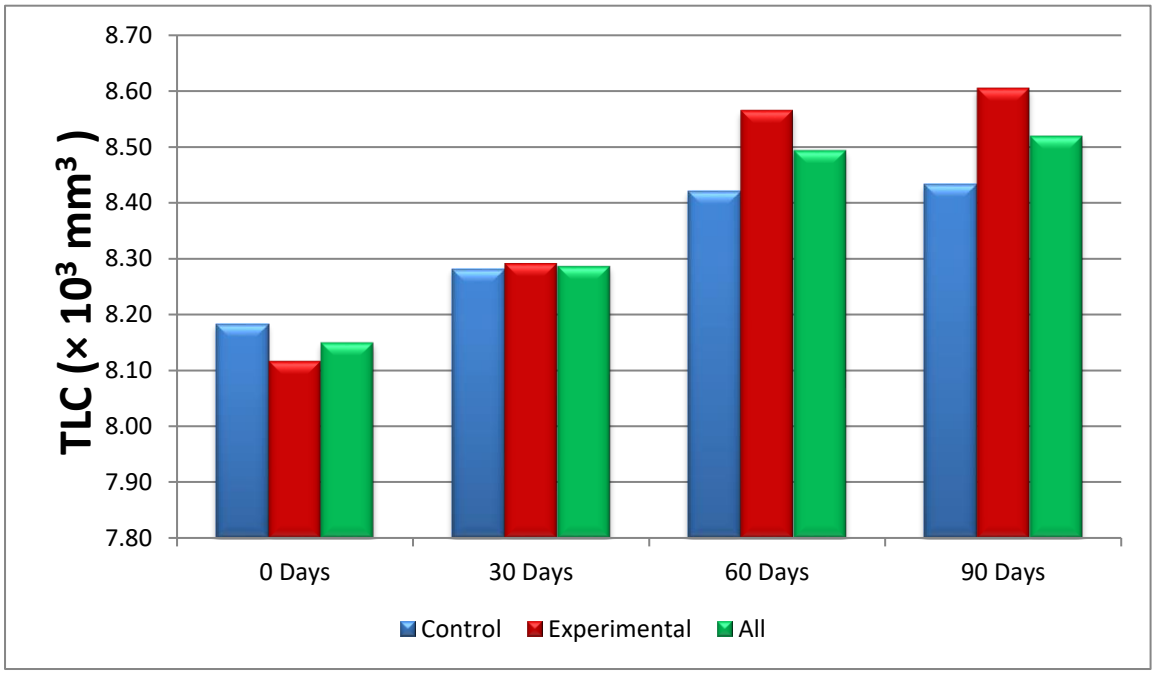

Fig 4.3.2: Mean Total Leucocyte count (×10^3/mm^3) in Sahiwal calves

4.3.3 Haemoglobin (Hb)

Blood examination of Sahiwal calves for the estimation of blood haemoglobin was performed at 0, 30, 60, 90 days by using haematological analyser. The findings of haemoglobin concentration has been presented in Table 4.3.3. The overall mean of Hb (g/dl) was10.8 ±0.31g/dl and11.84±0.31g/dl in control and experimental group respectively, which was statistically significant (P<0.05). Average Hb concentration at 30th of experiment was 10.25±0.66 g/dl and 11.57±0.58 g/dl in T1 and T2 group respectively. There was increasing trend found in Hb concentration in both control and experiment group with the increase in age of animal. This might be due to animal growing age and better feed utilization and nutrient absorption. This was further more in experimental group, this might be due to feeding of Moringa which is rich in mineral component like Fe, Ca, Cu and other hematopoietic substances.

The mean haemoglobin concentration of all groups were comparative and comes under the normal range of haemoglobin concentration as given by Smith, 2002 (8-15 g/dl).

Present findings of mean Hb concentration are in accordance with Yusuf *et al.,* (2018) who reported Hb value non-significantly higher in 100g/kg DM inclusion level of Moringa

leaves as compared to 50g/kg DM inclusion level of Moringa leaves group and no Moringa supplemented group.

Table: 4.3.3 Haemoglobin Concentration (g/dl) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	9.67±0.65	10.83±0.65	NS
30 Days	10.25±0.66	11.57±0.58	NS
60 Days	11.50±0.31	12.01±0.55	NS
90 Days	12.08±0.26	12.96±0.44	NS
All	10.87±0.31	11.8 ±0.31	**

NS: Non-Significant

***Note**: *** is significant at 1%, ** is significant at 5% and * is significant at 10%*

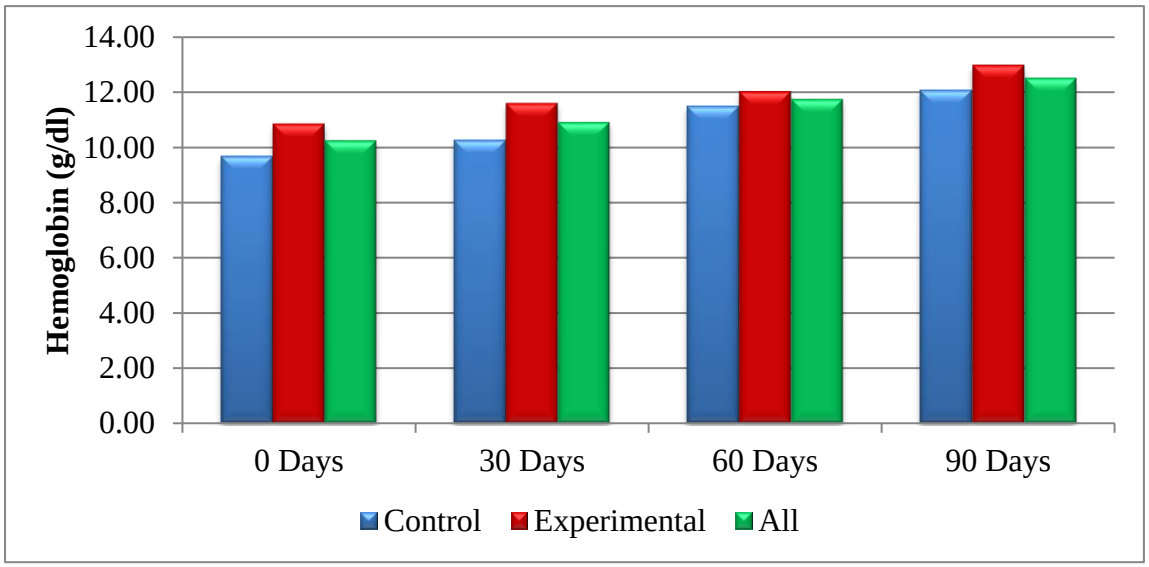

Fig 4.3.3: Mean Haemoglobin concentration (g/dl) in Sahiwal calves

4.3.4 Packed cell volume (%)

Blood examination of Sahiwal calves for packed cell volume estimation was performed at 0, 30, 60, and 90th day of experiment using haematological analyser. Results were tabled and presented in Table 4.3.4.

The overall mean of packed cell volume percentage was32.61±0.37mg/dl and 35.53±0.96mg/dl in T1 and T2 group respectively which was statistically significant (P<0.05).

Average packed cell volume percentage at start of experiment was 29.00±0.79mg/dl and 32.50±1.4mg/dl in T1 and T2 group respectively. At 30thday experiment it was 30.75±0.47mg/dl and 34.72±1.6mg/dl in T1 and T2 group respectively. Highest packed cell volume percentage of 36.20±0.51mg/dl and 36.20±1.4mg/dl was found in experiment at 90th days.

Table: 4.3.4 Packed cell volume (%) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	29.00±0.79	32.50±1.4	NS
30 Days	30.75±0.47	34.72±1.6	NS
60 Days	34.50±0.47	36.03±1.7	NS
90 Days	36.20±0.51	36.20±1.4	NS
All	32.61±0.37	35.53±0.96	**

NS: Non-Significant

***Note**: *** is significant at 1%, ** is significant at 5% and * is significant at 10%*

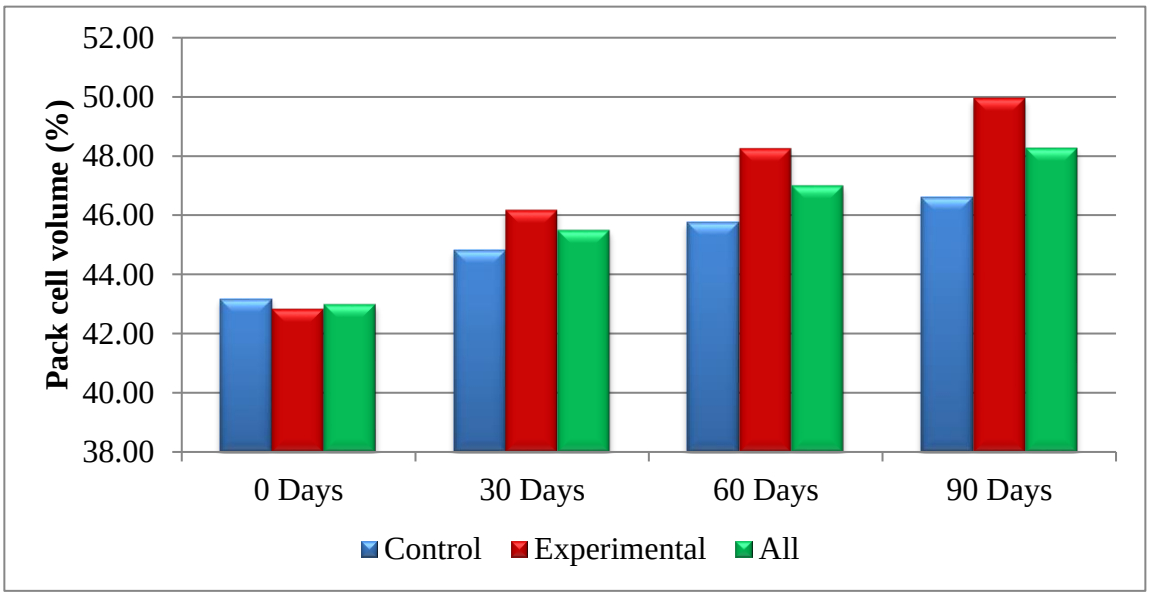

Fig 4.3.4: Mean Packed cell volume in Sahiwal calves

Statistically at all the experimental group there was no significant difference found in PCV value, however overall mean was having significant difference between T1 and T2 group. The PCV of all the groups were under normal range (24-46%) as given by Smith (2002). PCV

value recorded in normal range suggested that all diets were equally good in sustaining good health of calves.

In consonance with the study, Haridas (2018) found that 10% and 20% replacement of cotton seed cake with *M. oleifera* leaves meal in concentrate mixture do not affect the PCV value in goat.

Slight elevation in total erythrocyte count, total leucocyte count, packed cell volume and hemoglobin in experimental groups (T2) in respect to control group (T1) may be due to *M. oleifera* leaves are rich in all essential amino acids, vitamins and minerals particularly iron (Foidl and Paull, 2008). Iron is necessary for many functions in the body including the formation of hemoglobin and myoglobin (Elbashier and Ahmed, 2016). Ascorbic acid present in Moringa increase the absorption of iron by supporting the mechanism of converting ferric to ferrus form (Suzana *et al.,* 2017). Protein also contributes to the activity of erythropoiesis by providing amino acids for porphyrin, globin and transferrin synthesis (Koury and Pokka, 2004). Besides these *Moringa oleifera* has been reported to contain bioactive compound viz. alkaloids, flavonoids, phytosterols and saponin, which are known to possess hematopoietic property that have direct influence on the production of blood in the bone marrow (Hewitt *et al.,*1989). These all factors contribute to its beneficial effects on red blood cells hence higher values indicates a better health status in Moringa feeding on Sahiwal calves.

4.4 Effect of feeding *Moringa oleifera* on biochemical parameters

4.4.1 Serum Calcium

Perusual of the Table 4.4.1 indicates that overall mean of serum calcium was10.80±0.12 (mmol/lit) and 11.32±0.09 (mmol/lit) in T1 and T2 group respectively, which was statistically highly significant (P<0.01). At the start of experiment serum calcium was 10.57±0.33 (mmol/lit) and 10.81±0.20 (mmol/lit) in T1 and T2 group respectively. At 30 day of analysis serum calcium was 11.34±0.23(mmol/lit) and11.46±0.10(mmol/lit) in T1 and T2 respectively, which was non-significant. At 60th day of analysis serum calcium was 10.6±0.15 (mmol/lit) and 11.50 ±0.09 (mmol/lit) in T1 and T2 group respectively, which was highly significant (P<0.01). This level was further rises to 10.66±0.11 (mmol/lit) and 11.54±0.12 (mmol/lit) at 90th day of blood collection in T1 and T2 group respectively and it was also found highly significant (P<0.01). This might be due to increased bioavailability of calcium to Sahiwal calves due to feeding of Moringa.

The results obtained in present study are in agreement with (Gopalakrishnan *et al.*, 2016, Mahmood *et al.*, *2010, Newton et al., 2010*).

Table: 4.4.1 Serum Calcium (mmol/lit) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	10.57±0.33	10.81±0.20	NS
30 Days	11.34±0.23	11.46±0.10	NS
60 Days	10.63±0.15	11.50±0.09	***
90 Days	10.66±0.11	11.54±0.12	***
All	10.80±0.12	11.32 ±0.09	***

NS: Non-Significant

***Note**: *** is significant at 1%, ** is significant at 5% and * is significant at 10%*

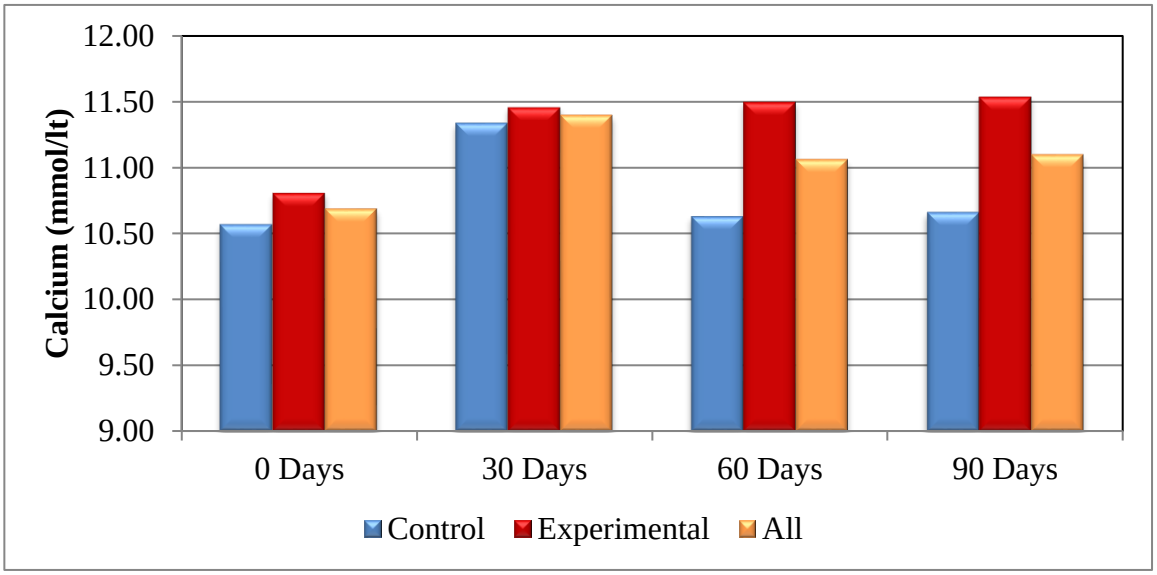

Fig 4.4.1: Mean Serum Calcium (mmol/lit) in Sahiwal calves

4.4.2 Serum Potassium

Perusal of the table 4.4.2 reveals that overall mean of serum potassium was4.45±0.08 (mmol/lit) and 4.85±0.13 (mmol/lit) in T1 and T2 group respectively, which was statistically significance (P<0.05). At starts of the experiment serum potassium was 4.33±0.19 (mmol/lit) and 4.54±0.22 (mmol/lit) in T1 and T2 group respectively. At 60thday of analysis, potassium was 4.49±0.16 (mmol/lit) in T1 and T2 group respectively which was also non-significant. This

level was further rise to 4.57±0.16 (mmol/lit) and 5.36±0.20 (mmol/lit) at 90th day of blood collection in T1 and T2 group respectively. This might due to rich potassium in *Moringa oleifera*.

Table: 4.4.2 Serum Potassium (mmol/lit) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	4.33±0.19	4.54±0.22	NS
30 Days	4.40±0.18	4.66±0.23	NS
60 Days	4.49±0.16	4.86±0.25	NS
90 Days	4.57±0.16	5.36±0.20	**
All	4.45±0.08	4.85±0.13	**

NS: Non-Significant

***Note**: *** is significant at 1%, ** is significant at 5% and * is significant at 10%*

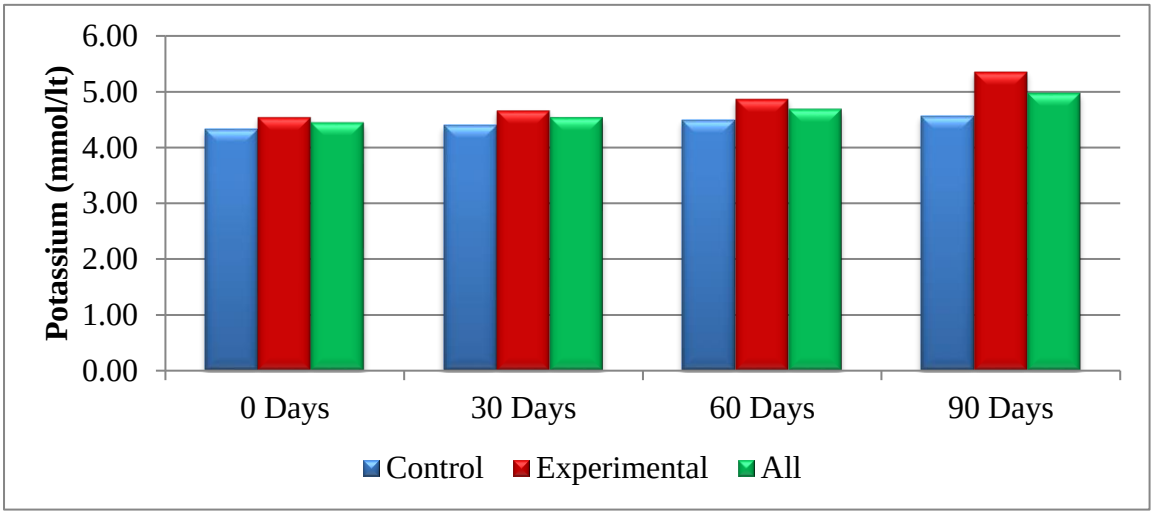

Fig 4.4.2: Mean Serum Potassium (mmol/lit) in Sahiwal calves

With regards to its nutritional composition, *M. oleifera* leaves have been reported to contain higher amount of vitamins C than orange, higher vitamin A than carrots, more amount of calcium than milk, higher potassium than banana and higher iron than spinach (Gopalakrishnan *et al.*,2016, Mahmood *et al., 2010, Newton et al., 2010*).

4.4.3 Serum Sodium

Perusal of the Table4.4.3indicates that overall mean of serum sodium was142.74±0.95 (mmol/lit) and 143.89±1.07 (mmol/lit) in T1 and T2 group respectively, which was non-

significant. At start of the experiment serum sodium level was 138.83±1.42 (mmol/lit) and 138.33 ± 1.83 (mmol/lit) in T1 and T2 group respectively which were non-significant. At 60th day of analysis serum potassium was 143.48±1.63 (mmol/lit) and 147.17±0.74 (mmol/lit) in T1 and T2 group respectively which was significant ($p<0.01$). This might due to high level of sodium present in Moringa. The results obtained in present study is in agreement with Mahmood *et al., (2010*).

Table: 4.4.3 Serum Sodium (mmol/lit) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	138.83±1.42	138.33±1.83	NS
30 Days	141.30±1.62	141.33±1.54	NS
60 Days	143.48±1.63	147.17±0.74	*
90 Days	147.33±1.25	148.73±0.71	NS
All	142.74±0.95	143.89±1.07	NS

NS: Non-Significant

***Note**: *** is significant at 1%, ** is significant at 5% and * is significant at 10%*

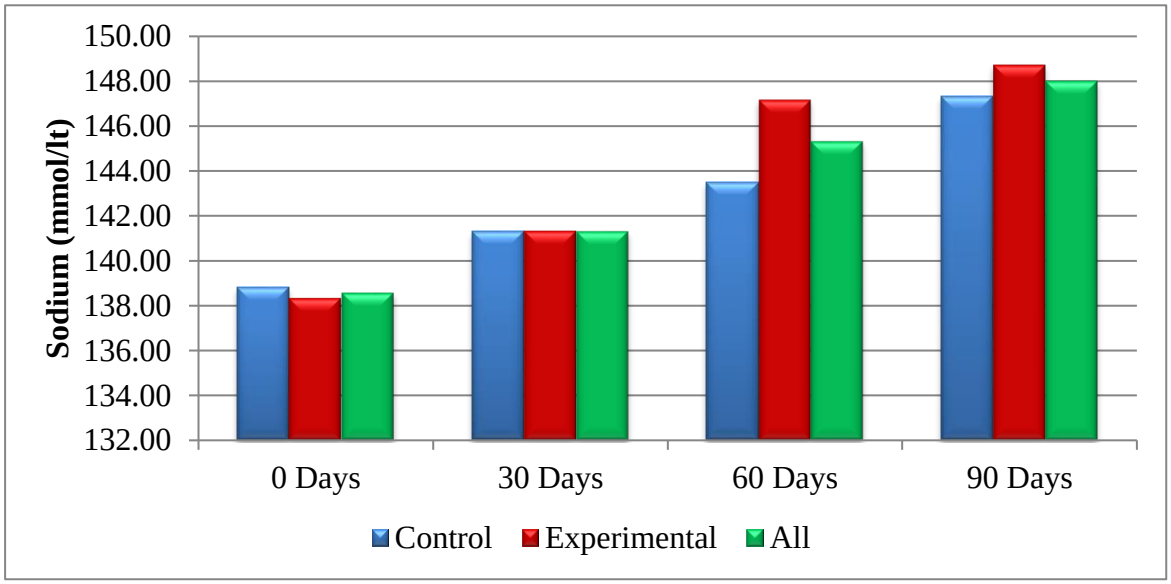

Fig 4.4.3: Mean Serum Sodium (mmol/lit) in Sahiwal calves

4.4.4 Serum Glucose

Serum glucose was recorded at 0, 30, 60, and 90th day of the study. Perusal of the table 4.4.4.reveals that overall mean of serum glucose was57.70±1.04 mg/dl and 58.20±0.93 mg/dl

in T1 and T2 group respectively. At start of the experiment serum glucose was 53.83±2.15 mg/dl and 53.83±1.74 mg/dl in T1 and T2 group respectively, which was non-significant. Highest average serum glucose was found in 90thday of experiment and it was 61.60±1.25 mg/dl and 61.61±1.30 mg/dl in T1 and T2 group respectively. In present study serum glucose ranges between 53.83±2.15 to 61.61±1.30mg/dl and fell within (45 -75 mg/dl) for calves. The low glucose level indicates that it is suitable for human diabetic consumption, as the presence of flavonoids. Farooq *et al.* (2007), stated that the *Moringa oleifera* plant is one of the highly potential antidiabetic plants, probably because of the presence of the ability of its compounds and some flavonoids to inhibit **α**-amylase activity to regulate the amount of glucose in the blood.

Results obtained in present study are in agreement with Damor *et al*., 2017, and Ali, 2017 who reported non-significance difference in serum glucose value in goat fed Moringa leaves by replacing concentrate mixture. However, the present findings are in disagreement with the observation done by Babeker and Bdalbagi (2015) who reported significant decrease in serum glucose value in goat fed Moringa leaves at 20% in goat ration.

Table: 4.4.4 Serum Glucose (mg/dl) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	53.83±2.15	53.83±1.74	NS
30 Days	56.33±2.04	57.67±1.38	NS
60 Days	59.02±1.71	59.70±1.70	NS
90 Days	61.60±1.25	61.61±1.30	NS
All	57.70±1.04	58.20±0.93	NS

NS: Non-Significant

Note : *** is significant at 1%, ** is significant at 5% and * is significant at 10%

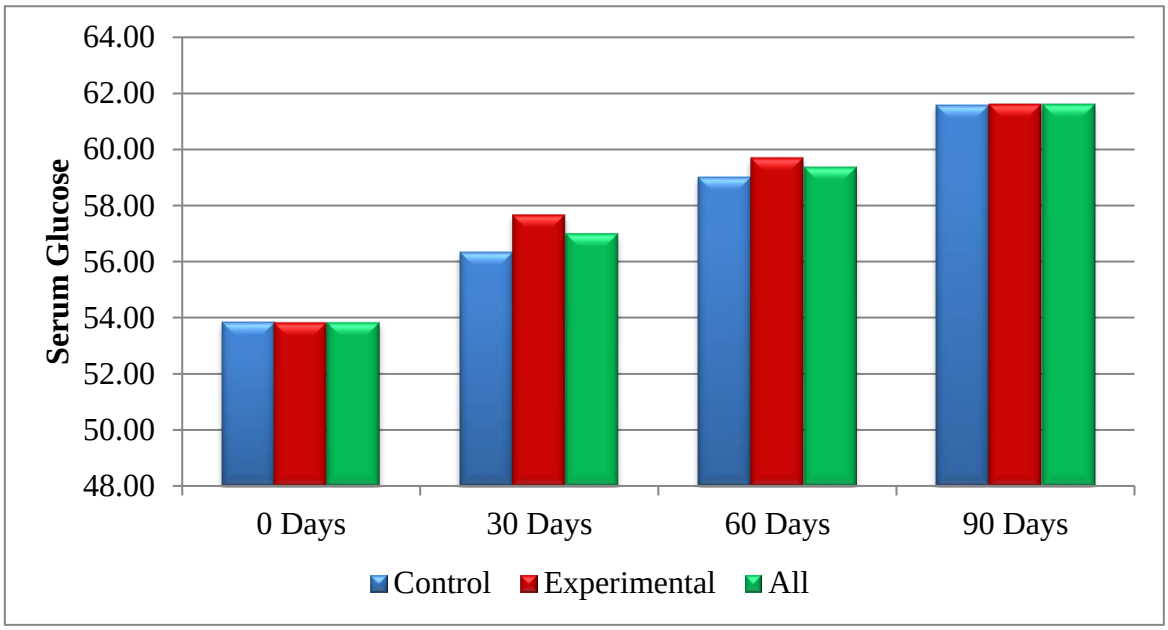

Fig 4.4.4: Mean Serum Glucose (mg/dl) in Sahiwal calves

4.4.5 Serum Creatinine

Serum examination of Sahiwal calves for serum creatinine performed at 0, 30, 60 and 90th day of experiment by using biochemical analyser. The finding of serum creatinine had been presented in table 4.4.5.

Table: 4.4.5 Serum Creatinine (mg/dl) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	0.94±0.04	1.09±0.07	NS
30 Days	1.05±0.02	1.19± 0.04	**
60 Days	1.2 ±0.02	1.14±0.05	NS
90 Days	1.21±0.03	1.16±0.03	NS
All	1.10±0.03	1.15± 0.03	NS

NS: Non-Significant

***Note**: *** is significant at 1%, ** is significant at 5% and * is significant at 10%*

The overall mean of serum creatinine was 1.10±0.03 mg/dl and 1.15±0.03 mg/dl in T1 and T2 group respectively, which was non-significant. Average serum creatinine at start of the experiment was 0.94±0.04 mg/dl and 1.09±0.07 mg/dl in T1 and T2 group respectively. The result obtained in present study are in agreement with Mahmoud (2013).

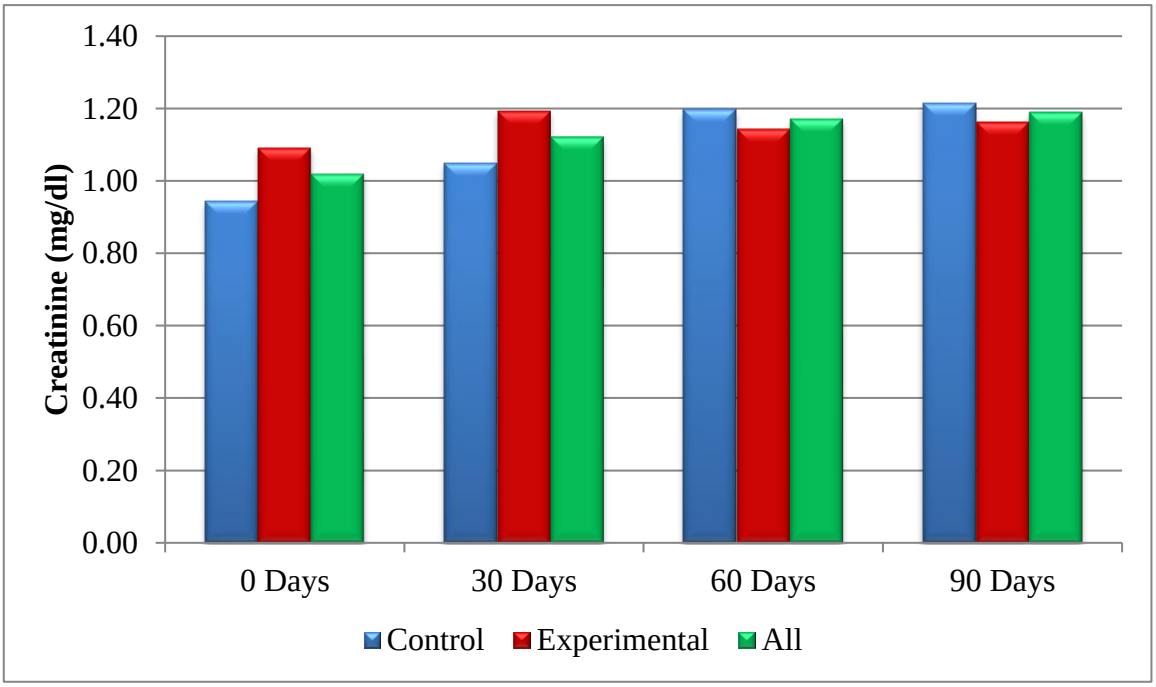

Fig 4.4.5: Mean Serum Creatinine (mg/dl) in Sahiwal calves

4.4.6 Blood Urea Nitrogen (BUN)

Blood urea nitrogen is an indicator of normal kidney and liver function. Blood urea nitrogen examination of Sahiwal calves were recorded at 0, 30, 60 and 90th day of experiment by using biochemical analyser. The finding of blood urea nitrogen has been presented in Table4.4.6.

Overall mean of blood urea nitrogen was 22.80±0.23 mg/dl and 23.90±0.29 mg/dl in T1 and T2 group respectively, which was significant (P<0.01). At start of the experiment, blood urea nitrogen was 22.13±0.39 mg/dl and 23.52±0.57 mg/dl in T1 and T2 group respectively, which was significant at (P>0.10). At 30, 60, and 90th day of experiment blood urea nitrogen was 22.90±0.50 mg/dl, and 24.13±0.71 mg/dl, 23.3±0.44 mg/dl and 24.33±0.67 mg/dl and 22.87±0.51 mg/dl and 22.87±0.51 mg/dl in T1 and T2 group respectively, which was also non-significant. All the value of blood urea nitrogen was under the normal range (20-30 mg/dl) as cited by (Kaneko et al., 2008).

Slightly increase in blood urea nitrogen in T2 group might be due to high level of protein in Moringa and its increased metabolism, absorption and utilization. Slightly increased blood urea nitrogen concentration can also be useful in urea recycling in ruminants, which is vital for growth and maintenance (Yusuf *et al.*,2018).

Table: 4.4.6 Blood Urea Nitrogen (mg/dl) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	22.13±0.39	23.52±0.57	*
30 Days	22.90 ±0.50	24.13±0.71	NS
60 Days	23.32±0.44	24.33±0.67	NS
90 Days	22.87±0.51	22.87±0.51	NS
All	22.80±0.23	23.90±0.29	***

NS: Non-Significant

Note: **** is significant at 1%, ** is significant at 5% and * is significant at 10%*

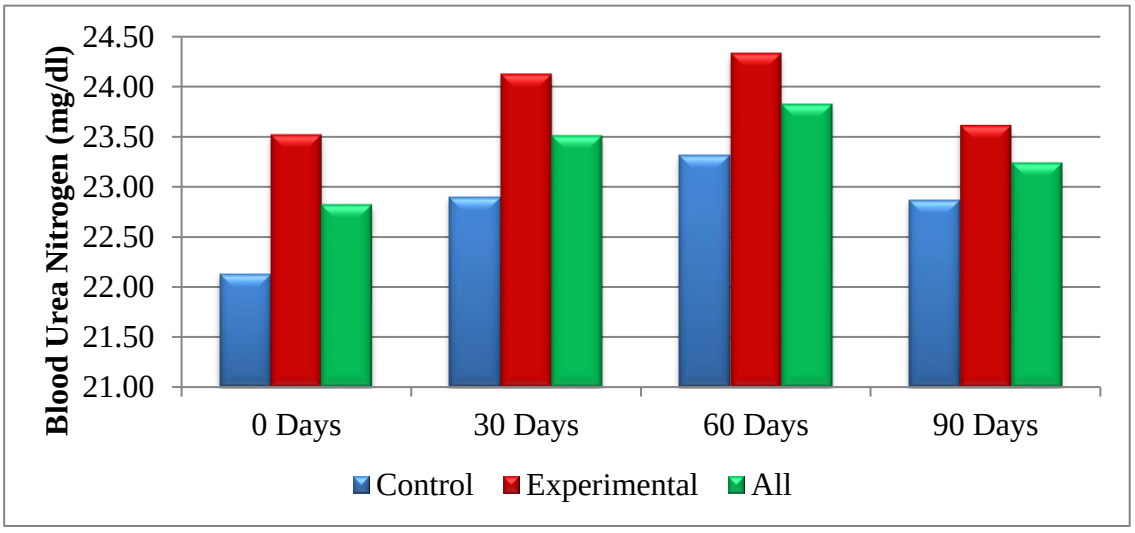

Fig 4.4.6: Mean Blood Urea Nitrogen (mg/dl) in Sahiwal calves

4.4.7 Serum Albumin

Serum albumin was recorded at 0, 30, 60, 90thdays of the study by using biochemical analyser. The finding of serum albumin value in group has been presented in Table 4.4.7 which has also been depicted in figure 4.4.7.

Overall mean of serum albumin was3.20±0.015 g/dl and 3.33±0.03 g/dl in T1 and T2 group respectively, which was highly significant (p<0.01). At start of the experiment serum albumin was 3.10±0.025 g/dl and 3.21±0.02 g/dl in T1 and T2 group respectively which was also highly significant at (p<0.01). At 30 days and 90th day of experiment serum albumin was 3.21±018g/dl and 3.29 ±0.03 g/dl, 3.25±.019 g/dl and 3.48±0.07 g/dl in T1 and T2 group respectively which was also significant at (P<0.05).

Table: 4.4.7 Serum Albumin (g/dl) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	3.10 ± .025	3.21± 0.02	***
30 Days	3.21 ± .018	3.29 ±0.03	**
60 Days	3.23 ±.019	3.35 ±0.03	***
90 Days	3.25 ±.019	3.48 ± 0.07	**
All	3.20 ±.015	3.33 ± 0.03	***

NS: Non-Significant

Note: **** is significant at 1%, ** is significant at 5% and * is significant at 10%*

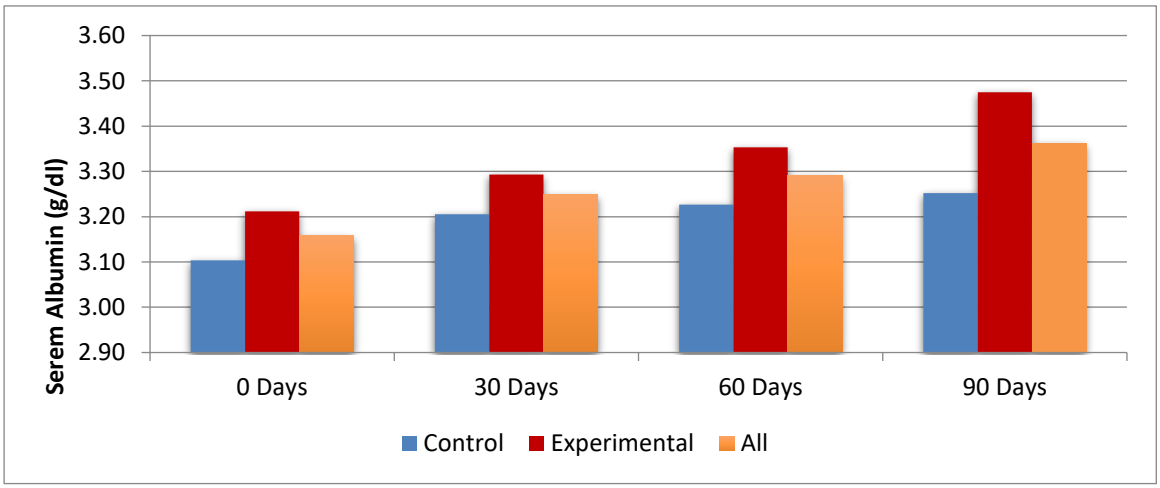

Fig 4.4.7: Mean Serum Albumin (g/dl) in Sahiwal calves

Serum albumin value ranges from 3.10-3.33 g/dl which is well within normal range 3-4.3 g/dl as per Smith (2002). Although, level of serum albumin in the experimental group is slightly higher in respect to control group. The results obtained in the present study are in agreement with Babeker and Bdalbagi (2015), Damor *et al.*, 2017 who reported significant difference in serum albumin value in goats fed Moringa leaves by replacing concentrate mixture.

4.4.8 Total Serum Protein

Total serum protein was recorded at 0, 30, 60, and 90 day of the study using biochemical-analyser (Table 4.4.8). Overall mean of total serum protein was6.81±0.03 g/dl and 6.94±0.04 g/dl in T1 and T2 group respectively, which was significant (P<0.05). At start of the experiment, total serum protein was 6.62±0.05 g/dl and 6.73±0.11 g/dl in T1 and T2 group respectively, which was also non-significant. At 30th day of experiment, total serum protein was 6.80±0.03 g/dl and 6.96±0.06 g/dl in T1 and T2 group respectively, which was significant at (P<0.05). At 60 day and 90 day of experiment total serum protein was 6.87± 0.03 g/dl, 6.87±0.03 g/dl and 6.95±0.04 g/dl, 7.08±0.05 g/dl in T1 and T2 group respectively, which was significant at (P<0.10).

Table: 4.4.8 Total Serum protein (g/dl) in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	6.62±0.05	6.73±0.11	NS
30 Days	6.80±0.03	6.96±0.06	**
60 Days	6.87±0.03	6.87±0.03	*
90 Days	6.95±0.04	7.08±0.05	*
All	6.81±0.03	6.94±0.04	**

NS: Non-Significant

***Note**: *** is significant at 1%, ** is significant at 5% and * is significant at 10%*

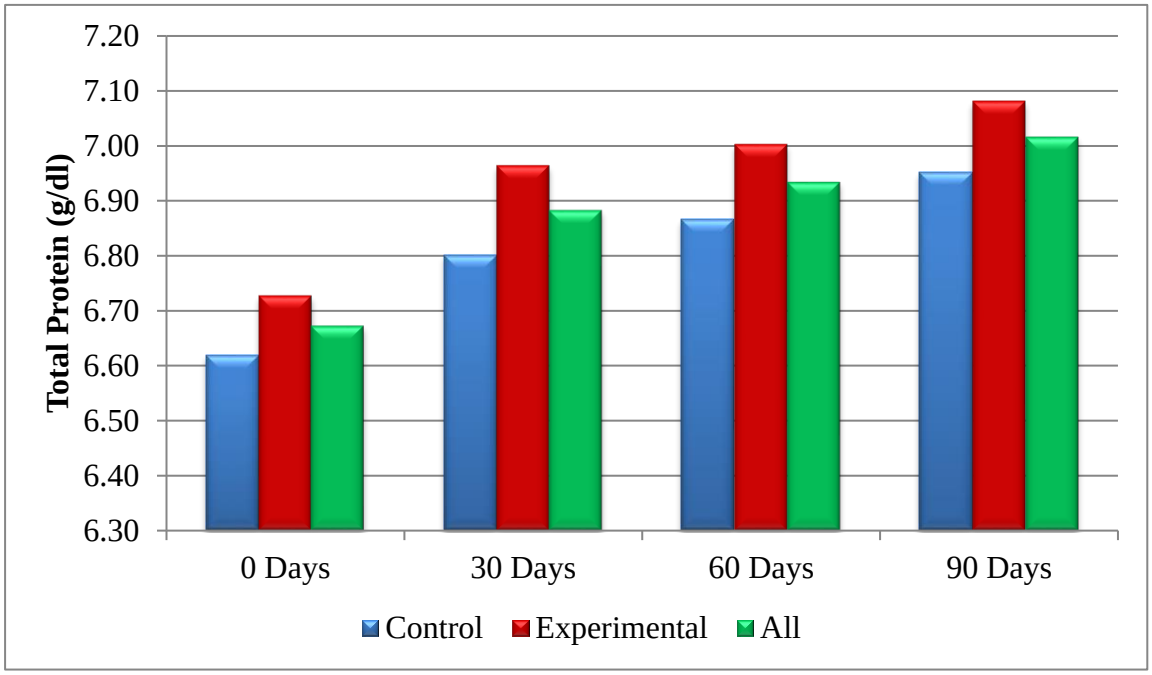

Fig 4.4.8: Mean Total Serum protein (g/dl) in Sahiwal calves

Highest average serum total serum protein was found at 90 days of experiment which was 6.95 ±0.04 g/dl and 7.08±0.05 g/dl in T1 and T2 group respectively. Normal range of total serum protein range as per Smith (2000) is 6.2 to 8.6 g/dl. The higher value of total seum protein obtained is safe and advantageous, and not possess any harmful effect because they impact the quality of rumen undegradable protein and improve protein utilization. Moringa leaves are also a source of good quality protein; it improves microbial protein synthesis in rumen (Soliva *et al.*, 2005). The results of total serum protein are in agreement with the Khalel *et al.*, (2014), and Damor *et al.*, (2017b).

4.4.9 Serum Globulin

Serum globulin was recorded at 0, 30, 60, and 90 days of the study using biochemical analyser (Table 4.4.8). Overall mean of serum globulin was3.58±0.03 g/dl and 3.63±0.04 g/dl in T1 and T2 group respectively, which was non-significant. At 0, 30, 60 and 90 days of experiment, serum globulin was3.47±0.03 g/dl, 3.46±0.07 g/dl; 3.57±0.04 g/dl 3.61±0.05 g/dl; 3.62±0.04 g/dl 3.69±0.04 g/dl and 3.69±0.06 g/dl 3.76±0.07 g/dl in T1 and T2 group respectively, which were non-significant. Similar results also obtained by the Ahmad *et al.*, (2017) who reported non significantly higher serum globulin concentration in Moringa supplemented buffalo calves than non supplemented ones.

Table: 4.4.9 Serum Globulin in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	3.47±0.03	3.46±0.07	NS
30 Days	3.57±0.04	3.61±0.05	NS
60 Days	3.62±0.04	3.69±0.04	NS
90 Days	3.69±0.06	3.76±0.07	NS
All	3.58±0.03	3.63±0.04	NS

NS: Non-Significant

Note: **** is significant at 1%, ** is significant at 5% and * is significant at 10%*

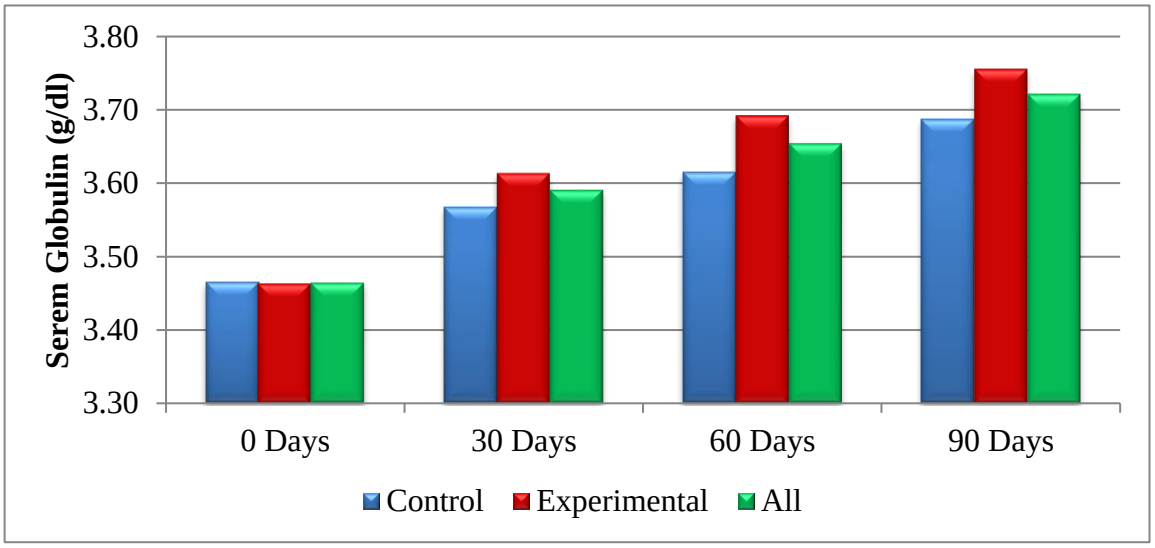

Fig 4.4.9: Mean Serum Globulin (g/dl) in Sahiwal calves

Globulin protein participates in maintenance of immune system, normal level of globulin in all the two groups (control and experimental) indicated that immune system of Sahiwal calves were in good condition and replacement of Moringa had positive effect on immune system of Sahiwal calves.

4.4.10 Serum Albumin: Globulin ratio

Perusal of the Table 4.410 reveals that over all mean of Serum albumin: globulin ratio was which was 0.89±0.01 and 0.91±0.01 in T1 and T2 group respectively, which was non-significant. At 0, 30, 60 and 90 day of experiment, Serum albumin: globulin analysis was 0.89±0.01,0.92±0.02;0.90±0.01, 0.90±0.02;0.89±0.02, 0.91±0.01 and 0.88±0.02, 0.93±0.03 in

T1 and T2 group respectively, which was also non-significant. Highest value of Serum albumin: globulin was found at 90 days of experiment which was 0.88 ± 0.02 and 0.93 ± 0.03in T1 and T2 group respectively.

Table: 4.4.10 Serum Albumin: Globulin ratio in Sahiwal calves

Days	Control	Experimental	Significant
0 Days	0.89±0.01	0.92±0.02	NS
30 Days	0.90±0.01	0.9 ±0.02	NS
60 Days	0.89±0.02	0.91±0.01	NS
90 Days	0.88±0.02	0.93±0.03	NS
All	0.89 ±0.01	0.91±0.01	NS

NS: Non-Significant

***Note**: *** is significant at 1%, ** is significant at 5% and * is significant at 10%*

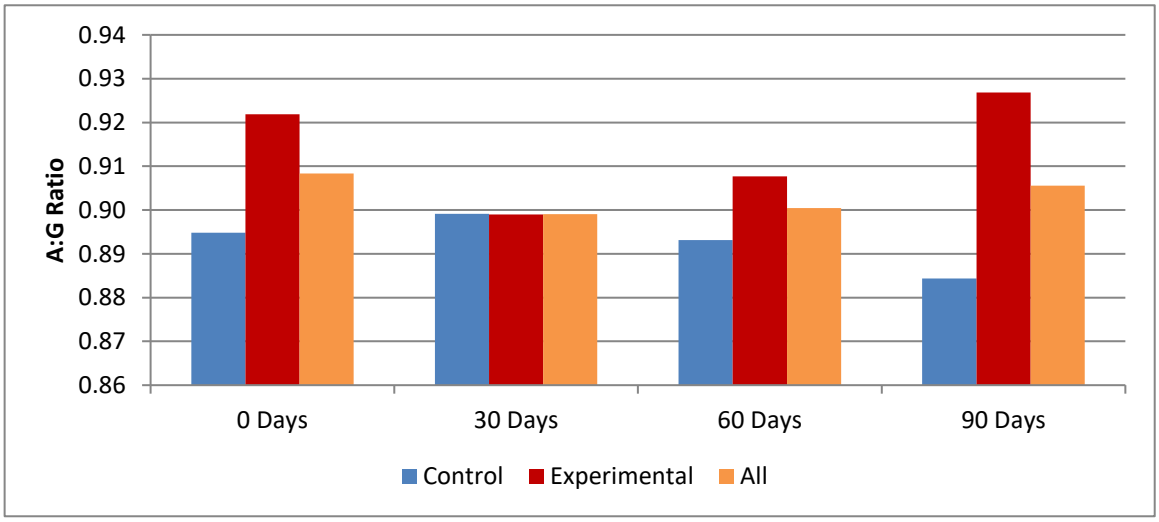

Fig 4.4.10: Mean Serum Albumin: Globulin ratio in Sahiwal calves

1.5 Economics of *Moringa oleifera* feeding

1.5.1 Feed consumption detail of Sahiwal calves

Economy calculation is very much important for the suitable livestock production. As far as economy of any husbandry is concerned, feeding of animals are most vital component. If we want to reduce the cost of production, we have to replace the higher cost bearing feed to low cost bearing feed with minimal change in nutrient component.

At the present study, which was conducted at livestock farm of Bihar Veterinary College, 12 calves were kept for observation of experiment among that T1 (6 calves of control) were fed on normal diet practiced at farm and T2 (6 calves of experimental) were fed on normal diet practiced at farm in that concentrate was replaced with Moringa.

Perusal of Table 4.5.1 reveals that on an average on 0.9 kg of concentrate were given to each calf per day *i.e.* total concentrate consumed/day/group (kg) was 5.4 kg. Moringa leaves and stem consumed/animal/day (kg) was 2.5 kg, which leads to total *Moringa oleifera* leaves & stem consumed/day/group (kg) was 15 kg. Among other observation during the study total maize (fodder) consumed/day/group (kg) was 24 kg and 15 kg in T1 and T2 group respectively. Similarly, Total Wheat straw consumed/day/group (kg) were 9 kg each in T1 and T2 group. The stated feed consumption data were used for calculation of economics of Moringa feeding to Sahiwal calves.

Table: 4.5.1 Feed consumption detail of Sahiwal calves

Particular	Control	Experimental
No. of Animal/group	6	6
Concentrate consumed/animal/day (Kg)	0.9	-
Total concentrate consumed/day/group (kg)	5.4	-
Moringa oleifera leaves & stem Consumed/animal/day (kg)	-	2.5
Total Moringa oleifera leaves & stem consumed/day/group (kg)	-	15
Green maize (fodder) consumed/animal/day (kg)	4	2.5
Total maize (fodder) consumed/day/group (kg)	24	15
Wheats straw consumed/animal/day/group (kg)	1.5	1.5
Total Wheats straw consumed/day/group (kg)	9	9

Results of the present investigation are in agreement with Khalel *et al*., (2014) as they reported that cost of feeding in dairy cows were reduced as well as profit was increased by increasing the level of inclusion of *Moringa oleifera* in the ration.

4.5.2 Economics of Moringa feeding

Economics of Moringa feeding was calculated and presented in Table 4.5.2. Perusal of Table 4.5.2 reveals that, during experiment period, control group (T1) calves were fed on concentrate (5.4 kg) which cost Rs 124.2. Similarly, in T2 (experimental group) calves total Moringa were consumed around 15 kg which costs Rs 60. Further, total feed cost/day/group was Rs 238.2 and Rs 117 for T1 and T2 group respectively. Ultimately total cost of feeding/day/animal in respective group T1 and T2 were Rs 39.7 and Rs 19.5. This mean in T2 group cost of rearing calves were much cheaper as compare to T1. This also brings solution to redundancy of male calves due to higher cost of rearing. Further along with economy, all the growth and haemato-biochemical parameters were found more satisfactory in T2 group as compare to T1 group.

Table: 4.5.2. Economics of *Moringa* feeding to Sahiwal calves

S. No.	Particular	Control		Experimental	
		Quantity (kg)	Cost (Rs)	Quantity (kg)	Cost (Rs)
1	Total concentrate consumed/day/group @ Rs. 23/kg	5.4	124.2	-	-
2	Total Moringa oleifera leaves & stem consumed/day/group @ Rs. 4/kg	-	-	15	60
3	Total maize consumed/day/ group @ Rs. 3/kg	24	42	15	45
4	Total wheat straw consumed/day/group @ Rs. 8/kg	9	72	9	72
5	Total feed consumed/day/group	38.4	-	39	-
6	Total feed cost/day/group	-	38.2	-	117
7	Total cost of feeding/day/animal		39.7		19.5

SUMMARY AND CONCLUSION

5

Moringa oleifera belongs to the family Moringaceae and order Brassica is a highly valuable plant distributed in many tropical and subtropical countries It is well known for its medicinal properties such as anticancer, anti-inflammatory, anti-diabetic, anti-microbial and antioxidant. The leaves of *Moringa oleifera* are willingly eaten by cattle, sheep, goats, pigs, chickens and rabbits as ingredient in their diet. The plant has been used to improve the health status, growth performance, milk production meat quality of several livestock species. Many researchers investigated the effect of *Moringa oleifera* leaves on productive performance of dairy cow, sheep, goats and laying hen and the growth and carcass characteristics of rabbits, broilers etc. Considering the above facts, the present study was designed with the objective to study the effect of feeding *Moringa oleifera* on feed intake and growth performances, haemato-biochemical changes, and economics in Sahiwal calves.

The present study was conducted at Livestock farm complex (LFC) of the Bihar veterinary college Patna. A total of 12 Sahiwal calves were selected of similar age group between 6-10 month of either sex for the experiment. All the calves were divided into two group of six calves each in Control (T1) and Treatment (T2) group; both control and treatment group were of approximate same weight.

Result indicated thatMoringa mature leaves contains (in %), moisture, dry matter, CP, EE & CF was 77, 23, 22.92, 5.9 & 20.8 respectively. Similarly, premature Moringa leaves contains 80.5% moisture, 19.5% dry matter, 25.23% CP, 6.33% EE & 18.74% CF. Whereas, proximate composition of Moringa leaves with mature stem was 76% moisture, 22% DM, 16.62% CP, 4.38% EE & 25.73 CF. Similarly, Moringa leaves with premature stem proximate composition had 82% moisture, 18% DM, 19.46% CP, 5.84% EE & 23.02% CF.

Study reveals that average body weight at start of the experiment was 93.50±12.94 kg and 104.83±12.48 kg for control and experimental group respectively. After 15 days of experiment average body weight was 93.58±12.80 kg for control group whereas, it was 107.33±12.04 kg in case of experimental group of animal. Similarly, at 45 days of experiment average body weight in control group was 97.00±11.55kg whereas it was 116.92±10.99 kg in experimental group of animals. Further, at 90 days of experiment in control group average body weight was 102.83±12.10 kg and in experimental group was 128.92±11.36 kg. Although average body weight was found Non-significant, however an increasing trend can be clearly evident in case of experimental group of animal.

Average daily body weight gain at 1st fortnight was0.10±0.02 kg and 0.17±0.05 kg respectively in T1 and T2 groups, although this was non-significant between the T1 and T2 groups. Similarly, at 4thfortnight this was 0.18±0.04 kg and 0.29±0.02 kg for T1 and T2 groups respectively. This was 0.11± 0.01 kg and 0.26±0.02 at 6th fortnight respectively in T1 and T2 group.

The average daily dry matter intake per calves in both the treatment group T1 and T2 was calculated which revels that during 1st fortnight, dry matter intake (kg/day) in Sahiwal calves was 2.26±0.08 kg in T1 groups and 2.43±0.04 kg in T2 groups. It also to note that animals in both the groups were consuming maximum at 6th fortnight (2.62±0.04 kg in T1 and 2.63±0.04 kg in T2) as their animal increase their size.

At 1st fortnight average total dry matter intake was 33.85±1.24 kg in T1 group and 36.38±0.69 kg in T2 group which was increase to 36.75±0.73 kg and 37.04±0.59 kg in T1 and T2 group respectively at 4th fortnight. It was at maximum (39.75±0.64 kg) in T1 and T2 (39.50±0.74 kg) groups at 6th fortnight.

The detail study on feed conversion ratio reveals that feed conversion ratio showed higher trend at all the fortnight in case of T1 group as compared to T2 group. This was 17.45±0.81 kg and15.87±2.68 kg in T1 and T2 groups respectively at 1stfortnight. At 4th fortnight, it was 15.87±2.68 kg and 8.90±0.87 kg in T1 and T2 group respectively. This was further higher at 6th fortnight in T1 (17.38±0.91 kg) and T2 (10.44±1.02kg) group.

The findings of total erythrocyte count reveals that at the start of experiment, total erythrocyte count was 4.93±0.28($x10^6/mm^3$) in T1 and 5.58±0.27($x10^6/mm^3$) inT2 groups. As study progress total erythrocyte count was increased in both the groups at 30th day of experiment, it was 5.17±0.31($x10^6/mm^3$) and 5.90±0.19($x10^6/mm^3$) respectively in T1 and T2 group. Further it was found highest in both the group at 90th day of experiment, which is5.93±0.11($x10^6/mm^3$) and6.45±0.15 ($x10^6/mm^3$) in T1 and T2 groups respectively. The statistical analysis of data reveal that there was significant difference found between the treatment groups at 5 % to 10% level which might be due to important nutritional attributes in the forms of minerals, vitamins, found in Moringa.

Overall mean total leucocyte count value were8.33±0.18 ($\times10^3/mm^3$) and 8.39±0.07 ($\times10^3/mm^3$) for T1 and T2 group respectively which was statistically non-significant. Highest total leucocyte count in Sahiwal calves were found at 90th days of experiment and this was 8.43±0.28 ($\times10^3/mm^3$) and 8.39 ±0.07 ($\times10^3/mm^3$) in T1 and T2 groups respectively. The trend of total leucocyte count was on higher side from start of experiment to the end of the experiment, however there was no significant difference found between Moringa fed (T2) and concentrate fed (T1) groups. Total leucocyte count in T2 group were in normal range which confirms that *Moringa oleifera* have antimicrobial, antifungal, antioxidant and anticancer property, which leads to keep animal healthy and free from infection.

The overall mean of Hb (g/dl) was10.8 ±0.31g/dl and11.84±0.31g/dl in control and experimental group respectively, which was statistically significant (P<0.05). Average Hb concentration at 30th of experiment was 10.25±0.66 g/dl and 11.57±0.58 g/dl in T1 and T2 group respectively. There was increasing trend found in Hb concentration in both control and experiment group with the increase in age of animal. This might be due to animal growing age and better feed utilization and nutrient absorption. This was further more in experimental group, this might be due to feeding of Moringa which is rich in mineral component like Fe, Ca, Cu and other hematopoietic substances.

The overall mean of serum calcium was10.80±0.12 (mmol/lit) and 11.32±0.09 (mmol/lit) in T1 and T2 group respectively, which was statistically highly significant (P<0.01). At the start of experiment serum calcium was 10.57±0.33 (mmol/lit) and 10.81±0.20 (mmol/lit) in T1 and T2 group respectively. At 30 day of analysis serum calcium was 11.34±0.23 (mmol/lit) and11.46±0.10 (mmol/lit) in T1 and T2 respectively, which was non-significant. This level was further rises to 10.66±0.11 (mmol/lit) and 11.54±0.12 (mmol/lit) at 90th day of blood collection in T1 and T2 group respectively and it was also found highly significant (P<0.01). This might be due to increased bioavailability of calcium to Sahiwal calves due to feeding of Moringa.

The overall mean of serum potassium was4.45±0.08 (mmol/lit) and 4.85±0.13 (mmol/lit) in T1 and T2 group respectively, which was statistically significance (P<0.05). At starts of the experiment serum potassium was 4.33±0.19 (mmol/lit) and 4.54±0.22 (mmol/lit) in T1 and T2 group respectively. At 60thday of analysis, potassium was 4.49±0.16 (mmol/lit) in T1 and T2 group respectively which was also non-significant. This level was further rise to

4.57±0.16 (mmol/lit) and 5.36±0.20 (mmol/lit) at 90th day of blood collection in T1 and T2 group respectively. This might due to rich potassium in *Moringa oleifera*.

At start of the experiment serum sodium level was 138.83±1.42 (mmol/lit) and 138.33 ± 1.83 (mmol/lit) in T1 and T2 group respectively which were non-significant. At 60th day of analysis serum potassium was 143.48±1.63 (mmol/lit) and 147.17±0.74 (mmol/lit) in T1 and T2 group respectively which was significant ($p<0.01$). This might due to high level of sodium present in Moringa.

The overall mean of serum glucose was 57.70±1.04 mg/dl and 58.20±0.93 mg/dl in T1 and T2 group respectively. At starts of the experiment serum glucose was 53.83±2.15 mg/dl and 53.83±1.74 mg/dl in T1 and T2 group respectively, which was non-significant. Highest average serum glucose was found in 90th day of experiment and it was 61.60±1.25 mg/dl and 61.61±1.30 mg/dl in T1 and T2 group respectively. In present study serum glucose ranges between 53.83±2.15 to 61.61±1.30mg/dl and fell within (45 -75 mg/dl) for calves. The low glucose level indicates that it is suitable for human diabetic consumption.

At start of the experiment, blood urea nitrogen was 22.13±0.39 mg/dl and 23.52±0.57 mg/dl in T1 and T2 group respectively, which was significant at ($P>0.10$). At 30, 60, and 90th day of experiment blood urea nitrogen was 22.90±0.50 mg/dl, and 24.13±0.71 mg/dl, 23.3±0.44 mg/dl and 24.33±0.67 mg/dl and 22.87±0.51 mg/dl and 22.87±0.51 mg/dl in T1 and T2 group respectively, which was also non-significant. Slightly increase in blood urea nitrogen in T2 group might be due to high level of protein in Moringa and its increased metabolism, absorption and utilization.

Overall mean of serum albumin was 3.20±0.015 g/dl and 3.33±0.03 g/dl in T1 and T2 group respectively, which was highly significant ($p<0.01$). At start of the experiment serum albumin was 3.10±0.025 g/dl and 3.21±0.02 g/dl in T1 and T2 group respectively which was also highly significant at ($p<0.01$). At 30 days and 90th day of experiment serum albumin was 3.21±018g/dl and 3.29 ±0.03 g/dl, 3.25±.019 g/dl and 3.48±0.07 g/dl in T1 and T2 group respectively which was also significant at ($P<0.05$).

Overall mean of serum globulin was 3.58±0.03 g/dl and 3.63±0.04 g/dl in T1 and T2 group respectively, which was non-significant. At 0, 30, 60 and 90 days of experiment, serum globulin was 3.47±0.03 g/dl, 3.46±0.07 g/dl; 3.57±0.04 g/dl 3.61±0.05 g/dl; 3.62±0.04 g/dl

3.69±0.04 g/dl and 3.69±0.06 g/dl 3.76±0.07 g/dl in T1 and T2 group respectively, which were non-significant.

Result reveals that on an average on 0.9 kg of concentrate were given to each calf per day *i.e.* total concentrate consumed/day/group (kg) was 5.4 kg. Moringa leaves and stem consumed/animal/day (kg) was 2.5 kg, which leads to total *Moringa oleifera* leaves & stem consumed/day/group (kg) was 15 kg. Among other observation during the study total maize (fodder) consumed/day/group (kg) was 24 kg and 15 kg in T1 and T2 group respectively. Similarly, Total Wheat straw consumed/day/group (kg) were 9 kg each in T1 and T2 group.

Study further reveals that, during experiment period, control group (T1) calves were fed on concentrate (5.4 kg) which cost Rs 124.2. Similarly, in T2 (experimental group) calves total Moringa were consumed around 15 kg which costs Rs 60. Further, total feed cost/day/group was Rs 238.2 and Rs 117 for T1 and T2 group respectively. Ultimately total cost of feeding/day/animal in respective group T1 and T2 were Rs 39.7 and Rs 19.5. This mean in T2 group cost of rearing calves were much cheaper as compare to T1. This also brings solution to redundancy of male calves due to higher cost of rearing. Further along with economy, all the growth and haemato-biochemical parameters were found more satisfactory in T2 group as compare to T1 group.

CONCLUSION

- Replacement of concentrate can be done in calves by *ad lib.* feeding of *Moringa*.
- Feeding Moringa can manage calves growth and performance without concentrate. Further, Moringa feeding will be cheaper protein source for calves growth.
- Moringa can improves physical conformation and average daily gain in Sahiwal calves.
- Haematological parameter such as (TEC, TLC, Hb and PCV) in Sahiwal calves remained within in normal range in both group but experimental group (T2) value was more than control group (T1).
- Biochemical parameter such as (Total serum protein, Serum Albumin, Serum globulin, A: G ratio, BUN, Serum creatinine, Serum glucose, Serum calcium, Serum potassium, Serum sodium) in Sahiwal calves remained within in normal range in both group but experimental group (T2) value was more than control group (T1).
- Cost of rearing of calves were much cheaper as compare to control group. This also brings solution to redundancy of male calves due to higher cost of rearing. Further along with economy, all the growth and haemato-biochemical parameters were found more satisfactory in T2 group as compare to T1 group.

LITERATURE CITED

Adegun, M. K and Aye, P. A. 2013. Growth performance and economic analysis of West African Dwarf Rams fed *Moringa oleifera* and cotton seed cake as protein supplement to *Panicum maximum*. *American J. Food Nutri*.3 (2):58-63.

Aharwal, B., Roy, B., Lakhani, G. P., Baghel, R. P. S., Saini, K. P. S. and Yadav, A. 2018. Effect of *Moringa oleifera* Leaf Meal on Feed Intake and Growth Performance of Murrah Buffalo Calves. *Intl.J. Curr. Microbiol. App.Sci.*7 (9):1960-1973.

Aharwal, B., Roy, B., Lakhani, G. P., and Yadav, A. 2019a. Effect of Moringa (*Moringa oleifera)* leaf meal on performance of Murrah buffalo calves. *Intl. J. Chem. Studies*, 7(2): 1722-1728.

Aharwal, B., Roy, B., Yadav, A. and Saini, K. 2019b. Economic analysis of *Moringa oleifera* leaf meal for Murrah buffalo calf rearing. *Intl. J. Recent Scientific Research*, 10(07):33337-33339.

Ahmad, A. E., Ibrahim, A. A.S., Ebtehag, I.M. A-E., Mohamed, S. A. and Hassan, M. S. 2017. Effect of feeding dry *Moringa oleifera* leaves on the performance of suckling buffalo calf. *Asian J. of Anim. Sci*., 11(1): 32-39.

Akinbamijo O.O., Seaker J., Adediran S.A., Nauala S. And Muenstermann S. 2004. *Moringa oleifera* high value feed resource in peri-urben animal production. International Trypanotolerance centre, 417-418

Akinyemi, A. F., Alokan, J. A. and Adebowale, N. F. 2010. Effect of inclusion level on nutrient intake, digestibility, nitrogen balance and haematological parameters of West African Dwarf (WAD) sheep fed *Moringa oleifera* as supplements to *Panicum maximum*. *J. Am. Sci*. 6(10): 634-643.

Ali, S.B. 2017. Growth performance of goats fed *Moringa oleifera* leaf meal incorporated in concentrate mixture. MVSC thesis submitted to Maharashtra Animal and Fishery Sciences University, Nagpur. 38- 49p.

Anjorin, T. S., Ikokoh, P and Okolo, S. 2010. Mineral Composition of *Moringa oleifera* leaves, Pods and Seeds from Two Regions in Abuja, Nigeria. *Intl. J. Agril&Bio.* 1814-9596.

AOAC. 2000. Official Methods of Analysis.17thed. Association of Official Analytical Chemists, Virginia, USDA, Washington, D.C.

Aregheore, E. M. 2002. Intake and digestibility of *Moringa oleifera*–batiki grass mixtures by growing goats. *Small Ruminant Res*. 46: 23–28.

Asaolu, V. O., Akinlade, J. A., Aderinola, O. A., Okewoye, A. T. and Alalad, J. A. 2012. Performance of grazing West African Dwarf goats on moringa multi nutrient block supplementation. *Asian J. Anim. Sci.*6 (6): 263-277.

Asaolu, V. O., Binumote, R. T. Akinlade, J. A. Oyelami O. S. and Kolapo K. O. 2011. Utilization of *Moringa oleifera* fodder combination with *Leucaena leucocephala* (LEU) and *Gliricidia sepium* (GLI) fodders by West African dwarf goats (WAD). *Int. J. Agric. Res.* 6(8): 607-619.

Asaolu, V. O., Odeyinka, S. M., Akinbamijo, O. O. and Sodeinde, F. G. 2010. Effects of moringa and bamboo leaves on groundnut hay utilization by West African Dwarf goats. *Livestock Res. for Rural Dev*. 22(1).

Ayandiran, S. K., Adeyinka, S. M. and Odedire, J.A. 2019. Growth performance and nutrient digestibility of West African Dwarf (WAD) goat fed bread and Moringa oleifera Leaf. Intl. J. Anim. Sci., 3 (2): 1047.

Aye, P.A. 2016. Feed intake, performance and nutrient utilization of West African Dwarf (WAD) sheep fed Panicum maximum and cassava peels supplemented with *Moringa oleifera*, Gmelina arborea and Tithonia diversi folia-based multi nutrient blocks. Sch. J. Agric. Vet. Sci. 3(2): 147-154

Babeker, E. A. and Bdalbagi, Y. M. A. 2015. Effect of feeding different level of *Moringa oleifera* leaves on performance, haematological, biochemical and some physiological parameters of Sudan Nubian goats**.** *J. Anim. Feed Res*., 5(2):50-61.

Babiker, E. E., Fahad, A.L., Ghafoor, K., Khalid, A. A. 2017. Comparative study on feeding value of Moringa leaves as a partial replacement for alfalfa hay in ewes and goats, *Livestock Sci.,* 195:21-26.

Baginski, E.S., Marie, S.S., Clark, W. L. and Zak, B. 1973. Direct micro determination of serum calcium. Clinica Chemica Sci. 43:271-273.

Bonses, R. W. and Tausskay, H.H. 1945. Estimation of serum creatinine. Journal of biological Chemistry. 158: 581-585.

Chaey, A. 1962.Analysis of blood urea nitrogen. *Clin chem*. 8:130.

Choudhary, R. K., Roy, A., Roy, P. S., Singh, K. M. and Kumar, P. 2018. Effect of replacing concentrate mixture with Moringa leaves (Moringa oleifera) on performance of Lactating Bengal Goats in Kishanganj District of Bihar, India.*Intl.J. Curr. Microb. App. Sci*., 7:2895-2900.

Church D.C., Rendall R.O. and Ortega E. 1984. Effect of complete feed on growth of lamb. *Journal of Animal Science*, 51:6

Damor, S. V., Pawar, M. M., Ankuya, K. J., Gami, Y. M., Srivastava, A. K., Chauhan and, H. D. and Chaudhary K. R. 2017a. Effect of feeding different levels of Moringa (*Moringa oleifera*) leaves on growth performance of Mehsana goat kids. *Biosci.trends.*10 (18): 3190-3193.

Damor, S. V., Pawar, M. M., Gami, Y. M, Ankuya, K. J., Srivastava, A.K. Chauhan H.D. and patel, V.K. 2017b. Effect of replacing concentrate mixture with Moringa (*Moringa oleifera*) leaves on blood biochemical and mineral profile of Mehsana goat kids. *Life Sci. Leaflets*. 89: 28-35.

Devendra C. 1997. Investments on pro-poor development project on goats ensuring success for improved Livelihood. *Asian Australian of Journal of Animal Sciences, 26:1-18.*

Divya, Mandal, A.B., Biswas, A., Yadav, A.S. and Biswas, A.K. 2014. Effect of dietary *Moringa oleifera* leaves powder on growth performance, blood chemistry, meat quality and gut microflora of broiler chicks. *Anim. Nutr. Feed Tech*. 14: 349-357.

Dong, L., Zhang, T., and Diao, Q. 2019. Effect of Dietary supplementation of *Moringa Oleifera* on the Production Performance and Fecal Methanogenic Community of Lactating Dairy Cows. Animal 2019,9,262; doi:10.3390/ani9050262.

Douman, B.T.1975. Analysis of serum protein and albumin.*Clin.chem*. 21:1159.

Elbashier, O. M. and Ahmed, H. E. 2016. The effect of feeding different levels of *Moringa oleifera* leaf meal on the performance and some blood parameters of broilers. *Int. J. Sci. Res.* 5(3): 632-635.

Fadiyimu, A.A., Alokan, J. A., Fajemisin A. N. and Onibi, G. E. 2016. Feed intake, growth performance and carcass characteristics of West African dwarf sheep fed *Moringa oleifera, Gliricidia sepium* or *cassava* fodder as supplements to *Panicum maximum. Exp. Agr. Int*. 14(4): 1-10.

Farooq A, Sajid L, Muhammad A and Anwarul-Hassan G. 2007.*Moringa oleifera*: A food plant with multiple medicinal uses. *Phytotherapy Research*, 21: 17-25

Foidl, N. and Paull, R. 2008.*Moringa oleifera*. In *the encyclopedia of fruit and nuts*. CABI, Oxford Shire, UK, pp. 509–512.

Fuglie L.J. 2005. The Moringa tree, A local solution to malnutrition church world service in senegal.

Gopalakrishnan, L., Doriya, K. and Kumar, D. S. 2016. Moringa oleifera: A review on nutritive importance and its medicinal application. *J. Food Sci. Human Wellness*, 5(2):49–56.

Government of India. 2019. Provisional Key results of 20th Livestock Census. Department of Animal Husbandry and Dairying, Ministry of fisheries, Animal husbandry and Dairying, Government of India.

Haridas, R.M. 2018. Effect of supplementation of *Moringa oleifera* leaf meal on the performance of growing sheep (*ovisaries*). MVSc. thesis submitted to Maharashtra Animal and Fishery Sciences University, Nagpur. 51-56 p.

Hewitt, C.D., Jnness, D.G. and Wills, M. R. 1989. Normal Biochemical and Hematological Values in New Zealand Rabbits. *Clinical Chem.*35: 1777-1779.

Jiwuba, P. C., Ahamefule, F. O., Okechukwa, O. S. and Ikwunze, K. 2016. Feed intake, body weight changes and hematology of West African dwarf goat fed dietary level of *Moringa oleifera* leaf meal. *Agriculture*,13(1-2): 71-77.

Kakengi, A. M. V., Shem, M. N., Sarvantt, S. V. and Fujihara, T. 2005. Can *Moringa oleifera* be used as a Protein supplement for Ruminants. *Asian-Aus. Anim.Sci.*18(1):42-47.

Kaneko, J.J., Harvey, J. W. and Bruss, M. L. 2008. Clinical Biochemistry of Domestic Animal.6th ed. Academic Press, Burlington, MA. pp 889-893

Khalel, M. S., Shwerab, A. M., Hassan, A. A., Yacout, M. H., El-Badawi, A. Y. and Zaki, M. S. 2014. Nutritional evalution of *Moringa oleifera* fodder in comparison with *Trifolium alexandrinum* (Berseem) and impact of feeding on lactation performance of cows. *Life Science J.*,11(10): 81-87.

Kholif, A.E., Gouda, G. A., Olafadehan, O.A. and Abdo, M. M. 2017. Effects of replacement of *Moringa oleifera* for berseem clover in the diets of Nubian goats on feed utilization, and milk yield, composition and fatty acid profile. *Animal*, 12(5):964-972.

Korsor, M., Nthonshikira, C., Haruna, M., Bello., and Habauka, M. K. 2017. Indirect effect of *Moringa oleifera* supplemented diet on growth rates of pre-weaning Boer goat. ISSN 2229-5518.

Koury, M.J. and Pokka, P. 2004. New insights into erythropoiesis: the Roles of folate, vi- tamin B12, and iron. *Annu. Rev. Nutri*.24: 105-131

Kumar, M., Parsad, S., Minj, N., Kumar, R., Kumar, R. and Himkar, K. H. 2019.Effect of feeding *Moringa oleifera* leaf powder on growth performance of growing female black Bengal goat under semi-intensive system of management. *Journal of Pharmacognosy and phytochemistry*,5:295-298.

Mahmood, K.T., Mugal T. and HaqI.U. 2010.Moringaoleifera a natural gift- A review. Journal of pharmaceutical Science Research, 2:775-781

Mahmoud, A. E. M. 2013. Effect of feeding on *Moringa oleifera* stem on productive performance of growing lambs. *Egyptian J. Nutrition and Feed*.16 (2):281-292.

Makkar, H. P. S and Becker, K. 1996. Nutritional value and anti-nutritional components of whole and ethanol extracted *Moringa oleifera* leaves. *Anim. Feed Sci. Tech*. 63(1-4): 211-228.

Mayo, B., Masika, P.J. and Muchenje.2014. Effect of feeding *Moringa oleifera* leaf meal on the physico-chemical characteristics and sensory properties of goat meat. *South Africa Journal of Animal Science*.44 (1): 11-17.

McDonald MW, Edwards and Greenhalgh J.F.D. (1993). Animal Nutrition, 4th edn., Longman Scientific and Technical Essex, UK.

Meel, P., Gurjar, M. L., Nagda, R. K., Sharma, M. C., Gautam, L and Manju. 2018. Growth performance of sirohi goat kids fed different levels of *Moringa oleifera* leaves. *Journal of Entomology and Zoology studies*.6 (4): 786-791.

Mendieta, A. B., Sporndly, E., Reyes-Sanchez, N. and Sporndly R. 2011.Feeding *Moringa oleifera* fresh or ensiled to dairy cows-effects on milk yield and milk flavor. *Trop. Anim. Health Prod.* DOI 10.1007/s11250-011-9803-7.

Moyo, B., Masika, P. J. and Muchenje, V. 2012. Effect of supplementing crossbred Xhosa lop-eared goat castrates with *Moringa oleifera* leaves on growth performance, carcass and non-carcass characteristics. *Trop. Anim. Health Prod.* 44:801–809.

National Action Plan on Dairy Development (Vision-2022). 2018. Department of Animal Husbandry and Dairying, Ministry of Agriculture and Farmers Welfare, Government of India.

NDDB. 2019. National Dairy Development Board. Department of Animal Husbandry and Dairying. Government of India.

Newton K.A., Bennett R.N., Curto R.B.L., Rosa E.A.S., Turc V.L., Giuffrida A., Curto A.L., Crea F. and Timpo G.M. 2010.Profiling selected phytochemical and nutrients in different tissues of the multipurpose tree Moringa oleifera leaves, grown in Ghana. Food Chemistry, 122: 1047-1064

Nouman, W., Basra, S. M. A., Siddiqui, M. T., Yasmeen, A., Gull, T. and Alcayde, M. A. C. 2014. Potential of *Moringa oleifera* L. as livestock fodder crop: a review. *Turk. J. Agric. For*. 38(1): 1-14.

Oyedele, J. O., Asaolu V. O. and Odeyinka, S. M. 2016. Nutrient digestibility and growth performance of West African Dwarf (WAD) goats fed foliage combinations of *Moringa oleifera* and *Gliricidia sepium* with equal proportions of a low-cost concentrate. *J. Natural Sci. Res.* 6(18): 20-31.

Parrotta, John A. 1993. *Moringa oleifera Lam*. Reseda, horseradish tree. Moringaceae. Horseradish tree family.USDA Forest Service, International Institute of Tropical Forestry. (SO-ITF-SM: 61).

Rajput, H., Prasad, S. G. M and Srivastav,P. 2019. Nutritional Quality analysis of dry Moringa powder varity-PKM-1.*Pharma Innovation Journal*; 8(7):95-98s.

Rockwood J.L., *Anderson* B.G. and Casamatta D.A. 2013. Potential uses of *Moringa oleifera* and an examination of antibiotic efficiency conferred by *Moringa oleifera* seed and leaf extracts using crude extraction techniques available to underserved indigenous populations. *International Journal of phytothearpy Research,* 3: 61-71.

Saladin, K.S.2007. Anatomy and Physiology: the Unity of Forms and Function. McGraw Hill Companies New York.

Sanchez, N. R., Sporndly, E. and Ledin, I. 2006.Effect of feeding different levels of foliage of *Moringa oleifera* to creole dairy cows on intake digestibility, milk production composition. *Livest. Sci.*101: 24-31.

Sarwatt, S. V., Kapange, S. S and Kakengi, A. M .V. 2002. Substituting sunflower seed- cake with *Moringa oleifera* leaves as a supplemental goat feed in Tanzania. *Agroforest. Syst*. 56: 241–247.

Sharma IJ and Singh HS. 2000. Student Laboratory Manual of Veterinary Physiology. Kalyani Publishers, New Delhi.pp.26-28.

Singh, K.M., Singh, R.K.P., Jha, A.K. and Kumar, Anjani. 2013. Understanding the Fodder Markets for Sustainable Development of Livestock Sector in Bihar - A Rapid Appraisal Approach. http://dx.doi.org/10.2139/ssrn.2266482.

Singh, K.M., Singh, R.K.P., Jha, A.K., Kumar, Abhay, Kumar, Anjani and Meena, M.S.(2013).Feed and Fodder Value Chains in Bihar: Some Empirical Evidences. Online at https://mpra.ub.uni-muenchen.de/48651/ MPRA Paper No. 48651.

Smith B.P. 2002. Large animal internal medicine. 3rd ed. Mosby, Harcourt Health science company America, USA. pp 393 – 416

Snedecor, G.W. and Cochran, W.G. 1994.StatisticalMethods.8th ed. Oxford and IBH.The Iowa State University Press, Ames, Iowa, USA.

Sobhy, M. A., Aboul-Fotouh, G.E. El-Garhy, G.M.and Gamal, O. 2015. Use of Moringa leaves (*Moringa oleifera*) in fattening lambs rations. *Egyptian J. Nutri.Feeds.*18(2): 11-17.

Soliva, C., Kreuzer, M., Foidl, N., Foidl, G., Machmüller, A. and Hess, H. 2005.Feeding value of whole and extracted *Moringa oleifera* leaves for ruminants and their effects on ruminal fermentation in vitro. Anim. *Feed Sci. and Tech*.118: 47-62.

Soltan, Y.A., Morsay, A.S., Hashem, N.M., Sallam, S.M. 2017.Utilization of *Moringa oleifera* in ruminant nutrition.

Sultana, N., Alimon, A. R., Haque, K. S., Sazili, A. O., Yaakub, H., Hussain, J. and Das,G. 2018. Study of Carcass Characteristics of Goats Fed Rice Straw Supplemented with Moringa (*Moringa oleifera* Lam) Foliage. *Asian Journal of Agriculture and Food Sciences*, ISSN: (2321-1571) vol (06)-issue 01.

Sun, J., Zeng, B., Chen, Z., Yan, S., Huang, W., Sun, B., He, Q., Chen, X., Chen, T., Jiang, Q., Xi, Q., and Zhang, Y. 2017. Characterization of faecal microbial communities of dairy cows fed diets containing ensiled *Moringa oleifera* fodder. *Scientific report 7:41403/DOI:10.1038/srep41403*.

Suzana, D., Suyatna F.D., Azizahwati, Andrajati, R., Sari, S.P., Mun'im, A. 2017. Effect of *Moringa oleifera* Leaves Extract Against Hematology and Blood Biochemical Value of Patients with Iron Deficiency Anemia. *J. Young Pharm.* 9(1):79-84.

Tope O. D., Emmanuel, O. O., Adebayo, O. A. and Tosin, O. V. 2017. Phytochemical constituents, proximate composition and mineral analysis of aqueous and ethanolic stem bark, seed extracts and plant parts of *Moringa oleifera. J. App. Life Sci. Int.* 10(4): 1-7.

Trinder P. 1969. Analysis of glucose. *Ann.Clin. Biochem*.6:24

Williams, F. E., Ogunsola, O. A., Akinbola, A. S., Faluyi, B., Fabviyi, O. S., Nwobi, N. L. and Owolabi J. O. 2016. Validating Phytomedicinal Potentials of *Moringa Oleifera*: Comparative Evaluation of Nutrients and Phytochemical Groups of Nigeria-Bred Moringa Oleifera Plant Parts. *Pharmaceutical and Chemical Journal*, 3(1):11-20.

Yusuf, A. O., Mlambo, V. and Lposu,S. O. 2018. A nutritional and economic evaluation of *Moringa oleifera* leaf meal as a dietary supplement in West African Dwarf goats. *South Afr. J. Ani. Sci.*, 48(1):81-87.

Zinder-Cohen, M., Weinberg, Z., Leibovich, H., Chen, Y., Rosen, M., Sagi, G., Orlov, A., Agmoni, R., Yishay, J., Miron, J and Shabtay, S. 2017. Ensiled Moringa oleifera: an antioxidant-rich feed that improves dairy cattle performance. *J.Agric.Sci*. 155(7): 1174-1186.

Resume

Name: Dr. Arjun Kumar Mandal

Father Name: Mr. Chandeshwar Mandal

Date of Birth: 15-01-1988

Address: Village-Durgeepatti, PO- Hudra

P.S.-Khutauna, Dist.-Madhubani-847227

Nationality: Indian

Email: arjun847227@gmail.com

Academic Qualification

Qualification	School/College	Board/ University	Passing year	Percentage/ OGPA
MATRIC	KISHAN HIGH SCHOOL, BATHANAHA	BSEB, PATNA	2004	52.24%
INTERMEDIATE	C. M. SC COLLEGE, MADHEPURA	BSEB, PATNA	2007	60%
B.V. Sc.& A.H	BIHAR VETERINARY COLLEGE	B.A.S.U. PATNA	2018	7.28/10
M.V. Sc. (LPM)	BIHAR VETERINARY COLLEGE	B.A.S.U. PATNA	2020	8.55/10

Title of the M.V.Sc. Thesis: "**EFFECT OF *MORINGA OLEIFERA* FEEDING ON PERFOMANCE OF SAHIWAL CALVES"**