GROWTH PERFORMANCE OF KIDS FED *JOWAR* HAY AND GROUNDNUT HAULMS BASED TOTAL MIXED RATION (TMR)

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ANAND – 388 110 (GUJARAT)

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A

THESIS

Submitted in partial fulfillment of the requirement for the award of the degree

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In

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By

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This is to certify that the thesis entitled **"GROWTH PERFORMANCE OF KIDS FED *JOWAR* HAY AND GROUNDNUT HAULMS BASED TOTAL MIXED RATION (TMR)"** submitted by **AJAY S. DHAMGUNDE** in the partial fulfillment of the requirements for the award of the degree of **MASTER OF VETERINARY SCIENCE** in **ANIMAL NUTRITION** of the Anand Agricultural University is a record of a bonafied research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

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ABSTRACT

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"GROWTH PERFORMANCE OF KIDS FED *JOWAR* HAY AND GROUNDNUT HAULMS BASED TOTAL MIXED RATION (TMR)"

A growth experiment of 84 days (12 weeks) duration was carried out on sixteen Surti kids to study the effect of feeding *jowar* hay and *jowar* hay + groundnut haulms based TMR. The kids under control group (T_1) were fed *jowar* hay based TMR whereas the kids under treatment group (T_2) were fed *jowar* hay + groundnut haulms based TMR. Completely randomized design was followed. The nutrient requirements of kids in term of DCP and TDN were met as per ICAR (1998) feeding standards.

The results revealed non significant ($P>0.05$) treatment differences for total and average daily weight gain and various body measurements. The average daily gain in weight was 62.15 and 62.70 g in T_1 and T_2, respectively. The data for daily DM intake g per day per kid, kg per 100 kg body weight and g per kg metabolic body weight were 536.84, 4.31 and 80.69 for control (T_1) while 437.21, 3.97 and 71.99 for treatment (T_2) group. The DM intake g per day per kid differed significantly ($P<0.01$) between treatment groups, however, non significant difference were observed for DM intake on per cent body weight basis and on metabolic body weight basis.

Abstract

The results for rumen fermentation pattern revealed that significantly higher ($P<0.01$) SRL pH was observed for T_2 (6.44) as compared to T_1 (6.20). However, there was non significant difference for the average TVFA concentration in both the groups. The average values of ammonia-N, total-N and protein-N concentrations under T_2 (23.43, 108.27 and 58.43 mg/dl, respectively) was higher than that of T_1 (21.84, 96.44 and 40.69 mg/dl, respectively), however, the treatment differences ($P>0.05$) for the same were non significant. The average concentration of NPN in SRL was significantly higher ($P<0.01$) in T_2 (64.46 mg/dl) as compared to T_1 (55.75 mg/dl).

The digestibilities of dry matter (57.09 & 61.19%), crude protein (72.74 & 75.36%), ether extract (71.01 & 74.79%) and crude fiber (46.64 & 48.08% under T_1 and T_2, respectively) were higher under treatment group (T_2) than control group (T_1), however treatment differences were non significant. The digestibilities of organic matter and nitrogen free extract were significantly higher ($P<0.05$) for kids fed *jowar* hay + groundnut haulms based TMR (64.92 and 60.74%, respectively) as compared to those fed *jowar* hay based TMR (60.61 and 55.47%, respectively). Average daily CP, DCP and TDN intakes were 61.95 and 54.61 g; 45.06 and 41.15 g & 276.37 and 247.24 g under T_1 and T_2, respectively and there values were at par.

The feed conversion efficiency (DM intake per kg gain) was superior under T_2 (7.13) than T_1 (8.79) and the treatment differences ($P<0.05$) were statistically significant. The values for CP, DCP and TDN intake per kg weight gain were 1.01, 0.74 and 4.52 kg in control group (T_1) and 0.89, 0.67 and 4.03 kg in treatment group (T_2), respectively, however the treatment differences were statistically non significant. These data suggested that kids fed *jowar* hay + groundnut haulms based TMR required less nutrients per gain in comparison to kids fed *jowar* hay based TMR.

Abstract

The daily feed cost was ` 5.49 and 3.81 under $T_1$ and $T_2$, respectively ($P<0.01$) which was 30.60% lower in $T_2$ in comparison to $T_1$. The cost of feed ` per kg gain was 89.86 and 62.04 ($P<0.01$) under T_1 and T_2, respectively. The cost of feed ` per kg gain was 30.96% reduced by incorporation of groundnut haulms at 30% in TMR by replacing *jowar* hay.

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LIST OF ABBREVIATIONS

a.m.	:	ante meridiem
ADF	:	Acid detergent fibre
ADG	:	Average daily gain
AIA	:	Acid insoluble ash
ANOVA	:	Analysis of variance
AOAC	:	Association of Official Analytical Chemists
Av.	:	Average
BW	:	Body weight
Ca	:	Calcium
CD	:	Complete diet
CF	:	Crude fibre
cm	:	Centimeter
CP	:	Crude protein
CPI	:	Crude protein intake
CR	:	Complete ration
d	:	Day
DCP	:	Digestible crude protein
df	:	Degree of freedom
dl	:	Decilitre
DM	:	Dry matter
DMI	:	Dry matter intake
Dr.	:	Doctor
EE	:	Ether extract
et al.	:	*Et alli* & others
'F'	:	Calculated 'F' or variance ratio
g	:	Gram
G. Av.	:	General average
GNH	:	Groundnut haulm
GNSP	:	Groundnut shell powder
hr	:	Hour
ICAR	:	Indian Council of Agricultural Research
kg	:	Kilo gram
L	:	Litre
Mcal	:	Mega calorie
ME	:	Metabolizable energy
mEq/L	:	Milli equivalent per litre
mg	:	Milligram
ml	:	Millilitre
mM	:	Millimole
MSS	:	Mean sum of square
N	:	Nitrogen
NB-21	:	Napier bajara-21
NDF	:	Neutral detergent fibre
NFE	:	Nitrogen free extract
NH_3-N	:	Ammonia nitrogen
No.	:	Number
NPN	:	Non protein nitrogen
NS	:	Non significant

OM	:	Organic matter
OMI	:	Organic matter intake
P	:	Phosphorus
p.m.	:	post meridiem
PPR	:	Peste des petits ruminants
R:C	:	Roughage : Concentrate ratio
SE	:	Standard error
SRL	:	Strained rumen liquor
SS	:	Sum of square
SV	:	Sources of variation
T	:	Treatment
TA	:	Total ash
TCA-N	:	Tri-carboxylic acid precipitated nitrogen
TDN	:	Total digestible nutrients
TMR	:	Total mixed ration
Total-N	:	Total nitrogen
TVFA	:	Total volatile fatty acids
viz.	:	Namely
w/w	:	Weight by weight
$W^{0.75}$	:	Metabolic body weight
yr	:	Year
>	:	More than, not less than
<	:	Less than, not more than
`	:	Rupees
@	:	At the rate of
%	:	Per cent

Chapter- I

INTRODUCTION

Goat is the second most important livestock enterprise next to bovine in India. They have multidimensional utility providing milk, meat, hide, fiber, manure, etc. Among the livestock assets of India, goats occupy a prominent place and have served the mankind earlier and longer than cattle and sheep. Despite of great diversity in climate conditions, goats are distributed throughout the country and are very useful in semi-arid and arid zones. They can convert a wide range of vegetation into a delicious and nutritious milk and meat. They can also utilize wide variety of plants compared to sheep or cow (Deshpande, 2011).

Goats constitute an important component of the domestic animal genetic resources of India. They play pivotal role in the rural agrarian economy of semi-arid and arid zones of India. Livestock sector has progressed remarkably in recent past which had a noticeable impact on the lives of small, marginal farmers and landless laborers. Among the livestock species, goat had a significant contribution in improving the social and economic conditions of these farmers and laborers. In spite of heavy pressure these small ruminants have shown an appreciable increase in their number over the last few decades (Patel, 2011).

India is a major reservoir of goat resources and currently topping in the goat world, ranks first in population with 124.35 million accounting about 20% of the world goat population and about 30% of Indian livestock population (Table 1.1). Currently goat population is annually increasing at a rapid rate of 1.60%, in spite of nearly 39% annual slaughter and 15.5% natural death rate (Deshpande, 2011). Gujarat

is a rich repository of animal genetic resources that have developed special adaptational features over the year to survive and simultaneously give sustainable production under the agro climatic conditions of their habitat. Total goat population in Gujarat is 47.27 lakh, which comprises of five breeds *i.e.* Zalawadi (8.21 lakh), Kuchchi (6.61 lakh), Surti (6.71 lakh), Mehsani (5.96 lakh), Gohilwadi (3.21 lakh) and non-discript (15.67 lakh), contributing towards meat and milk production. Surti goat population of Gujarat is 6.71 lakh, which is 14.5% of total goat population of the state. Surti goats are mainly reared for milk and meat production. Average milk production of Surti doe is about 1.0 to 1.2 kg/d with reproduction efficiency of about 1.2 – 1.5 kids/year (Patel, 2011).

Table 1.1: Goat population of India and Gujarat

Indian Goat Population (Millions)	124.35	(Deshpande, 2011)
India's Share in World goat population (%)	20	
India Ranks	I	
Gujarat Goat Population (Millions)	4.73	(Patel, 2011)

Goat plays an important role in the economy of rural poor in India, but their productivity is low, due to their poor nutritional status. The goats are reared on pasture land, vegetation, road side trees and farm side vegetation. They are managed by nomadic tribes *i.e. Bharwad*, *Ahir*, *Charan* and *Rabari*, who are generally landless or small land owners, with no or little literacy rate and hence goats are generally maintained traditionally with little technological interventions. There are stationary and migratory flocks. Majority of the goat keepers are having poor socio-economic status, therefore goat rearing is a major source of income and availability of certain amount of meat and milk for home consumption. Some owners provide little nutritional inputs in the form of concentrate at pre breeding season and to lactating

does and kids. Goats are reared mainly for meat, milk and fiber. Among the products of goats, meat constitutes 433 million kg *i.e.* 37% of total meat production, where as milk constitutes 1900 million kg *i.e.* 3% of total milk production in the country. Total production of skin, pashmina and manure was found to be 110.9, 30 and 85000 metric tons in the country. The estimated value of different types of produce from goats is about ` 2612 million per annum and it also generates 4.2% rural employment per year. About 15 million families of poor and weaker sections of villages are keeping goats. The main source of income is from sale of surplus kids & does (50%), sale of manure (15-20%) and milk (30-35%). The average income per doe/year to goat keeper varies from ` 900 to 1000 (Patel, 2011).

Goats are major contributors of animal proteins for human consumption in India. Current availability of animal proteins (10.8 g/d/capita) is just half of the daily requirement (20 g/d/capita) and it is targeted to be achieved by the year 2020. Accordingly, meat production will have to grow by 5.8% per year to fulfill this requirement (Jha and Chand, 1999). As the demand for animal products is increasing in developing countries (Delgado *et al.*, 1999), commercial goat farming is coming up with fast pace, but research in terms of digestibility, ruminal fermentation or microbial protein synthesis in goats fed different quality forages is scarce compared with that carried out with other animal species. The small ruminant sectors will therefore, can play a significant role in the coming decade in impacting on the livelihoods of small and marginal farmers engaged in goat rearing.

Nutrition probably is the most important factor influencing the production from goats under controlled managemental conditions (Devendra, 1984) and there is a need for better utilization of crop residues and agro-industrial by products to maximum extent through different feed processing methods and technologies. Therefore, it is high time to develop alternate feeding schedules, suitable for pace of changes occurring in land utilization pattern particularly due to shrinkage of grazing land. To solve seasonal fluctuations in productivity of goat, intensive system of goat rearing needs to be adapted. Acute shortage of grazing and browsing resources in the country can be managed by using complete feed/total mixed ration (TMR) formulated with locally available crop residues and agro-industrial byproducts (Reddy, 1995). The TMR/complete feed system not only ensures better utilization of nutrients from agricultural crop residues but also supplies balanced nutrients, controls roughage: concentrate ratio, provides uniform feed, increases bulk density, reduces feed wastage and is easy to handle during transportation. Feed ingredients of low palatability may also be better utilized as this system prevents selection of more palatable component of TMR. Over and above this, TMR system has also been noted to provide stable rumen environment, reduced fermentation losses and less fluctuation in release of ammonia. Further, TMR permits incorporation of deficient nutrients (Samanta *et al.*, 2006), ensures cheaper mode of transportation from production areas to the scarcity areas and also reported to improve the feed consumption, growth rate and efficiency of feed utilization (Jakhmola, 2003).

Groundnut (*Arachis hypogaea*) is a principal oil seed crop of India. Crop residue left after harvesting the pods is known as groundnut *gotar* in Gujarati an equivalent word for haulms. Haulms are fed in green form or hay. The ratio between pods and the crop residue is 40:60 (Murthy *et al.*, 2004). It is an excellent source of

crude protein, ether extract, calcium and phosphorus (14.7, 3.6, 2.3 and 1.6% respectively) with 5.7% DCP and 55.8% TDN contents (Shukla *et al.*, 1985).

The extensive use of leguminous straws may play a significant role in sustainable goat production as incorporation of leguminous straws in the diets of ruminants would help in ensuring better nutrient supply to the animal. Groundnut haulms is the most abundantly available agricultural crop residue and could be incorporated as basal roughage in the complete diet of sheep up to 60% level, as reported by Ramaprasad *et al.* (2000). Groundnut haulms form major roughage source for livestock feeding in the groundnut crop growing areas. Enhanced nitrogen (N) balance and growth response with complete rations containing legume straws was reported (Bonsi *et al.*, 1994). Little work has been done on the incorporation of groundnut haulms in the total mixed rations of goats as a roughage source.

Hence an attempt has been made to study the growth performance of kids fed *jowar* hay and groundnut haulms based total mixed ration (TMR) with following objectives:

- To study the effect of TMR based on *jowar* hay and *jowar* hay + groundnut haulms on **voluntary feed intake**.
- To study the effect of TMR based on *jowar* hay and *jowar* hay + groundnut haulms on **body weight gain**.
- To study the effect of TMR based on *jowar* hay and *jowar* hay + groundnut haulms on **rumen fermentation pattern**.
- To study the effect of TMR based on *jowar* hay and *jowar* hay + groundnut haulms on **digestibility of nutrients**.
- To study the effect of TMR based on *jowar* hay and *jowar* hay + groundnut haulms on **nutrient utilization** and **feed conversion efficiency**.

- To workout **cost of feeding**.

CHAPTER II

REVIEW OF LITERATURE

The present study on growth performance of kids fed *jowar* hay and groundnut (*Arachis hypogaea*) haulms based total mixed ration (TMR) has been reviewed and described under following heads:

2.1 Nutritive value of groundnut haulms

2.2 Effect on body weight gain

2.3 Effect on DM intake

2.4 Effect on rumen fermentation pattern

2.5 Effect on digestibility and nutrients intake

2.6 Effect on feed conversion efficiency

2.7 Effect on cost of feeding

2.1 NUTRITIVE VALUE OF GROUNDNUT HAULMS:

The values of proximate nutrients of groundnut haulms ranged from CP 9.10 to 12.40%, EE 1.20 to 2.70%, CF 17.74 to 31.90%, NFE 42.30 to 58.21%, total ash 9.50 to 14.20%, AIA 1.90 to 7.49%, Ca 1.2 to 2.7% and P 0.4 to 0.6% on DM basis as reported by different workers (Table 2.1). The DCP and TDN contents of groundnut haulms were 6.49 and 59.07%, respectively on DM basis in rams as reported by Ramratan (1999). The groundnut haulms contained 46.1% NDF, 38.8% ADF, 7.3% hemicellulose, 26.7% cellulose and 10.2% lignin on DM basis. The *in vitro* and *in vivo* digestibility of DM of groundnut haulms was found to be 55.9 and 54.9%, respectively, whereas *in vitro* and *in vivo* digestibility of NDF was 35.2 and 40.2%, respectively (Kumaresan and Parthasarathy, 2008).

Table 2.1: Chemical composition (% on DM basis) of groundnut haulms and groundnut haulms silage

CP	EE	CF	NFE	TA	AIA	Ca	P	DM	OM	Reference
Groundnut haulms										
10.38	1.20	25.40	50.36	12.66	7.49	-	-	92.76	87.34	Durgaprasad *et al*. (1986)
10.60	2.60	30.70	42.30	13.80	6.50	1.9	0.4	-	86.20	Ramaprasad *et al*. (1999)
10.15	2.61	17.83	58.21	11.20	-	-	-	95.94	88.71	Ramratan (1999)
12.40	2.70	31.90	42.90	10.20	4.00	2.7	0.6	-	89.80	Murthy *et al*. (2004)
9.10	1.50	26.50	48.70	14.20	7.30	1.9	0.6	-	85.80	Aasharekha *et al*. (2005)
10.40	1.40	24.80	52.50	10.90	3.10	1.2	0.4	-	89.10	Patel *et al*. (2007)
11.10	1.60	30.30	47.50	9.50	1.90	-	-	-	90.50	Kumaresan and Parthasarathy (2008)
Groundnut haulms silage										
11.96	1.83	17.79	44.17	24.25	12.50	-	-	28.09	75.75	Yadav *et al*. (1995)
9.73	1.17	16.78	41.40	31.21	18.60	-	-	30.57	68.79	Mandal *et al*. (1999) (GH + Paddy straw, 1:4)

The data for proximate composition of groundnut haulms silage as quoted by different research workers are presented in Table 2.1. The groundnut haulm silage was found to contain DCP 5.96%, TDN 40.92% and ME 1.55 Mcal/kg with a pH of 5.04, as reported by Yadav *et al*. (1995). The nutritive value index and effective feeding potential of silage was 55.61 and 94.32%, respectively. Silage of groundnut haulms and paddy straw mixture (4:1 on fresh basis) had a pH of 4.75 (Mandal *et al.*, 1999).

2.2 EFFECT ON BODY WEIGHT GAIN:

Durgaprasad *et al*. (1986) formulated four complete rations by blending groundnut haulms (10.38% CP) with a conventional concentrate mixture (14.75 % CP) in ratios of 80:20 (CR-1), 60:40 (CR-2), 40:60 (CR-3) and 20:80 (CR-4) and evaluated using 32 Nellore Brown weaned lambs (11.16 kg). The average daily gain of lambs fed CR-1, CR-2, CR-3 and CR-4 was 40.33, 58.78, 71.88 and 86.76 g, respectively. The average daily gain (g) was significantly higher ($P<0.01$) in lambs fed CR-3 or CR-4 than those fed CR-1. The differences in ADG between treatments 1 and 2 or among the treatments 2 to 4 were not significant. The recommended optimum level of inclusion of groundnut haulms in the complete ration was 40%.

Lu and Potchoiba (1990) conducted an experiment on growing 45 Alpine and 45 Nubian goats and reported average daily gain as 115, 113 and 99 g for goats fed diets containing 2.46, 2.77 and 3.05 Mcal/kg ME, respectively. However, the average daily gain was 104, 106 and 117 g for goats fed diets having 11.2, 12.7 and 15.1% CP, respectively. The data for ADG were similar between the breeds.

Ramratan (1999) carried out an experiment on eight yearling Nali rams (29.8±0.66 kg body weight) fed groundnut haulms *ad libitum* along with mineral mixture and common salt. The body weight gain was 90.3 g/d in rams during experimental period.

Three isonitrogenous complete rations (CR) containing groundnut haulms at 50 (CR_1), 60 (CR_2) and 70% (CR_3) levels were formulated (Ramaprasad *et al.*, 2000) and evaluated using twelve growing Nellore Brown lambs (14.2±0.1 kg BW). The average daily gain (ADG) was significantly ($P<0.05$) higher in lambs fed CR_1 (59 g) or CR_2 (53 g) than those fed CR_3 (46 g).

Raut *et al.* (2002) reported average daily gain of 75.0 g in non descript male goats (8.42 months; 17.18 kg BW) fed pelleted complete feed containing 60% *arhar* (*Cajanus cajan*) straw and 40% concentrate mixture (*Jowar* 30, cotton seed cake 27, *arhar* chunni 30, groundnut cake 10, mineral mixture 2 and common salt 1%).

An experiment was conducted by Rajendiran and Kadirvel (2002) to evaluate the dried casuarina leaf meal (CLM) as a roughage component in complete diets. Casuarina leaf meal was fed to 20 male goat kids (3-4 months age) for 30 days. The five, isonitrogenous and isocaloric, complete diet pellets containing CLM were not readily accepted by the kids. All animals on experimental diets containing 20, 40 or 60% CLM lost weight, while maximum weight loss (45 g/d) was recorded in kids fed complete diet pellets containing 60% CLM. These animals also suffered from generalized dermatitis with thick, folded skin and rough hair coat suggesting a possible zinc deficiency. The animals in basal group suffered only 8.3 g loss in body weight per day without any skin lesions. Casuarina leaf meal may have limited value as a feed ingredient in rations for young goats.

Rekhate *et al.* (2004) divided non-descript local goats (18; 320 d old of 21.8±0.8 kg BW) into 3 equal groups and offered complete feed pellets based either on *arhar* straw (ASCF), gram straw (GSCF) or exclusive *arhar* straw pellets supplemented with concentrate pellets (AS-CONC) for 110 days. The roughage to concentrate ratio was maintained at 60:40 in all the diets. The average daily gain in goats was 83.5, 108.1 and 94.8 g under ASCF, GSCF and AS-CONC groups, respectively. The daily live weight gain was considerably higher in goats fed gram straw based pellets. It was concluded that goats fed on gram straw based pelleted complete diet performed better and fulfills the requirement of goats growing at 108 g/d under stall fed conditions.

Bhadane *et al.* (2004) conducted a study to assess the effect of feeding pelleted complete feed of varying protein levels on body weight gain in twelve non descript local goats divided into two treatment groups. Goats under both the treatments were fed pelleted complete feed G_1 (12% CP, 65.81% TDN) and G_2 (14% CP, 67.44% TDN) containing *arhar* straw as a sole roughage for 140 days. Roughage to concentrate ratio in the two diets was maintained at 60:40 with *arhar* straw as the sole roughage. The average gain in the respective groups was 75.7 and 72.9 g/d.

Ravi and Ramaprasad (2005) studied the effect of strategic supplementation with concentrate (Maize and deoiled groundnut cake) C, or C along with groungnut haulms (GH), dry leaf meal of *Leucaena leucocephala* (LL), *Sesbania grandiflora* (SG), *Gliricidia maculate* (GM) or *Ficus bangalensis* (FB) on the performance of male kids maintained on daily 6-8 hrs browsing (Semi-intensive system, SIS) or stall fed on NB-21 green fodder (Intensive system, IS) for 180 days. The total weight gain and average daily gain was 7.7 and 42.8, 7.2 and 40.2, 7.2 and 39.1, 8.2 and 45.8, 7.6 and 42.0 & 6.0 kg and 33.7 g under C, GH, LL, SG, GM and FB groups, respectively. The total gain in weight and average daily gain under SIS and IS was 10.3 and 57.1 & 4.3 kg and 23.9 g, respectively and showed significant ($P<0.05$) variation. The gain in weight was highest ($P<0.01$) in SG and lowest ($P<0.01$) in FB group, while other groups did not differ significantly.

An experiment was conducted by Dhore *et al.* (2005) to assess the effect of variation in energy and protein levels on the performance of kids. Local kids (12; 147.26±1.82 d and 16.35±1.05 kg BW) were divided into 2 equal groups and fed *arhar* straw based pelleted complete diet containing either 7% DCP and 60% TDN (CD_1) or 9% DCP and 55% TDN (CD_2) for 150 days. The daily gain in weight was significantly ($P<0.01$) higher in CD_2 (59.8 g) as compared to CD_1 (54.2 g).

Thirty-six growing Boer goats were divided into three equal groups by Pi *et al.* (2005) and randomly allocated to receive one of the following diets: (1) unpelletized ryegrass hay-based TMR (TMR-1), (2) tp-TMR in Trial 1 (TMR-2), and (3) TMR-2 plus 0.12% zinc-methionine (TMR-3). The experimental period lasted for 75 days with the first 15 days as adaptation period. Daily weight gain was significantly higher ($P<0.01$) in TMR-2 and TMR-3 than in TMR-1, however, differences between TMR-2 and TMR-3 were non-significant ($P>0.05$).

An experiment was conducted by Mane *et al.* (2006) to compare the effect of feeding iso-nitrogenous conventional (T_1) and complete feed (T_2) in growing goats. The animals (16; 12.6±0.45 kg BW) were divided into 2 equal groups and offered either conventional feed or complete feed *ad libitum* for 90 days. Weight gain was significantly higher ($P<0.05$) in T_2 (46.8 g/d) than T_1 (35.2 g/d).

Local kids (18; 111.16±1.01 days and 10.42±0.05 kg BW) were divided into three equal groups by Dhore *et al.* (2006). The animals in T_1 group (control) were offered tree leaves of *apta* (*Bauhinia racemosa*), *anjan* (*Hardwickia binata*) and *subabul* (*Leucaena leucocephala*); T_2 : urea treated sugarcane bagasse based pelleted complete ration and T_3 : urea treated wheat straw based pelleted complete ration for 90 days. The pelleted feeds were having 8% DCP and 62% TDN. The roughage to concentrate ratio was 1:1. The ADG for the respective groups was 44.37, 68.73 and 76.31 g with significant ($P<0.01$) variations between the groups. It was concluded that urea treated wheat straw based pelleted complete ration performed better in respect of weight gain, hence can be utilized successfully for economic goat rearing under stall fed condition.

According to Payne *et al.* (2006), rangeland or hay-based finishing systems often do not allow kids to reach slaughter weights of 30-50 kg by 12 months. They determined the effects of a complete feed (CF) and a self-limiting complete feed (LCF) alone or in combination with *ad libitum* access to sorghum-sudan hay (SS) on average daily gain (ADG) in Boer cross doelings. Thirty kids (21.1 kg) were randomly assigned to one of five treatments (SS, CF, LCF, SS + CF, and SS + LCF). The ADG over 63 days of feeding was greater for all treatments with CF and LCF when compared with SS (21.8, 152, 123, 181, and 172 g/d for SS, CF, LCF, SS + CF and SS + LCF, respectively). In this experiment, traditional and self-limiting supplements for forage-fed goats were useful in increasing ADG and controlling supplement intake when compared with supplement feeding alone.

Fungus (*Trichoderma viride*) fermented sugar beet pulp was supplemented at 0.0 (T_1), 0.3 (T_2), 0.6 (T_3) and 0.9% (T_4) (w/w) to complete feed mixture and mixed well just before feeding to goats by Salman *et al.* (2008). The un-supplemented complete feed mixture (T_1) served as a control group. The average daily gain was significantly ($P<0.05$) better for goats fed T_4 (104.83 g) followed by T_3 (95.25 g) compared to T_2 (89.17 g) and control group (88.58 g).

The four dietary treatments were randomly allocated into 5 blocks of the twenty goats (15.84±2.35 kg) by Chobtang *et al.* (2009). Dietary treatments contained 8, 10, 12 and 14% CP (% on DM basis in total mixed ration) with a concentrate: roughage ratio of 85: 15. The feeding trial lasted for 120 days. Increasing CP levels in TMR resulted in linear increase in the body weight (23.10, 23.42, 24.10 and 27.42 kg, respectively), weight gain (6.84, 7.37, 7.60 and 11.06 kg, respectively) and average daily gain (56.97, 61.42, 63.30 and 92.13 g, respectively). The treatment differences were highly significant ($P<0.01$).

Twelve non-descript local kids (4 months age) were divided into two equal groups (7.85, 7.58 kg BW, respectively) by Chopade *et al.* (2010). One group (TSS) was fed untreated soybean straw while other (TUSS) was fed 4% urea treated soybean straw in the form of pelleted complete ration (R:C; 60:40) with 12% CP and 60% TDN for 100 days. Average daily gain in weight was 63.97 and 71.18 g under TSS and TUSS groups, respectively. The data for gain in weight in both the groups were comparable and suggested that urea treated soybean straw can be successfully incorporated in pelleted complete ration at 60% level for growth and maintenance of kids.

Wadhwani *et al*. (2010) carried out an experiment (for 120 d) on twenty one Marwari, Patanwadi and Merino X Patanwadi weaner lambs (12.40 to 14.68 kg). The animals were randomly allotted to three dietary treatments on body weight basis *viz*. T_1 : TMR-I conventional group (maize- 22%, groundnut cake- 15%, rice polish- 15%, molasses- 10%, mineral mixture- 3% and urea treated wheat straw- 35 %), T_2 : TMR-II supplemented non conventional group I (azolla- 10%, PJ pods -15 %, corn steep liquor -12 %, rice polish- 10 %, groundnut cake- 5 %, molasses- 10%, mineral mixture- 3% and urea treated wheat straw- 35 %) and T_3 : TMR-III supplemented non conventional group II (azolla-20%, PJ pods -17 %, corn steep liquor -15 %, molasses-10%, mineral mixture- 3% and urea treated wheat straw- 35 %). The average gain in weight at the end of the experimental period was recorded as 94.17, 81.61 and 59.96 g/d for the lambs fed TMR-I, TMR-II and TMR-III, respectively. The daily gain recorded in TMR-I and TMR-II was at par but was significantly ($P<0.05$) lower under TMR-III. The total gain of height at withers, heart girth and body length under TMR-I, TMR-II and TMR-III were 10.64, 14.71 and 12.93; 10.00, 12.86 and 10.00 & 6.14, 7.07 and 4.14 cm, respectively. The overall trend of increase in heart girth, height at withers and body length was similar under TMR-I (conventional) and TMR-II (non conventional I) but was superior ($P<0.05$) compared to TMR-III.

A feeding experiment was conducted by Murthy *et al.* (2004) on eighteen Gir calves (three groups, each consisting of three male and three female animals) to evaluate groundnut haulms at 20% (T_1), 30% (T_2) and 40% (T_3) levels in their rations following completely randomized design. Average gain was 443.5, 464 and 497 g/d in T_1, T_2 and T_3 groups, respectively. Biometrical differences were also non significant. The results indicated that groundnut haulms could be incorporated up to 40% in the rations of Gir calves without any adverse effect on growth and the health of animals.

Castrated Gir bullocks (6; 4.5±0.4 yr old and 276.7±13.6 kg BW) were offered *jowar* straw and groundnut haulms mixed either in 100:0 (JS_{100}), 80:20 (JS_{80}), 70:30 (JS_{70}) or 60:40 (JS_{60}) ratio in a switch over design for 30 days as sole feed by Patel *et al.* (2007). The body weight gain/loss was -5.33 (JS_{100}), -2.3 (JS_{80}), 3.3 (JS_{70}) and 10.3 kg (JS_{60}). The treatment differences were significant ($P<0.01$). Overall results indicated that *jowar* straw fortified with 30 or 40% of groundnut haulms as sole feed will maintain the body weight of bullocks.

2.3 EFFECT ON DM INTAKE:

Ramratan (1999) carried out an experiment on eight yearling Nali rams (29.8±0.66 kg body weight). The rams were fed groundnut haulms *ad libitum* along with mineral mixture and common salt. The DMI was 113.32 g/kg $W^{0.75}$ and the water intake was 2.36 L/kg DMI in rams.

Four isonitrogenous complete rations containing *subabul* leaf meal (CR-1), sunnhemp hay (CR-2), *Stylo hamata* hay (CR-3) and groundnut haulms (CR-4) each at 60% level were evaluated for 28 days by Ramaprasad *et al*. (1999) following a 4 × 4 Latin Square design using 4 Nellore Brown rams. The dry matter (DM) intake was 903, 882, 863 and 868 g/d ($P>0.05$) for CR-1, CR-2, CR-3 and CR-4, respectively. The daily DMI was relatively higher in rams fed CR-1 as compared to CR-2, CR-3 and CR-4. The data for daily DMI expressed as per cent of body weight (3.0 – 3.1 kg/100 kg BW) or on metabolic body weight basis (70.0 – 72.3 g/kg $W^{0.75}$) were similar in all the rams fed different complete rations and treatment differences were non-significant.

Mandal *et al.* (1999) divided ten adult rams into two groups of 5 each. Control group was maintained on gram straw and concentrate mixture in the ratio of 60:40 on ME basis while the experimental group was fed groundnut haulms and paddy straw silage (4:1 on fresh basis) *ad libitum* as sole ration for 68 days including a metabolism trial of 6 days duration. The average per cent DM intake was 3.17 kg and 2.32 kg ($P<0.01$), respectively in rams fed silage and conventional ration.

Three isonitrogenous complete rations (CR) containing groundnut haulms at 50 (CR_1), 60 (CR_2) and 70% (CR_3) levels were formulated (Ramaprasad *et al.*, 2000) and fed to twelve growing Nellore Brown lambs (14.2±0.1 kg BW). The total DM intake in lambs was 616, 573 and 537 g/d under CR_1, CR_2 and CR_3, respectively. The DM intake as expressed on per cent of body weight was 4.1, 4.0 and 3.9 kg under CR_1, CR_2 and CR_3, respectively. The similar values on metabolic body weight basis were 82, 78 and 66 g, respectively. The DM intake (g/d, per cent of body weight and on metabolic body weight basis) was significantly higher ($P<0.01$) in lambs fed CR_1 than those fed CR_3. They concluded that the groundnut haulms can be incorporated at 60% levels in complete rations of growing lambs as roughage source.

Three complete rations containing 60% either sorghum straw (CR1), soybean straw (CR2) or corn cobs (CR3) and 40% concentrate mixture were fed to Osmanabadi goats by Rajmane and Deshmukh (2000). The DMI was 615, 924 and 782 g/d under CR 1, CR 2 and CR 3, respectively. The respective values for % DMI were 2.19, 3.33 and 2.76 kg ($P>0.05$). These findings suggested that experimental complete rations could maintain the body weight of adult Osmanabadi goats during the study period.

Raut *et al.* (2002) fed pelleted complete feed containing 60% *arhar* (*Cajanus cajan*) straw and 40% concentrate mixture (*Jowar* 30, cotton seed cake 27, *arhar chuni* 30, groundnut cake 10, mineral mixture 2 and common salt 1%) to six local non descript male goats (8.42 months; 17.18 kg BW). The DM intake was 743.94±41.56 g/d and 4.20±0.28 kg/100 kg BW. Feeding of 60% *arhar* straw based complete ration could maintain the body weight and health of goats.

An experiment was conducted by Rajendiran and Kadirvel (2002) to evaluate the dried casuarina leaf meal (CLM) as a roughage component in complete diets. The CLM was fed to 20 male kids (3-4 months age) for 30 days. The five, isonitrogenous and isocaloric, complete diet pellets containing CLM were not readily accepted by the kids. The DM intake ranged from 32 g/kg $W^{0.75}$ in 60% CLM diet to 45 g/kg $W^{0.75}$ on basal diet.

Four iso-nitrogenous complete feeds were formulated by Prakash *et al*. (2003) using untreated and urea ammoniated maize (*Zea mays*) stover and fed to Osmanabadi bucks (20.53±0.44 kg) in a 4 × 4 Latin Square design. The bucks were fed either untreated ground maize stover and lucerne hay (R_1), untreated ground maize stover and concentrate mixture (R_2), urea treated ground maize stover and concentrate mixture (R_3) or urea treated chopped maize stover and concentrate mixture (R_4). The DMI was 504.4, 559.0, 591.4 and 510.4 g/d ($P<0.05$) under R_1, R_2, R_3 and R_4, respectively. The DM intake was improved significantly by treating the ground maize stover with urea (R_3) as compared to untreated ground maize stover (R_1) supplemented with lucerne hay. The grinding of maize stover did not have any beneficial effect on DM intake over that of treated chopped maize stover. The DM intake as per cent of body weight did not differ significantly between the groups and ranged from 2.5 to 2.9 kg. Urea ammoniation of maize stover did not improve the DMI, however, grinding of maize stover prior to urea-ammoniation increased the DMI ($P<0.05$) significantly.

An experiment was conducted by Samanta *et al.* (2003) on fifteen Barbari goats (average BW 13 kg) randomly divided into three groups of five each. All animals were fed complete diets consisting of natural grass hay and concentrate mixture in the ratio of 60:40 on DM basis. Either 15% (T_2) or 30% (T_3) CP of mustard cake was replaced with *Leucaena* leaf meal (LLM) in concentrate mixture. The diet of the control group (T_1) was offered as such, whereas T_2 and T_3 diets were offered in the form of blocks. Densification of complete diets increased the bulk density by 3.2–3.9 times. Voluntary feed intake was similar in T_1 (431 g/d), T_2 (409 g/d) and T_3 (415 g/d). The DMI as per cent of body weight was 3.06, 2.90 and 2.95 kg under groups T_1, T_2 and T_3, respectively. However, the DMI on metabolic body weight was 59.28, 56.23 and 57.17 g/kgW$^{0.75}$ under groups T_1, T_2 and T_3, respectively.

The non-descript local goats (18; 320 d old and 21.8±0.8 kg BW) were divided into 3 equal groups and offered complete feed pellets based either on *arhar* straw (ASCF), gram straw (GSCF) or exclusive *arhar* straw pellets supplemented with concentrate pellets (AS-CONC) for 110 days (Rekhate *et al*., 2004). The roughage to concentrate ratio was maintained at 60:40 in all the diets. The DMI as g/d and as per cent of body weight was 1213.4 and 4.3, 1298.5 and 4.5 & 1425.2 and 5.3 under ASCF, GSCF and AS-CONC, respectively. The DMI (g/d or as % of BW) was comparable in goats fed complete feed pellets containing either *arhar* or gram straw but was improved ($P<0.01$) in group fed *arhar* straw pellets supplemented with concentrate pellets.

An experiment was conducted by Bhadane *et al.* (2004) to assess the effect of pelleted complete feed of varying protein levels on feed intake. Twelve non descript local goats were randomly divided into two treatment groups. Goats under both the treatments were fed pelleted complete feed G_1 (12% CP, 65.81% TDN) and G_2 (14% CP, 67.44% TDN) containing *arhar* straw as a sole roughage for 140 days. Roughage to concentrate ratio in the two diets was maintained at 60:40 with *arhar* straw as the sole roughage. The goats consumed 989.3 and 835.4 g ($P<0.05$) dry matter per day. However, per cent DMI in G_1 and G_2 was 4.6 and 4.9 kg, respectively.

Similarly Dhore *et al.* (2005) also assessed the effect of different energy and protein levels on the performance of local kids (12; 147.26±1.82 d old and 16.35±1.05 kg BW). The kids divided into 2 equal groups and fed pelleted complete diet containing either 7% DCP and 60% TDN (CD_1) or 9% DCP and 55% TDN (CD_2) for 150 days. The DMI (g/d) was comparable between the treatment groups (726.1 and 739.1 g). However, per cent DMI was significantly ($P<0.01$) higher in CD_2 (3.7) as compared to CD_1 (3.3).

Complete rations containing groundnut haulms (GNH) and concentrates in 60:40 or 70:30 ratios with or without yeast culture product (YCP) were fed to sheep by Aasharekha *et al.* (2006) to study the effect on dry matter intake in a switch over manner. The daily DMI was 83.5, 83.1, 82.4 and 84.5 g/kg $W^{0.75}$ under 60:40, 70:30, without YCP and with YCP, respectively, while the total daily DMI was 1.4 kg in all the groups. The roughage to concentrate ratio or YC supplementation did not have any significant effect on DM intake. It was concluded that groundnut haulms inclusions up to 60% in the complete diets along with yeast culture could improve DMI of sheep.

Local kids (18; 111.16±1.01 d old and 10.42±0.05 kg BW) were divided into three equal groups by Dhore *et al.* (2006). The animals in T_1 group (control) were offered tree leaves of *apta* (*Bauhinia racemosa*), *anjan* (*Hardwickia binata*) and *subabul* (*Leucaena leucocephala*); T_2 : urea treated sugarcane bagasse based pelleted complete ration and T_3 : urea treated wheat straw based pelleted complete ration for 90 days. The pelleted feeds were having 8% DCP and 62% TDN. The roughage to concentrate ratio was 1:1. The DMI was 471.38, 578.77 and 625.69 g/d ($P<0.01$) under T_1, T_2 and T_3, respectively. Similar pattern was also observed for % DMI (4.36 to 5.12 kg/100 kg BW). These findings suggested that the DM intake was significantly ($P<0.01$) higher in T_3 group in comparison to other groups.

Mane *et al.* (2006) also compared the effect of feeding iso-nitrogenous conventional (T_1) and complete feed (T_2) in goats. Growing goats (16; 12.6±0.45 kg BW) were divided into 2 equal groups and fed either conventional feed or complete feed *ad libitum* for 90 days. The average DMI was significantly ($P<0.05$) higher in T_2 (536.6±9.6 g/d) as compared to T_1 (417.1±8.2 g/d) which may be due to blending and processing of ingredients in complete feed and higher nutrient density. The values for DMI as per cent of body weight were also higher ($P<0.05$) in T_2 (4.0) than T_1 (3.5) group. The goats fed complete feed consumed more dry matter than the goats fed under conventional system of feeding.

Fungus (*Trichoderma viride*) fermented sugar beet pulp was supplemented at 0.0, 0.3, 0.6 and 0.9% (w/w) to complete feed mixture and mixed well just before feeding for treatments T_2, T_3 and T_4, respectively (Salman *et al*., 2008). The un-supplemented complete feed mixture (T_1) served as a control group. The DMI (g/d) was significantly ($P<0.05$) higher for goats fed T_4 (932) followed by those fed T_3 (908), but the differences between T_2 (898) and T_1 (885) were not significant. The respective values for DMI as per cent of body weight were 3.97, 4.00, 4.00 and 4.05 ($P>0.05$).

The experiment was conducted by Chobtang *et al.* (2009) to evaluate the dry matter intake of Thai indigenous male goats fed different levels of crude protein (CP) in total mixed rations (TMR). Twenty goats with average body weight of 15.84±2.35 kg were used. The four dietary treatments were randomly allocated into 5 blocks of the animals stratified on their initial body weight. Dietary treatments contained 8, 10, 12 and 14% CP with a concentrate: roughage ratio of 85: 15. The feeding trial lasted for 120 days. The DMI was 563.41, 567.31, 562.76 and 603.30 g/d under different treatments containing 8, 10, 12 and 14% CP, respectively. Increasing level of CP did not affect the DMI in goats.

Twelve non-descript local kids (4 months age) were divided into two equal groups (7.85 and 7.58 kg BW) by Chopade *et al.* (2010). One group (TSS) was fed on untreated soybean straw (TSS) while other was fed on 4% urea treated soybean straw (TUSS) in the form of pelleted complete ration (R:C; 60:40) with 12% CP and 60% TDN for 100 days. The average DMI (g/d) in TSS group (702.28±48.46) was significantly ($P<0.01$) higher than that in TUSS group (680.10±49.41). They concluded that urea treated soybean straw can successfully be incorporated in pelleted complete ration at 60% level for growth and maintenance of kids.

Wadhwani *et al*. (2010) carried out an experiment on twenty one Marwari, Patanwadi and Merino X Patanwadi weaner lambs (12.40 to 14.68 kg). The animals were randomly divided into three dietary treatments on body weight basis *viz.* T_1 : TMR-I conventional group, T_2 : TMR-II supplemented non conventional group I (azolla 10%) and T_3 : TMR-III supplemented non conventional group II (azolla 20%). The dry matter intake (kg/head) during the entire experimental period was recorded as 85.37 ± 19.10, 90.86 ± 4.30 and 81.02 ± 6.09 under TMR-I, TMR-II and TMR-III, respectively and differed ($P<0.05$) significantly. During metabolism trial, the total DMI in terms of g/d, as per cent of body weight and g/kg $W^{0.75}$ was 570.50±23.34, 2.50±0.14 and 54.64±2.12; 831.02±106.30, 3.53±0.15 and 77.74±4.90 & 895.16±43.48, 4.27±0.14 and 91.41±3.06 under TMR-I, TMR-II and TMR-III, respectively. The DMI was significantly ($P<0.05$) lower in TMR-I as compared to TMR-II and TMR-III which did not differ from each other.

Murthy *et al.* (2004) evaluated incorporation of groundnut haulms at 20% (T_1), 30% (T_2) and 40% (T_3) in the ration of growing Gir calves in a completely randomized design. The daily DMI was 3.1, 3.3 and 3.4 kg, respectively under T_1, T_2 and T_3. However, per cent DMI was found to be 2.7 kg under all treatment groups. It was concluded that DMI was not affected significantly, indicating similar palatability and acceptability, at all levels of inclusion. The results indicated that groundnut haulms could be incorporated up to 40% in the rations of Gir calves without any adverse effect on DMI and health of animals.

Castrated Gir bullocks (6; 4.5±0.4 yr old and 276.7±13.6 kg BW) were offered *jowar* straw and groundnut haulms mixed either in 100:0 (JS_{100}), 80:20 (JS_{80}), 70:30 (JS_{70}) or 60:40 (JS_{60}) ratio in a switch over design for 30 days as sole feed by Patel *et al.* (2007). The daily DMI was 3.8, 3.9, 4.2 and 4.9 kg under the groups JS_{100}, JS_{80}, JS_{70} and JS_{60}, respectively. The DMI was improved ($P<0.05$) linearly with the increase in level of groundnut haulms in the diet. However, the DMI as per cent of body weight was 1.4, 1.4, 1.5 and 1.5 ($P>0.05$) under the groups JS_{100}, JS_{80}, JS_{70} and JS_{60}, respectively. Overall results indicated that *jowar* straw fortified with 30 or 40% of groundnut haulms as sole feed will maintain the bullocks.

2.4 EFFECT ON RUMEN FERMENTATION PROFILE:

Complete rations containing groundnut haulms (GNH) and concentrates in 60:40 or 70:30 ratios with or without yeast culture product (YCP) were fed to sheep by Aasharekha *et al.* (2006) to study the effect on rumen fermentation pattern in a switch over manner. Higher ($P<0.05$) concentration of ammonia nitrogen (14.0 mg/dl) and bacterial count (2.7×10^3/ml) in the rumen liquor was observed in sheep fed YCP supplemented diet than those sheep fed diet without YCP supplementation (13.4 mg/dl and 2.0×10^3/ml, respectively). Sheep fed 60:40 complete diet also sustained higher ($P>0.05$) ammonia nitrogen concentration (13.8 mg/dl) than the sheep fed 70:30 complete diet (13.6 mg/dl). Whereas, the pH (6.6 to 6.7), concentration of total nitrogen (84.6 to 91.2 mg/dl) and TVFA (60.9 to 62.4 mEq/L) were comparable among the treatments. It was concluded that groundnut haulms inclusions at 60% in the complete diets along with yeast culture could improve rumen fermentation in sheep.

Sahlu *et al.* (1992) used twenty-eight Angora goat doelings (average BW 22.1 kg) in a 150-d study period to examine the effects of dietary CP level and degradability on rumen fermentation. A 2 x 2 factorial arrangement was instituted using conventional, solvent-extracted soybean meal (high degradability) or expelled, heat-treated soybean meal (low degradability) incorporated into low- (12%) or high- (19%) CP diets. Ruminal fluid pH and TVFA concentrations were not affected (P>0.10) by diet. Ruminal ammonia N concentration increased (P<0.05) as CP level in the diet increased, and postprandial changes in concentrations were less noticeable in the group fed expelled, heat-treated soybean meal.

Raut *et al.* (2002) fed pelleted complete feed containing 60% *arhar* (*Cajanus cajan*) straw and 40% concentrate mixture to six local non descript male goats (8.42 months; 17.18 kg BW). The rumen liquor samples were collected on 0, 7, 14, 21 and 28th d of experiment at 4 hrs of post feeding. The pH of rumen liquor varied significantly (P<0.05) between the period. The mean pH was 6.88±0.05, where as the pH of rumen liquor at respective days of collection at 4 hrs of post feeding was 7.03, 6.83, 6.83, 6.98 and 6.75. The mean NH_3-N level in the SRL was 12.50±0.95 mg/100 ml SRL, where as the NH_3-N level at 0, 7, 14, 21 and 28th d of experiment was 8.76, 13.33, 14.06, 13.01 and 13.37 mg/100 ml SRL. There was significant (P<0.05) difference between the period for the ruminal NH_3-N level after feeding of complete feed pellet. The TVFA concentration varied significantly (P<0.05) between the period. The TVFA concentration at 0, 7, 14, 21 and 28th d of experiment was 4.01, 6.61, 8.74, 8.81 and 8.23 mEq/dl SRL. An increasing trend was observed in TVFA concentration from 0 to 28th d of experiment with the mean value of 7.28±0.91 mEq/dl SRL. An increasing trend of TVFA concentration may be due to higher digestibility of crude fibre.

An experiment was conducted by Samanta *et al.* (2003) on fifteen Barbari goats (average BW 13 kg) randomly divided into three groups of five each. All animals were fed complete diets consisting of natural grass hay and concentrate mixture in the ratio of 60:40 on DM basis. In the concentrate mixture, 15% (T_2) or 30% (T_3) CP of mustard cake was replaced with *Leucaena* leaf meal (LLM). The diet of the control group (T_1) was offered as such, whereas T_2 and T_3 diets were offered in the form of blocks. The pH of SRL did not differ significantly ($P>0.05$) and varied from 6.68 to 7.01, being lower in the mash-fed control group (T_1). The TVFA concentration in the rumen fluid was almost identical (10.10 – 11.60 mEq/dl SRL) in all three groups and did not differ significantly. The NH_3-N concentration was higher ($P<0.05$) in mash-fed goats T_1 (30.23±1.14 mg/dl SRL) than in the block-fed goats T_2 (22.69±0.16 mg/dl SRL) and T_3 (22.02±0.60 mg/dl SRL). Total N (mg/dl SRL) as well as NPN (mg/dl SRL) concentrations were also significantly ($P<0.05$) higher in T_1 (78.45 and 50.35) than T_2 (67.50 and 29.85) and T_3 (68.45 and 29.62). The TCA-N did not differ significantly and ranged from 35.10 to 38.82 mg/dl of SRL.

Rekhate *et al.* (2004) divided non-descript local goats (18; 320 d old and 21.8±0.8 kg BW) in 3 equal groups and offered complete feed pellets based either on *arhar* straw (ASCF), gram straw (GSCF) or exclusive *arhar* straw pellets supplemented with concentrate pellets (AS-CONC) for 110 days. The roughage to concentrate ratio was maintained at 60:40 in all the diets. The levels of NH_3-N (mg/dl), TVFA (mEq/dl), total-N (mg/dl), TCA-N (mg/dl) and NPN (mg/dl) were 20.5, 9.4, 82.8, 31.6 and 51.1; 20.2, 5.3, 92.8, 41.8 and 51.2 and 19.5, 7.0, 88.1, 43.5 and 44.5 under ASCF, GSCF and AS-CONC groups, respectively. The significantly ($P<0.01$) low NH_3-N and NPN concentrations in the rumen liquor of goats fed AS-CONC diet were responsible for significantly ($P<0.01$) higher TCA-N as compared to other groups. The highest ($P<0.01$) TVFA production was observed in the rumen of goats fed *arhar* straw based complete feed pellets as compared to other groups.

Dhore *et al.* (2005) assessed the effect of different energy and protein levels on rumen fermentation in local kids (12; 147.26±1.82 d old of 16.35±1.05 kg BW) fed pelleted complete feed containing either 7% DCP and 60% TDN (CD_1) or 9% DCP and 55% TDN (CD_2) for 150 days. The ruminal pH ranged from 6.2 to 6.3 ($P>0.05$). The NH_3-N concentration in the SRL was apparently higher ($P>0.05$) in group CD_2 (20.5 mg/dl) than CD_1 (19.8 mg/dl) indicating higher availability of soluble nitrogen required for optimum microbial activity. The TVFA production was higher ($P>0.05$) in group fed CD_2 (12.0 mEq/dl) than CD_1 (11.5 mEq/dl) which may be due to higher fibre digestibility. The total nitrogen content was significantly ($P<0.01$) higher in group fed CD_2 (88.2 mg/dl) than CD_1 (78.9 mg/dl). The mean TCA-N was ($P<0.01$) higher in CD_2 than CD_1 (56.6 mg/dl Vs 49.3 mg/dl) may be due to higher DCP content of the diet. The NPN also revealed non significant variations between the groups (31.7 mg/dl Vs 29.6 mg/dl).

Local kids (18; 111.16±1.01 days old and 10.42±0.05 kg BW) were divided into three equal groups by Dhore *et al.* (2006). The animals in T_1 group (control) were offered tree leaves of *apta* (*Bauhinia racemosa*), *anjan* (*Hardwickia binata*) and *subabul* (*Leucaena leucocephala*); T_2 : urea treated sugarcane bagasse based pelleted complete ration and T_3 : urea treated wheat straw based pelleted complete ration for 90 days. The pelleted feeds were having 8% DCP and 62% TDN. The rumen liquor profile revealed that the pH was in the normal physiological range of 6.2 to 7.2. The TVFA concentration was significantly ($P<0.01$) more in treatment groups T_2 and T_3 (11.56 and 11.47 mM/dl, respectively) than in control group (9.70 mM/dl). The NH_3-N concentration was significantly ($P<0.01$) higher in T_2 (20.74 mg/dl) and T_3 (21.18 mg/dl) groups than T_1 (15.13 mg/dl) group. The concentrations of total-N (89.56, 101.20 and 106.43 mg/dl under T_1, T_2 and T_3, respectively), TCA-N (41.70, 50.60 and 57.51 mg/dl under T_1, T_2 and T_3, respectively) and NPN (47.59, 51.49 and 48.91 mg/dl under T_1, T_2 and T_3, respectively) were significantly ($P<0.01$) higher in kids fed pelleted complete feed.

Fungus (*Trichoderma viride*) fermented sugar beet pulp was supplemented at 0.0, 0.3, 0.6 and 0.9% (w/w) to complete feed mixture and mixed well just before feeding for treatments T_2, T_3 and T_4, respectively (Salman *et al*., 2008). The un-supplemented complete feed mixture (T_1) served as a control group. Ruminal pH was significantly ($P<0.05$) lower under T_3 (6.45) and T_4 (6.47) than T_2 (6.71) and T_1 (6.81) groups after 3 hrs post feeding. Ruminal TVFA values were within the normal range (10.5 – 12.8 mEq/dl of rumen liquor). However, TVFA (mEq/dl) values for T_4 (12.81) and T_3 (12.73) were higher ($P<0.05$) than T_1 and T_2 but differences between T_2 (10.48) and T_1 (10.49) were non significant. The NH_3-N (mg/dl) concentrations for treatments T_4 (23.57) and T_3 (21.01) were higher ($P<0.05$) than that of T_2 (19.93) and T_1 (19.84) groups. In conclusion, biological treatments of sugar beet pulp could be used to enrich roughages and improved performance of goats.

Twelve non-descript local kids (4 months age) were divided into two equal groups (7.85 and 7.58 kg BW) by Chopade *et al.* (2010). One group was fed on untreated soybean straw (TSS) while other was fed on 4% urea treated soybean straw (TUSS) in the form of pelleted complete ration (R:C; 60:40) with 12% CP and 60% TDN for 100 days. The ruminal pH, NH_3-N, TVFA, total-N, TCA-N and NPN values were 6.62 & 6.70; 19.02 & 19.97 mg/dl SRL; 9.16 & 9.48 mEq/dl SRL; 91.07 & 98.40 mg/dl SRL; 38.25 & 42.20 mg/dl SRL and 53.05 & 56.37 mg/dl SRL under TSS and TUSS groups, respectively which revealed significant ($P<0.01$) variation.

2.5 EFFECT ON DIGESTIBILITY AND NUTRIENTS INTAKE:

Durgaprasad *et al*. (1986) evaluated four complete rations by blending groundnut haulms (10.38% CP) with a conventional concentrate mixture (14.75 % CP) in ratios of 80:20 (CR-1), 60:40 (CR-2), 40:60 (CR-3) and 20:80 (CR-4) using 32 Nellore Brown weaned lambs (11.16 kg) for 84-days. The crude fibre digestibility was significantly lower ($P<0.05$) in CR-4 (19.35%) than CR-1 (34.87%) or CR-2 (33.79%). The differences for crude fibre digestibility between CR-3 (23.82%) and CR-4 or among complete rations 1 to 3 were not significant. The level of concentrate mixture in the complete rations CR-1, CR-2, CR-3 and CR-4 did not affect the digestibilities of DM (56.48, 60.39, 61.13 and 63.37%), CP (54.30, 61.12, 59.88 and 57.69%), EE (59.74, 64.81, 71.98 and 69.47%) and NFE (70.60, 78.37, 79.69 and 82.09%) significantly. The nitrogen retention was significantly higher ($P<0.05$) in lambs fed CR-2, CR-3 or CR-4 than those fed CR-1 and the differences among treatments 2 to 4 were not significant. The DCP (6.21 to 8.08%) and TDN (52.94 to 62.59%) values increased as the level of concentrate increased in the complete ration. The nutritive ratio was 1:7.5, 1:6.9, 1:6.7 and 1:6.7 under CR-1, CR-2, CR-3 and CR-4, respectively, which did not differ significantly ($P>0.05$).

Reddy *et al*. (1998) formulated four isonitrogenous complete rations (CR) by replacing groundnut haulms with sunnhemp hay at 0 (CR-1), 15 (CR-2), 30 (CR-3) and 45% (CR-4) levels (w/w). These rations were evaluated using 4 Nellore Brown ram lambs (16.7±0.5 kg) in a 4 × 4 Latin Square design. Gradual increase in level of sunnhemp hay in place of groundnut haulms in complete rations CR-1 to CR-4 decreased the digestibilities of OM (73.53, 72.57, 69.25 and 68.59%, respectively), CF (58.54, 56.16, 54.16 and 53.69%, respectively) and NFE (81.18, 79.37, 73.38 and 70.93%, respectively) linearly ($P<0.01$). There was proportionate increase in CP digestibility in CR-1 to CR-4 (65.29, 66.24, 66.74 and 67.53%, respectively). All animals were in positive N, Ca and P balances. The DCP and TDN contents of CR-1 to CR-4 were 8.24 and 68.30; 8.33 and 68.60; 8.34 and 64.98 & 8.55 and 64.08%, respectively. There was no effect on the DCP content of the rations whereas the TDN values of the rations 3 and 4 were lower ($P<0.01$) than those of rations 1 and 2. The intakes of DCP and TDN by lambs were in the range of 42.22 to 43.77 and 332 to 356 g/d, respectively.

Ramratan (1999) fed groundnut haulms *ad libitum* to eight yearling Nali rams (29.8±0.66 kg body weight) along with mineral mixture and common salt. The digestibility of DM, OM, CP, EE, CF and NFE was 61.97, 67.21, 64.88, 42.87, 53.60 and 73.06%, respectively. The intake of DM, OM, CP and TDN (g/kg $W^{0.75}$) was 113.32±4.51, 104.27±3.88, 12.20±0.63 and 66.94±2.66, respectively.

Four isonitrogenous complete rations containing *subabul* leaf meal (CR-1), sunnhemp hay (CR-2), *Stylo hamata* hay (CR-3) and groundnut haulms (CR-4) each at 60% level were evaluated by Ramaprasad *et al*. (1999) following a 4 × 4 Latin Square design using 4 Nellore Brown rams. There was no significant difference in the apparent digestibilities of DM (52.5 to 59.8%), CP (62.6 to 69.7%) and NFE (58.5 to 69.1%) among rations. However, CF digestibility of CR-1 (60.0%) and CR-4 (58.3%) was higher ($P<0.05$) than those of CR-2 (44.6%) and CR-3 (48.1%). Digestibility of EE was higher ($P<0.05$) in CR-4 (68.8%) and CR-2 (68.1%) than those of CR-1 (55.4%) and CR-3 (49.9%). Nitrogen retention was also similar among rams fed four complete rations. The DCP and TDN contents were 8.8 and 60.6, 9.3 and 51.7, 9.7 and 55.3 & 9.5 and 61.8%, respectively under CR-1, CR-2, CR-3 and CR-4.

Mandal *et al.* (1999) divided ten adult rams into two groups of 5 each. Control group was maintained on gram straw and concentrate mixture in the ratio of 60:40 on ME basis while the experimental group was fed on silage prepared by mixing groundnut haulms and paddy straw (4:1 on fresh basis) *ad libitum* as sole ration for 68 days including a metabolism trial of 6 days duration. The digestibility of DM, OM, CP and NFE were significantly (P<0.01) higher in conventional concentrate group (53.47, 60.70, 57.64 and 67.94%, respectively) than those observed in silage fed group (42.87, 57.10, 47.59 and 59.82%, respectively). However, the CF digestibility was higher (P<0.01) in silage fed group (56.06%) than the other group (42.33%). The CP of the silage group (9.92%) was significantly (P<0.01) higher than that of conventional concentrate group (8.87%), however, the DCP content was at par (4.72 and 5.11%, respectively) under both the groups. The TDN content was significantly (P<0.01) higher in conventional concentrate group (54.80%) than those of silage group (40.86%). The silage fed rams consumed significantly (P<0.01) higher CP 7.79g and DCP 3.71g/kg $W^{0.75}$ than the corresponding values on conventional concentrate and gram straw-based ration (5.03g and 2.90g/kg $W^{0.75}$, respectively).

Three isonitrogenous complete rations (CR) containing groundnut haulms at 50 (CR_1), 60 (CR_2) and 70% (CR_3) level were evaluated (Ramaprasad *et al.*, 2000) using twelve growing Nellore Brown lambs (14.2±0.1 kg BW). The DCP and TDN contents were 7.7 and 61; 7.6 and 59 & 7.4 and 56% under CR_1, CR_2 and CR_3, respectively. The digestibility of DM, NFE and cellulose as well as intake of DCP and TDN were higher ($P<0.05$) in lambs fed CR_1 (61.8, 75.9 and 57.4%, 47.5 and 37.6 g/d) or CR_2 (60.4, 74.3 and 54.5%, 40.3 and 34.0 g/d) than those fed CR_3 (58.6, 71.9 and 51.8%, 39.7 and 30.1 g/d). The digestibility of CP, CF and EE was 62.3, 43.8 and 66.8; 62.1, 42.7 and 70.4 & 60.5, 39.8 and 72.8% ($P>0.05$) under CR_1, CR_2 and CR_3, respectively. Higher Ca (3.6 g/d) and P (3.8 g/d) retentions ($P>0.05$) were observed in lambs fed CR_1 than those fed CR_2 (2.9 and 1.8 g/d) or CR_3 (2.8 and 0.5 g/d).

Three complete rations containing sorghum straw (CR1), soybean straw (CR2) and corn cobs (CR3) each at 60% level and concentrate mixture at 40% level were evaluated by Rajmane and Deshmukh (2000) using Osmanabadi goats. The digestibility of DM, NFE ($P<0.01$) and CF ($P<0.05$) was higher on CR3 (64.81, 63.72 and 67.38%, respectively) compared to CR1 (47.31, 45.49 and 49.29%, respectively) while the digestibility of EE was higher ($P<0.01$) on CR1 (79.50%) compared to CR3 (46.81%). The CP digestibility did not vary among the groups (79.60 to 85.63%). The DCP and TDN contents of CR1, CR2 and CR3 were 6.85 and 47.94, 8.32 and 57.89 & 7.18 and 63.58%, respectively. The DCP intake ranged from 68.58 to 83.26 g/day in all the groups ($P>0.05$). However, the TDN intake was significantly ($P<0.05$) higher in CR3 (685.84 g/d) as compared to CR1 (497.40 g/d).

Raut *et al.* (2002) fed pelleted complete feed containing 60% *arhar* (*Cajanus cajan*) straw and 40% concentrate mixture to six local non descript male goats (8.42 months; 17.18 kg BW). The DCP and TDN content of the ration was 8.93 and 55.12%, respectively. The intakes of DCP and TDN were 66.58 and 410.06 g/d, respectively. The digestibility coefficients were 56.43 (DM), 66.37 (CP), 74.96 (EE), 67.56 (CF), 45.64 (NFE), 48.95 (NDF) and 40.44% (ADF). The goats were in positive nitrogen balance.

Prakash *et al*. (2003) fed either untreated ground maize stover and lucerne hay (R_1), untreated ground maize stover and concentrate mixture (R_2), urea treated ground maize stover and concentrate mixture (R_3) or urea treated chopped maize stover and concentrate mixture (R_4) to Osmanabadi bucks (20.53±0.44 kg). The digestibilities of DM, OM, CP, EE, CF and NFE were 52.6, 53.2, 61.9, 57.9, 55.6 and 48.9; 56.9, 57.9, 64.1, 65.1, 62.5 and 54.8; 58.4, 60.1, 67.7, 67.0, 67.2 and 54.9 & 59.9, 63.0, 69.5, 62.9, 65.0 and 59.2% under rations R_1, R_2, R_3 and R_4, respectively. The DCP and TDN contents were 7.55 and 48.22, 7.75 and 51.85, 8.32 and 53.82 & 8.68 and 55.03% under rations R_1, R_2, R_3 and R_4, respectively. The digestibility of nutrients as well as DCP and TDN contents increased significantly ($P<0.01$) by urea-ammoniation of maize stover. However, the digestibility of nutrients except EE in ground urea treated stovers (R_3) was significantly ($P<0.01$) lower than that of chopped urea-treated stovers (R_4). Hence, processing beyond chopping prior to urea-ammoniation has no advantage on digestibility and nutritive value of maize stover in goats.

Digestibility coefficients (%) of DM (60.10 – 64.10), OM (63.88 – 66.94), CP (63.84 – 66.16), CF (55.26 – 61.26) and NFE (59.67 – 64.12) including N-retention (35.42 – 43.42% of N absorbed) among treatment groups did not differ significantly as reported by Samanta *et al.* (2003) when *Leucaena* leaf meal was included by replacing mustard cake in the ration of Barbari goats. The DCP and TDN intakes (3.14 – 3.41 and 31.82 – 34.33 g/kg $W^{0.75}$) were sufficient for maintenance. It was concluded that *Leucaena* leaf meal can be incorporated by replacing mustard cake safely and inexpensively without affecting nutrient utilization and N balance in Barbari goats.

The digestibility of OM, CP and EE were 55.9, 64.0 and 74.2; 58.4, 72.8 and 76.3 & 51.3, 59.6 and 67.4% under ASCF, GSCF and AS-CONC, respectively. The digestibility of CP ($P<0.01$), OM and EE ($P<0.05$) was significantly higher in goats fed gram straw based pelleted complete feed. The DCP and TDN contents were 9.5 and 53.4, 10.8 and 55.0 & 9.0 and 58.1% under ASCF, GSCF and AS-CONC, respectively. The gram straw based complete feed pellets had highest ($P<0.01$) DCP content compared to other diets, but the TDN content was comparable in all groups. The goats under all the treatments were in positive nitrogen, calcium and phosphorous balances as reported by Rekhate *et al.* (2004).

An experiment was conducted by Bhadane *et al.* (2004) to assess the effect of feeding pelleted complete feed of varying protein levels in non descript local goats on digestibility and nutrients intake. Goats under both the treatments were fed pelleted complete feed G_1 (12% CP, 65.81% TDN) and G_2 (14% CP, 67.44% TDN) containing *arhar* straw as a sole roughage for 140 days. Roughage to concentrate ratio in the two diets was maintained at 60:40 with *arhar* straw as the sole roughage. The digestibility of nutrients in the two diets was statistically comparable except that of CF ($P<0.01$) and ADF ($P<0.05$), which was significantly higher in G_2 (65.5 and 49.7%, respectively) than that of G_1 (61.1 and 45.2%, respectively), however, reverse trend was observed for NFE ($P<0.05$) digestibility (71.0% for G_2 and 74.2% for G_1). The DCP ($P<0.01$) and TDN values were 8.5 and 65.8% in G_1 & 9.9 and 67.4% in G_2 group, respectively. The goats under both the groups were in positive nitrogen balance. It was concluded that the pelleted complete feed containing 60% *arhar* straw and 40% concentrate with 12% CP and 65.81% TDN fulfills the requirement of goats growing at the rate of 76 g/d.

Ravi and Ramaprasad (2005) studied the effect of strategic supplementation with concentrate (Maize and deoiled groundnut cake) C, or C along with groungnut haulms (GH), dry leaf meal of *Leucaena leucocephala* (LL), *Sesbania grandiflora* (SG), *Gliricidia maculate* (GM) or *Ficus bangalensis* (FB) on the digestibility of male kids maintained on daily 6-8 hrs browsing (Semi-intensive system, SIS) or stall fed on NB-21 green fodder (Intensive system, IS). Irrespective of feeding system, diets with concentrates (C) or legume leaf meal (LL, SG or GM) promoted higher ($P<0.05$) digestibility of nutrients than supplementation with groundnut haulms or *Ficus bengalensis*. Supplementation with *Ficus* leaf meal decreased the overall digestibility. Irrespective of supplement, the digestibility of CP ($P<0.05$) and other nutrients ($P<0.01$) was higher in IS than in SIS.

Aasharekha *et al.* (2005) evaluated the groundnut (*Arachis hypogaea*) haulms (GNH) alone or with yeast culture (GNH-YC) as sole feed in Nellore Brown rams. The digestibility of DM, CP, NDF, ADF, cellulose and hemicelluloses was 47.2, 31.0, 43.9, 40.2, 30.2 and 61.6 & 48.6, 37.9, 49.6, 45.0, 38.7 and 69.7% under GNH and GNH-YC, respectively. Supplementation of yeast culture to GNH improved the digestibility of nutrients considerably especially of cellulose ($P<0.05$). The daily DCP intake was higher ($P<0.01$) under GNH-YC (45.2 g) than those of GNH (27.7 g) group. The efficiency of utilisation of phosphorus was also improved ($P<0.01$).

Complete rations containing groundnut haulms (GNH) and concentrates in 60:40 or 70:30 ratios with or without yeast culture product (YCP) were fed to sheep by Aasharekha *et al.* (2006) to know the digestibility and nutrients intake. The daily DCP intake (88.9, 82.6, 81.2 and 86.4 g under 60:40, 70:30, without YCP and with YCP supplementation, respectively) was higher ($P<0.01$) in sheep fed 60:40 diet without YCP and was also higher ($P<0.05$) in YCP supplemented group. The daily DCP intake on metabolic body weight basis (6.5 – 6.8 g/kg $W^{0.75}$) was comparable among the treatments. The digestibility of DM (53.0 – 55.1%), CP (55.7 – 57.3%), NDF (43.0 – 44.6%), ADF (41.6 – 45.6%), cellulose (42.9, 41.7, 40.5 and 44.0% under 60:40, 70:30, without YCP and with YCP supplementation, respectively) and hemicelluloses (46.2 – 47.4%) was comparable among treatments, except for a higher ($P<0.05$) cellulose digestibility in sheep fed YCP supplemented diets. The nitrogen retention (10.5, 8.1, 8.5 and 10.1 g/d under 60:40, 70:30, without YCP and with YCP supplementation, respectively) was higher ($P<0.05$) in sheep fed 60:40 diet and in YCP supplemented diets. The calcium retention (3.0 – 3.7 g/d) was not affected by the treatments while phosphorus retention (2.2, 2.6, 2.1 and 2.8 g/d under 60:40, 70:30, without YCP and with YCP supplementation, respectively) was higher ($P<0.05$) in sheep fed YCP supplemented diet. It was concluded that groundnut haulms inclusions up to 60% in the complete diets along with yeast culture could improve the digestibility of nutrients.

Mane *et al.* (2006) compared the effect of feeding iso-nitrogenous conventional (T_1) and complete feed (T_2) in goats. Growing goats (16; 12.6±0.45 kg BW) were divided into 2 equal groups and offered either conventional feed or complete feed *ad libitum* for 90 days. The digestibility of DM, CF, NFE was improved significantly ($P<0.05$) in goats fed T_2 - complete feed (74.1, 78.2 and 68.9%, respectively) as compared to those fed T_1 - conventional feed (63.9, 71.8 and 55.6%, respectively), whereas the CP and EE digestibility (66.2 and 63.7% for T_1 and 69.1 and 68.3% for T_2, respectively) among the groups were comparable. The DCP and TDN values were 10.2 and 58.9 & 10.8 and 66.5% under T_1 and T_2, respectively, however, the DCP and TDN intakes under T_2 (57.8 and 356.8 g/d, respectively) were significantly ($P<0.05$) higher than T_1 (42.5 and 245.6 g/d, respectively). The N, Ca and P retention in the complete feed group (9.3, 9.4 and 2.2 g/d) was considerably higher than those fed conventional feed (6.8, 5.5 and 1.0 g/d, respectively).

Local kids (18; 111.16±1.01 days old and 10.42±0.05 kg BW) were divided into three equal groups. The animals in T_1 group (control) were offered tree leaves of *apta* (*Bauhinia racemosa*), *anjan* (*Hardwickia binata*) and *subabul* (*Leucaena leucocephala*); T_2 : urea treated sugarcane bagasse based pelleted complete ration and T_3 : urea treated wheat straw based pelleted complete ration for 90 days. The roughage to concentrate ratio was 1:1. Dhore *et al.* (2006) reported the DCP and TDN contents 6.61 and 52.26; 8.17 and 59.45 & 8.35 and 58.84% under T_1, T_2 and T_3, respectively. The digestibility of CP (49.14, 67.13 and 68.85% under T_1, T_2 and T_3, respectively), EE (67.00, 79.49 and 77.06% under T_1, T_2 and T_3, respectively) and hemicellulose (61.38, 61.76 and 73.92% under T_1, T_2 and T_3, respectively) was significantly ($P<0.01$) higher in experimental groups as compared to that of control group. The goats under all groups were in positive nitrogen, calcium and phosphorus balance. It was concluded that urea treated wheat straw based pelleted complete ration performed better in respect of nutrient utilization, hence can be utilized successfully for economic goat rearing under stall fed condition.

The experiment was conducted by Chobtang *et al.* (2009) to evaluate the digestibility and crude protein intake of Thai indigenous male goats fed different levels of crude protein (CP) in total mixed rations (TMR). Twenty goats with average body weight of 15.84±2.35 kg were used. The four dietary treatments were randomly allocated into 5 blocks of the animals stratified on the basis of their initial body weight. Dietary treatments contained 8, 10, 12 and 14% CP (% of DM) with a concentrate: roughage ratio of 85: 15. The feeding trial lasted for 120 days. Crude protein digestibility (62.05, 67.39, 71.23 and 74.89%, respectively) was increased linearly ($P<0.05$) with increasing CP levels in TMR. It was concluded that increasing levels of CP content in TMR not only improved CPI but also enhanced CP digestibility.

Twelve non-descript local kids (4 months age) were divided into two equal groups (7.85, 7.58 kg BW respectively) by Chopade *et al.* (2010). One group was fed on untreated soybean straw (TSS) while other was fed on 4% urea treated soybean straw (TUSS) in the form of pelleted complete ration (R:C; 60:40) with 12% CP and 60% TDN for 100 days. The digestibility coefficient of CP (64.91 and 74.18% under TSS and TUSS groups, respectively) and EE (75.59 and 84.00% under TSS and TUSS groups, respectively) vary significantly ($P<0.05$) between the groups. The DCP and TDN content were 7.45 and 51.93 & 8.57 and 55.12% under TSS and TUSS groups, respectively. The kids fed on urea treated soybean straw based pelleted complete ration were in positive nitrogen, calcium and phosphorus balance. They concluded that 4% urea treated soybean straw can successfully be incorporated in pelleted complete ration at 60% level for growing kids.

Wadhwani *et al*. (2010) divided twenty one Marwari, Patanwadi and Merino X Patanwadi weaner lambs (12.40 to 14.68 kg) into three dietary treatments on body weight basis *viz.* T_1 : TMR I-Conventional group, T_2 : TMR-II supplemented non conventional group I (Azolla 10%) and T_3 : TMR-III supplemented non conventional group II (Azolla 20%). The DM (59.58, 51.60 and 51.98% under TMR-I, TMR-II and TMR-III, respectively) and CP (80.50, 73.82 and 73.40% under TMR-I, TMR-II and TMR-III, respectively) digestibility was significantly ($P<0.05$) affected by the treatments. The DCP and TDN intake g/head/d under TMR-I (77.44 and 362.64, respectively), TMR-II (94.56 and 483.13, respectively) and TMR-III (98.26 and 499.89, respectively) group did not differ from each other. The mean retention of nitrogen (8.70 – 9.98 g/head/d) in lambs under all the groups was similar.

A feeding experiment was conducted on eighteen Gir calves (three groups, each consisting of three male and three female animals) to evaluate incorporation of groundnut haulms. The DCP and TDN contents of the rations containing groundnut haulms at 20% (T_1), 30% (T_2) and 40% (T_3) were 11.66, 11.17 and 11.20% & 58.71, 61.21 and 61.49%, respectively. The digestibility of DM, OM, CP, EE, CF and NFE was 61.1, 63.4, 69.2, 53.7, 55.3 and 62.2; 60.0, 61.8, 69.3, 55.4, 56.8 and 61.5 & 59.7, 61.1, 70.0, 54.2, 59.0 and 60.9% under T_1, T_2 and T_3, respectively. The DCP and TDN intakes per kg body weight gain in corresponding groups were 0.87 and 4.51 kg for T_1, 0.82 and 4.48 kg for T_2 & 0.81 and 4.48 kg for T_3 (Murthy *et al*., 2004). The digestibility and nutrients intake were not affected significantly by inclusion of varying levels of groundnut haulms as roughage source in the ration for growing Gir calves. The results indicated that groundnut haulms could be incorporated up to 40% in the rations of Gir calves without any adverse effect on digestibility and nutrients intake.

Castrated Gir bullocks (6; 4.5±0.4 yr old of 276.7±13.6 kg BW) were offered *jowar* straw and groundnut haulms mixed either in 100:0 (JS_{100}), 80:20 (JS_{80}), 70:30 (JS_{70}) or 60:40 (JS_{60}) ratio for 30 days as sole feed by Patel *et al.* (2007). The digestibility of DM, OM, CP, CF, EE and NFE was 52.2, 57.8, 54.7, 54.1, 54.5 and 52.6; 53.9, 58.0, 55.9, 55.4, 55.5 and 54.0; 55.8, 59.9, 58.1, 58.0, 58.0 and 55.8 & 56.5, 60.3, 58.8, 58.8, 58.7 and 57.2% under JS_{100}, JS_{80}, JS_{70} and JS_{60}, respectively. Nutrient digestibility was improved ($P<0.01$) in JS_{60} and JS_{70} groups compared to sole feeding of *jowar* straw or JS_{80} supplementation with groundnut haulms. The daily DCP and TDN intake (89.3 and 1.9; 133.2 and 2.0; 169.8 and 2.2 & 188.8 g and 2.3 kg under JS_{100}, JS_{80}, JS_{70} and JS_{60}, respectively) improved linearly ($P<0.01$) with the increase in level of groundnut haulms in the ration. Overall results indicated that *jowar* straw fortified with 30 or 40% of groundnut haulms as sole feed will maintain the bullocks.

2.6 EFFECT ON FEED CONVERSION EFFICIENCY:

Durgaprasad *et al*. (1986) evaluated four complete rations prepared by blending groundnut haulms (10.38% CP) with a conventional concentrate mixture (14.75 % CP) in ratios of 80:20 (CR-1), 60:40 (CR-2), 40:60 (CR-3) and 20:80 (CR-4) with 32 Nellore Brown weaned lambs (11.16 kg). The average feed/gain ratio for CR-1, CR-2, CR-3 and CR-4 was 14.66, 11.65, 9.94 and 7.53, respectively. The average feed/gain ratio was superior ($P<0.05$) in lambs fed CR-3 or CR-4 than those fed CR-1. The differences in feed/gain ratio between treatments 1 and 2 or among the treatments 2 to 4 were not significant. The CP intake per kg gain was 0.71, 0.84, 0.93 and 1.14 kg under CR-1, CR-2, CR-3 and CR-4, respectively. The recommended optimum level of inclusion of groundnut haulms in the complete ration was 40%.

Three isonitrogenous complete rations (CR) containing groundnut haulms at 50 (CR_1), 60 (CR_2) and 70% (CR_3) levels were formulated (Ramaprasad *et al.*, 2000) and evaluated using twelve growing Nellore Brown lambs (14.2±0.1 kg BW). The lambs required 10.41, 10.80 and 11.80 kg DM per kg gain ($P>0.05$) under CR_1, CR_2 and CR_3, respectively. These data suggested that lambs fed CR_1 or CR_2 required less DM per unit gain in comparison to lambs fed CR_3.

Rekhate *et al.* (2004) fed pelleted complete feed based either on *arhar* straw (ASCF), gram straw (GSCF) or exclusive *arhar* straw pellets supplemented with concentrate pellets (AS-CONC) for 110 days to non-descript local goats (18; 320 d old of 21.8±0.8 kg BW). The roughage to concentrate ratio was maintained at 60:40 in all the diets. The feed conversion efficiency (DMI/kg gain) in goats was 16.7, 15.2 and 19.0 kg under ASCF, GSCF and AS-CONC groups, respectively. The best feed conversion efficiency was observed in goats fed gram straw based complete feed (GSCF). It was concluded that goats fed on gram straw based pelleted complete diet performed better and fulfills the requirement of goats growing at 108 g/day under stall fed conditions.

Bhadane *et al.* (2004) divided 12 non descript local goats (122 d old) randomly into two treatment groups and assessed the effect of pelleted complete feed of varying protein levels on feed conversion efficiency. Goats under both the treatments were fed pelleted complete feed G_1 (12% CP, 65.81% TDN) and G_2 (14% CP, 67.44% TDN) containing *arhar* straw as a sole roughage for 140 days. Roughage to concentrate ratio in the two diets was maintained at 60:40 with *arhar* straw as the sole roughage. The feed conversion efficiency (DMI/kg gain) in goats was 13.4 and 11.8 kg ($P<0.01$) under G_1 and G_2 groups, respectively.

Ravi and Ramaprasad (2005) studied the effect of strategic supplementation with concentrate (Maize and deoiled groundnut cake) C, or C along with groundnut haulms (GH), dry leaf meal of *Leucaena leucocephala* (LL), *Sesbania grandiflora* (SG), *Gliricidia maculate* (GM) or *Ficus bangalensis* (FB) on feed conversion efficiency in male kids maintained on daily 6-8 hrs browsing (Semi-intensive system, SIS) or stall fed on NB-21 green fodder (Intensive system, IS). The data for feed conversion efficiency (DMI/kg gain) for C, GH, LL, SG, GM and FB were 13.6, 13.7, 13.3, 11.7, 12.5 and 16.4 kg, respectively. The same values for SIS and IS were 11.6 and 15.4 kg, respectively. The efficiency of feed utilization varied ($P<0.05$) among the supplements and the values were optimum in SG supplemented group under both the system of management.

Local kids (12; 147.26±1.82 d old of 16.35±1.05 kg BW) were divided into 2 equal groups and fed pelleted complete feed containing either 7% DCP and 60% TDN (CD_1) or 9% DCP and 55% TDN (CD_2) for 150 days (Dhore *et al*., 2005). The feed conversion efficiency (DMI kg/kg gain) was significantly ($P<0.01$) higher in CD_2 (9.9) as compared to CD_1 (10.8). Similar data for feed conversion efficiency were also reported by Dhore *et al*. (2006) in local kids.

Thirty-six growing Boer goats were divided into three equal groups by Pi *et al.* (2005) and randomly allocated to receive one of the following diets: (1) unpelletized ryegrass hay-based TMR (TMR-1), (2) tp-TMR in Trial 1 (TMR-2), and (3) TMR-2 plus 0.12% zinc-methionine (TMR-3). The data for feed conversion ratio were significantly higher ($P<0.01$) in TMR-2 and TMR-3 than in TMR-1, however, the differences between TMR-2 and TMR-3 ($P>0.05$) were non significant.

Salman *et al.* (2008) carried out a study to determine the use of biologically treated sugar beet pulp as a supplement in goat rations. Fungus (*Trichoderma viride*) fermented sugar beet pulp was supplemented (w/w) at 0.0 (T_1), 0.3 (T_2), 0.6 (T_3) and 0.9% (T_4) to complete feed mixture and mixed well just before feeding. The feed conversion efficiency (DMI/kg gain) was significantly ($P<0.05$) better for goats fed T_4 (8.89 kg) followed by T_3 (9.53 kg) compared to T_2 (10.07 kg) and T_1 *i.e.* control group (9.99 kg).

Wadhwani *et al*. (2010) carried out an experiment on twenty one Marwari, Patanwadi and Merino X Patanwadi weaner lambs (12.40 to 14.68 kg). The animals were randomly divided into three dietary treatments on body weight basis *viz.* T_1 : TMR-I conventional group, T_2 : TMR-II supplemented non conventional group I (Azolla 10%) and T_3 : TMR-III supplemented non conventional group II (Azolla 20%). The DM, DCP and TDN intake (kg/kg gain) was 8.10, 1.11 & 5.09; 10.90, 1.14 & 5.83 and 13.16, 1.35 & 7.13 under TMR-I, TMR-II and TMR-III, respectively. The DCP and TDN intake (kg/kg gain) observed under treatment groups did not differ from each other, however, DM intake per kg gain was higher in non conventional group ($P<0.05$).

2.7 EFFECT ON COST OF FEEDING:

Durgaprasad *et al*. (1986) prepared four complete rations by blending groundnut haulms with a conventional concentrate mixture in ratios of 80:20 (CR-1), 60:40 (CR-2), 40:60 (CR-3) and 20:80 (CR-4) and fed to 32 Nellore Brown weaned lambs (11.16 kg). The feed cost (`/kg gain) was 9.44, 9.18, 9.27 and 8.10 for the lambs fed CR-1, CR-2, CR-3 and CR-4 containing 80, 60, 40 and 20% level of groundnut haulms (P>0.05). It was concluded that a complete ration formulated with groundnut haulms and a conventional concentrate mixture in the ratio of 40:60 was superior and economical to other complete rations. The optimum level of inclusion of groundnut haulms in the complete ration was 40%.

Murthy *et al.* (2004) fed groundnut haulms at 20% (T_1), 30% (T_2) and 40% (T_3) levels to growing Gir calves in a completely randomized design. The daily cost of feeding was significantly (P<0.05) higher in T_3 (` 14.3±0.31) than in $T_2$ (` 13.0±0.36) and T_1 (` 11.5±0.31). The cost of feeding per kg gain was not significantly different among groups (` 27.7±1.38 in T_1, 28.9±1.02 in T_2 and 31.0±1.68 in T_3). It was concluded that groundnut haulms could be used at 40% level in the ration of Gir calves to achieve profitable growth.

Ravi and Ramaprasad (2005) studied the effect of strategic supplementation with concentrate (Maize and deoiled groundnut cake) C, or C along with groungnut haulms (GH), dry leaf meal of *Leucaena leucocephala* (LL), *Sesbania grandiflora* (SG), *Gliricidia maculate* (GM) or *Ficus bangalensis* (FB) on the cost of feeding in male kids maintained daily on 6-8 hrs browsing (Semi-intensive system, SIS) or stall fed on NB-21 green fodder (Intensive system, IS). The cost of feeding (`/Kg gain) under C, GH, LL, SG, GM and FB was 80.5, 60.2, 57.9, 51.5, 55.2 and 76.3, respectively and the same under SIS and IS was 48.1 and 79.1, respectively. The cost of feeding (`/kg gain) varied ($P<0.05$) among the supplements and the values were optimum in SG supplemented group under both the management system. The value was significantly lower ($P<0.01$) in SIS than in IS. It was concluded that, supplementation of locally available roughage resources particularly *Sesbania* leaf meal along with small quantities of concentrate was economical than supplementation of concentrate alone for sustainable and economically viable goat production, particularly in semi-intensive management system.

According to Payne *et al.* (2006), rangeland or hay-based finishing systems often do not allow kids to reach slaughter weights of 30 - 50 kg by 12 months. Their study determined the effects of a complete feed (CF) and a self-limiting complete feed (LCF) alone or in combination with *ad libitum* access to sorghum-sudan hay (SS) on cost of gain of Boer cross doelings. Thirty kids (21.1 kg) were randomly assigned to one of five treatments (SS, CF, LCF, SS + CF, and SS + LCF). There were no statistical differences between the costs of gain for the five treatments. Finishing systems that promote gains of 4.6 to 7.3 times those of hay-only systems should be attractive to producers.

Wadhwani *et al*. (2010) carried out an experiment on twenty one Marwari, Patanwadi and Merino X Patanwadi weaner lambs (12.40 to 14.68 kg). The animals were randomly divided into three dietary treatments on body weight basis *viz.* T_1 : TMR-I conventional group, T_2 : TMR-II supplemented non conventional group I (Azolla 10%) and T_3 : TMR-III supplemented non conventional group II (Azolla 20%). The estimated total feed cost (`/animal) for experimental lambs was the lowest ($P<0.05$) in TMR-III (496.96±16.42) followed by TMR-II (592.50±22.05) and TMR-I (863.55±64.09). The feed cost (`/kg live weight) was 63.26±1.12, 35.90±2.43 and 39.72±3.17 under TMR-I, TMR-II and TMR-III, respectively which was having significantly higher ($P<0.05$) value for TMR-I. The return as per cent of feed cost and feed cost `/kg dressed weight were 150.12 ± 2.46 and 67.01 ± 0.86, 198.59 ± 6.44 and 52.46 ± 1.64 & 213.57 ± 9.31 and 51.04 in TMR-I, TMR-II and TMR-III, respectively which is the reflection of significantly ($P<0.05$) lower total feed cost incurred in non conventional groups. Lambs fed non conventional feed based TMR had similar live weights as those fed conventional TMR but cost less to achieve those weights.

Chapter- III

MATERIALS AND METHODS

The present study on growing Surti kids was conducted at Animal Nutrition Research Department, College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand, to know the effect of feeding *jowar* hay and groundnut haulms based TMR on their growth performance. The *jowar* hay and *jowar* hay + groundnut haulms based TMR was fed to growing kids during 27/04/2011 to 20/07/2011 to study the effect on voluntary feed intake, body weight gain, nutrient utilization, feed conversion efficiency in terms of DM, CP, DCP and TDN intake per kg weight gain along with the cost of feeding.

Design of experiment: Completely Randomized Design was followed.

Experimental period: The experimental period was of 12 weeks.

Experimental kids:

Sixteen Surti kids of 4.5 – 9 months were randomly divided into two groups considering their age, body weight and body measurements (Plate 3.1). The details regarding experimental kids selected for the experiment are presented in Table 3.1.

Treatments:

There were two treatments and the details are given below:

T_1 - TMR based on *jowar* hay

T_2 - TMR based on *jowar* hay + groundnut haulms

All the ingredients used in preparation of TMR including *jowar* hay and groundnut haulms were purchased in bulk for the study period. The proportions of different ingredients used to prepare respective TMR are given in Table 3.2.

Table 3.1: Grouping of experimental Surti kids

Kid No.	Initial BW (kg)	Initial Height (cm)	Initial Length (cm)	Initial Girth (cm)	Initial Age (days)
T_1					
M-71 (1)	9.4	49.7	47.0	49.0	183
M-72 (2)	10.7	50.0	48.0	52.3	183
M-82 (3)	10.3	50.0	47.3	49.7	178
M-86 (4)	10.9	49.7	49.0	49.7	176
M-91 (5)	9.6	47.7	45.7	47.3	161
F-163 (6)	8.6	45.3	43.0	46.0	141
F-243 (7)	10.1	49.0	46.3	49.3	255
F-246 (8)	6.0	43.7	43.0	42.3	244
Average ±SE	**9.45 ±0.56**	**48.13 ±0.85**	**46.17 ±0.78**	**48.21 ±1.06**	**190 ±13.90**
T_2					
M-74 (9)	5.6	43.0	40.0	44.0	181
M-87 (10)	9.2	48.0	45.0	48.3	174
M-92 (11)	7.4	45.7	43.3	45.7	151
M-94 (12)	9.5	49.0	47.0	47.7	147
F-157 (13)	6.3	45.7	44.0	45.0	177
F-242 (14)	10.6	50.0	47.0	51.0	268
F-249 (15)	9.2	49.0	46.3	48.0	239
F-251 (16)	9.1	49.7	45.7	48.0	226
Average ±SE	**8.37 ±0.61**	**47.50 ±0.87**	**44.79 ±0.83**	**47.21 ±0.79**	**195 ±15.48**
G. Average ±SE	**8.91 ±0.42**	**47.81 ±0.59**	**45.48 ±0.58**	**47.71 ±0.65**	**193 ±10.07**
'F' value	**1.70 NS**	**0.26 NS**	**1.46 NS**	**0.57 NS**	**0.06 NS**

Table 3.2: Proportions (%) of ingredients used to prepare total mixed ration

Sr. No.	Ingredients	T_1	T_2
1	Deoiled rice bran	12.8	12.8
2	Cotton seed extraction	2.0	2.0
3	Rapseed extraction	4.8	4.8
4	*Guar bharda*	2.0	2.0
5	Rice polish fine	2.8	2.8
6	GNSP	2.0	2.0
7	Maize	2.8	2.8
8	*Jowar*	2.0	2.0
9	*Bajri*	2.0	2.0
10	Whey Powder	0.2	0.2
11	Molasses	4.4	4.4
12	Bentonite powder	0.6	0.6
13	Salt	0.788	0.788
14	Calcite Powder	0.8	0.8
15	Trace mineral	0.012	0.012
16	***Jowar* hay**	**60.0**	**30.0**
17	**Groundnut haulms**	**0**	**30.0**
	Total	**100**	**100**

Feeding and management of experimental kids:

The kids under control group were fed *jowar* hay based TMR whereas the kids under treatment group were fed *jowar* hay + groundnut haulms based TMR. Individual feeding of all the growing kids was carried out during the study period (Plate 3.2). Quantity of TMR offered was adjusted at weekly interval according to change in body weight and growth rate of kids. The quantity of TMR required each day was offered in two installments *i.e.* half in morning and half in evening. The nutrient requirements of growing kids in term of DCP and TDN were met as per ICAR (1998) feeding standards.

The kids were housed in ideal sheds with proper ventilation, flooring and tying arrangements with facility of individual feeding. The kids were let loose daily (except during the period of digestion trial) in an open paddock, for two hrs in the morning from 8.30 to 10.30 a.m. and one hr in the afternoon from 4.00 to 5.00 p.m. under controlled conditions for exercise. During these periods all the kids had free access to fresh, clean and wholesome drinking water. The leftover of TMR for individual kid was recorded daily in the morning after 8 a.m. throughout the experimental period. Kids were vaccinated for PPR and enterotoxaemia and deworming of all kids with broad spectrum anthelmintics was also carried out before start of experiment. The kids were adopted for respective feed for minimum fifteen days.

Body weight and body measurements:

The experimental growing kids were weighted at weekly interval and body measurements (height at wither, body length and heart girth) were taken biweekly in the morning between 8.00 to 8.30 a.m. for three consecutive days (Plate 3.3) before feeding and watering for the entire experimental period of 12 weeks.

Digestibility trial:

The digestion trial was conducted on all the kids once during the course of experimental period (Plate 3.4). The collection period was of 5 days during which the representative samples of TMR fed to the kids along with the left over and faeces voided were collected.

Analysis of feed samples:

The pooled samples collected during the digestion trial were analyzed for proximate principles as per AOAC (1995) in the Laboratory of Animal Nutrition Research Department, College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand- 388110.

Collection and analysis of rumen liquor:

Rumen liquor samples were collected from three kids in each treatment once at the end of experiment. The samples were collected at 0 hr (pre feeding) and at 3 and 6 hrs post feeding to study progressive changes in the pH, total volatile fatty acids (TVFA) and various nitrogenous constituents of strained rumen liquor (SRL). About 50 ml of rumen liquor was collected from each kid using stomach tube (Plate 3.5) and employing suction (Lane *et al.*, 1968). The rumen liquor was immediately brought to the laboratory and strained through four layers of cheese cloth. The pH of SRL was determined using "Systronic" digital pH meter having glass and reference electrodes. The total volatile fatty acids were determined by Markham steam distillation method (AOAC, 1995). Ammonia nitrogen was estimated as per Conway (1957) method immediately from SRL. However, total-N was determined by Kjeldahl's method. Rest of the SRL was stored in glass bottles by adding mercuric chloride @ 0.5 g / 100 ml SRL (Rust *et al.*, 1965) and preserved in refrigerator for further analysis. Non protein nitrogen was estimated from SRL following Kjeldahl's method after precipitating the protein with 20% trichloro acetic acid solution. However, protein nitrogen content was calculated by difference of total nitrogen and non-protein nitrogen.

Cost of feeding:

The cost of feeding for experimental growing kids was calculated from the records of daily feed consumption and by considering the procurement price of feeds and fodder used for feeding of experimental kids.

Parameters studied:

1. Body weight at weekly intervals for 3 consecutive days (kg)
2. Body measurement at biweekly intervals for 3 consecutive days (cm)
3. Daily dry matter intake (g)
4. Rumen fermentation pattern
5. Digestibility trial to delineate nutrient utilization
6. Daily DCP intake (g)
7. Daily TDN intake (g)
8. Feed conversion efficiency
9. Cost of feeding

Statistical analysis:

Observations of various parameters recorded during experimental period were tabulated and the data generated were analyzed statistically as per Snedecor and Cochran (1994).

Chapter- IV

RESULTS AND DISCUSSION

The present study on the growth performance of Surti kids was conducted to investigate the comparative effect of feeding *jowar* hay and *jowar* hay + groundnut haulms based total mixed ration (TMR) on growth, dry matter and organic matter intake, rumen fermentation pattern, digestibility and nutrients intake, feed conversion efficiency and cost of feeding. The treatments were T_1 (control group fed *jowar* hay based TMR) and T_2 (treatment group fed *jowar* hay + groundnut haulms based TMR). The ICAR (1998) feeding standard for growing kids was followed to meet the nutrient requirements. The daily DCP, TDN and dry matter requirements were met by feeding TMR.

4.1 CHEMICAL COMPOSITION OF FEEDS AND FODDER:

The feeds and fodder used to prepare the total mixed rations for feeding of growing kids during the experimental period were analyzed for chemical composition and results are presented in Table 4.1.

Table 4.1: Average chemical composition* (% on DM basis) of feeds, fodder and total mixed ration used under experiment

Feeds → / Constituents ↓	Groundnut haulms	*Jowar* hay	Compound concentrate mixture	T_1 (Control group)	T_2 (Treatment group)
CP	11.69±0.16	5.90±0.06	19.69±0.12	11.52±0.09	12.51±0.04
EE	2.47±0.05	2.08±0.16	2.49±0.06	3.28±0.08	3.73±0.02
CF	24.35±0.37	32.38±0.20	11.76±0.22	19.53±0.20	18.78±0.20
NFE	51.40±0.79	51.69±0.25	49.66±0.13	51.86±0.30	52.35±0.21
Ash	10.09±0.28	7.95±0.16	16.40±0.03	13.81±0.01	12.63±0.01
Silica	1.63±0.20	2.26±0.13	5.52±0.04	5.93±0.04	4.03±0.08
Ca	1.50±0.03	0.51±0.005	1.54±0.02	0.69±0.01	1.05±0.01
P	0.27±0.005	0.21±0.004	1.18±0.04	0.64±0.02	0.54±0.01

*Average of four samples

The average chemical composition of groundnut haulms is presented in Table 4.1 and values ranged for CP 11.32 to 12.07, EE 2.38 to 2.61, CF 23.66 to 25.39, NFE 49.08 to 52.61, ash 9.56 to 10.85, silica 1.17 to 2.10, Ca 1.45 to 1.56 and P 0.25 to 0.27% on DM basis. These values were similar with those reported by Kumaresan and Parthasarathy (2008). Similar range of values for chemical composition of groundnut haulms were also observed by Durgaprasad *et al*. (1986), Ramaprasad *et al*. (1999), Ramratan (1999) and Patel *et al*. (2007). Slightly higher value for CP (12.40%) was observed by Murthy *et al*. (2004), however, lower value for CP (9.10%) was observed by Aasharekha *et al*. (2005).

The chemical composition (% on DM basis) of control group TMR (T_1) ranged for CP 11.29 to 11.69, EE 3.07 to 3.46, CF 19.10 to 19.97, NFE 51.26 to 52.54, ash 13.79 to 13.83, silica 5.82 to 6.03, Ca 0.67 to 0.70 and P 0.59 to 0.67, whereas for treatment group TMR (T_2) ranged for CP 12.43 to 12.62, EE 3.67 to 3.75, CF 18.20 to 19.13, NFE 52.01 to 52.92, ash 12.60 to 12.65, silica 3.82 to 4.20, Ca 1.01 to 1.06 and P 0.52 to 0.56.

4.2 GROWTH STUDIES:

4.2.1 Body weight gain

The data for total gain and average daily gain in body weight of individual kids under both the treatment groups during experimental period of 12 weeks along with ANOVA are given in Table 4.2. The data for weekly body weight of all the kids under treatments T_1 and T_2 are depicted in Figure 4.1.

Table 4.2: Total body weight gain (kg) and average daily gain (g) in Surti kids fed total mixed ration

Kid No.	Treatments	
	T_1	T_2
1	3.8	3.8
2	6.2	6.9
3	5.7	6.2
4	6.7	5.3
5	4.9	5.9
6	4.7	4.5
7	5.6	4.3
8	4.2	5.3
Av. total gain (kg) ±SE	**5.22±0.35**	**5.27±0.37**
Av. daily gain (g) ±SE	**62.15±4.16**	**62.70±4.43**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment	1	0.0084	0.0084	0.008 NS
Error	14	14.5688	1.0406	-
Total	15	-	-	-

NS=Non significant

Average total gain in weight of Surti kids during entire experimental period of 12 weeks was 5.22±0.35 and 5.27±0.37 kg with average daily gain of 62.15±4.16 and 62.70±4.43 g, respectively in T_1 and T_2. The treatment differences for total gain and average daily gain (P>0.05) in body weight were non significant. Durgaprasad *et al*. (1986) reported daily gain of 40.33, 58.78, 71.88 and 86.76g in Nellore Brown weaned lambs fed groundnut haulms at 80, 60, 40 and 20% level in complete ration. There was linear increase in weight gain (P<0.01) as the level of groundnut haulms was decreased in complete ration. Ramaprasad *et al.* (2000) observed significantly (P<0.05) higher average daily weight gain in lambs fed CR_1 (59 g) or CR_2 (53 g) than those fed CR_3 (46 g) when complete rations (CR) containing groundnut haulms at 50 (CR_1), 60 (CR_2) and 70% (CR_3) levels were fed.

Raut *et al.* (2002) observed average daily gain of 75.0 g in non descript male goats fed pelleted complete feed containing 60% *arhar* (*Cajanus cajan*) straw and 40% concentrate mixture. Similarly, Rekhate *et al.* (2004) reported 83.5, 108.1 and 94.8 g average daily gain in goats offered complete feed pellets based either on *arhar* straw (ASCF), gram straw (GSCF) or exclusive *arhar* straw pellets supplemented with concentrate pellets (AS-CONC) for 110 days. The daily live weight gain was considerably higher in goats fed gram straw based pellets. It was concluded that goats fed on gram straw based pelleted complete diet performed better and fulfills the nutrients requirement of goats growing at 108 g/d under stall fed conditions.

Higher average daily gain of 75.7 and 72.9 g was observed by Bhadane *et al.* (2004) in goats fed pelleted complete feed based on 60% *arhar* straw as sole roughage containing either 12% CP, 65.81% TDN and 14% CP, 67.44% TDN, respectively. Similarly higher body weight gain (90.3 g/d) was also observed by Ramratan (1999) in rams fed *ad libitum* groundnut haulms. The findings observed by these research workers were higher in comparison to the present findings observed for Surti kids.

The total weight gain and average daily gain was observed during 180 days of experimental period as 7.7 and 42.8, 7.2 and 40.2, 7.2 and 39.1, 8.2 and 45.8, 7.6 and 42.0 & 6.0 kg and 33.7 g in male kids maintained on daily 6-8 hrs browsing (Semi-intensive system, SIS) or stall fed on NB-21 green fodder (Intensive system, IS) supplemented with concentrate (Maize and deoiled groundnut cake) C, or C along with groundnut haulms (GH), dry leaf meal of *Leucaena leucocephala* (LL), *Sesbania grandiflora* (SG), *Gliricidia maculate* (GM) or *Ficus bangalensis* (FB), respectively. The total gain in weight and average daily gain under SIS and IS was 10.3 and 57.1 & 4.3 kg and 23.9 g, respectively and showed significant ($P<0.05$) variation (Ravi and Ramaprasad, 2005).

Dhore *et al.* (2005) also reported similar body weight gain in local kids fed *arhar* straw based pelleted complete feed containing either 9% DCP and 55% TDN (59.8 g) as compared to 7% DCP and 60% TDN (54.2 g). In another study Dhore *et al.* (2006) observed ADG for the respective groups as 44.37, 68.73 and 76.31 g in local kids fed T_1: tree leaves of *apta* (*Bauhinia racemosa*), *anjan* (*Hardwickia binata*) and *subabul* (*Leucaena leucocephala*); T_2 : urea treated sugarcane bagasse based pelleted complete ration and T_3 : urea treated wheat straw based pelleted complete ration for 90 days. The findings of Mane *et al.* (2006) revealed lower body weight gain as 35.2 and 46.8 g/d in growing goats fed iso-nitrogenous conventional (T_1) and complete feed (T_2), respectively, in comparison to present study.

Higher average daily gain (88.58, 89.17, 95.25 and 104.83 g) in goats fed complete feed mixture supplemented with fungus (*Trichoderma viride*) fermented sugar beet pulp at 0.0 (T_1), 0.3 (T_2), 0.6 (T_3) and 0.9% (T_4) (w/w), respectively was reported by Salman *et al.* (2008) in comparison to the growth rate observed under the present study in Surti kids.

Similar average daily gain in weight as observed under the present study were also reported (63.97 and 71.18 g) in non-descript local kids by Chopade *et al.* (2010) fed on untreated soybean straw or 4% urea treated soybean straw in the form of pelleted complete ration, respectively.

Wadhwani *et al*. (2010) reported average daily gain in weight as 94.17, 81.61 and 59.96 g for the lambs fed TMR-I, TMR-II and TMR-III, respectively. The daily gain recorded in TMR-I and TMR-II was at par but was significantly ($P<0.05$) lower under TMR-III. These values for growth rates for TMR-I and TMR-II are higher than the values observed under the present study for Surti kids.

4.2.2 Body measurements

Body growth of an animal is a function of muscular and skeletal growth. Therefore, to find out the adequacy of growth, the height at withers, body length and heart girth at biweekly intervals were measured.

4.2.2.1 *Height at withers*

The total increase and average daily increase in height at withers of Surti kids along with ANOVA is given in Table 4.3. The changes in height at withers at biweekly intervals are depicted in Figure 4.2.

Table 4.3: Total increase and average daily increase in height at withers (cm) of Surti kids fed total mixed ration

Kid No.	Treatments	
	T_1	T_2
1	3.0	3.3
2	7.0	7.7
3	7.7	9.7
4	6.3	6.0
5	8.3	6.3
6	7.7	6.0
7	5.7	6.0
8	7.7	8.0
Av. total increase (cm) ±SE	**6.67±0.60**	**6.63±0.66**
Av. daily increase (cm) ±SE	**0.079±0.007**	**0.079±0.008**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment	1	0.0069	0.0069	0.002 NS
Error	14	44.7639	3.1974	-
Total	15	-	-	-

NS=Non significant

The average increase in height at withers of Surti kids under T_1 and T_2 was 6.67±0.60 and 6.63±0.66 cm, whereas the average daily increase in height was 0.079±0.007 and 0.079±0.008 cm, respectively during 12 weeks experimental period, being slightly higher in T_1 in comparison to T_2. The treatment differences were found to be non significant. Higher values for total increase in height at withers (10.64, 10.00 and 6.14 cm under TMR-I, TMR-II and TMR-III, respectively) in lambs were observed by Wadhwani *et al*. (2010) during 120 days of experimental period. The increase in height at withers under TMR-I (conventional) and TMR-II (non conventional I) was similar but was significantly higher (P<0.05) compared to TMR-III.

4.2.2.2 *Body length*

The total increase and average daily increase in body length (cm) of Surti kids along with statistical analysis is given in Table 4.4. The changes in body length of kids during biweekly interval are also depicted in Figure 4.3.

Table 4.4: Total increase and average daily increase in body length (cm) of Surti kids fed total mixed ration

Kid No.	Treatments	
	T_1	T_2
1	3.7	4.3
2	8.0	8.7
3	8.7	9.7
4	5.0	6.7
5	8.3	5.7
6	8.3	8.0
7	9.7	5.3
8	6.3	9.3
Av. total increase (cm) ±SE	**7.25±0.73**	**7.21±0.70**
Av. daily increase (cm) ±SE	**0.086±0.009**	**0.086±0.008**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment	1	0.0069	0.0069	0.002 NS
Error	14	57.2639	4.0903	-
Total	15	-	-	-

NS=Non significant

The total increase in body length of individual kid was 7.25±0.73 and 7.21±0.70 cm under treatment T_1 and T_2, respectively, whereas the average daily increase for the same was 0.086 cm under both the groups. The differences were found to be statistically non significant. Wadhwani *et al*. (2010) observed higher values for increase in body length (12.93, 10.00 and 4.14 cm under TMR-I, TMR-II and TMR-III, respectively) in lambs during experimental period of 120 days. The increase in body length for lambs fed TMR-I (conventional) and TMR-II (non conventional I) was comparable but significantly lower value ($P<0.05$) was observed for lambs fed TMR-III. Non significant differences were also observed by Murthy *et al.* (2004) in Gir calves when fed groundnut haulms at 20%, 30% and 40% levels in complete ration.

4.2.2.3 *Heart girth*

The data for total increase and average daily increase in heart girth (cm) of Surti kids are given in Table 4.5 along with ANOVA. The changes in heart girth at biweekly intervals are depicted in Figure 4.4.

Table 4.5: Total increase and average daily increase in heart girth (cm) of Surti kids fed total mixed ration

Kid No.	Treatments	
	T_1	T_2
1	4.3	5.3
2	5.7	7.3
3	6.3	8.3
4	6.3	6.0
5	7.7	7.0
6	6.7	3.7
7	6.7	5.3
8	6.0	6.3
Av. total increase (cm) ±SE	**6.21±0.34**	**6.17±0.51**
Av. daily increase (cm) ±SE	**0.074±0.004**	**0.073±0.006**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment	1	0.0069	0.0069	0.005 NS
Error	14	20.8750	1.4911	-
Total	15	-	-	-

NS=Non significant

The average increase in heart girth during 12 weeks of experimental period was 6.21±0.34 and 6.17±0.51 cm and average daily increase in heart girth was 0.074 and 0.073 cm under T_1 and T_2, respectively. The treatment differences were non significant (P>0.05). Wadhwani *et al*. (2010) reported the total gain in heart girth of 14.71, 12.86 and 7.07 cm in lambs fed TMR-I, TMR-II and TMR-III, respectively during experimental period of 120 days. The increase in heart girth for lambs under TMR-I (conventional) and TMR-II (non conventional I) was at par but there values were significantly higher (P<0.05) compared to TMR-III. These values were higher than the values observed in present study. Non significant differences were also observed by Murthy *et al.* (2004) in Gir calves when fed groundnut haulms at 20%, 30% and 40% levels in complete ration.

The data for body measurements for kids fed groundnut haulms in complete ration / TMR are not available in literature.

The data for daily gain in weight and body measurements were found to be within the normal range and revealed no adverse effect of feeding different TMR on their performance.

4.3 DRY MATTER AND ORGANIC MATTER INTAKE:

4.3.1 Dry matter intake (g/d)

The data for average daily dry matter intake (g) of Surti kids during the experimental period and during digestion trial under both the treatments are given in Table 4.6 along with ANOVA. The average data for daily dry matter intake by experimental kids fed different TMR are depicted in Figure 4.5.

Table 4.6: Average daily dry matter intake (g) of Surti kids fed total mixed ration during the experimental period and digestion trial

Kid No.	During experiment		During digestion trial	
	Treatments		Treatments	
	T_1	T_2	T_1	T_2
1	470	351	491	306
2	556	477	739	566
3	604	477	672	617
4	580	390	622	630
5	579	445	673	607
6	428	523	437	585
7	590	368	615	503
8	487	468	432	472
Av. ±SE	**536.84 ±23.21**	**437.21 ±21.55**	**585.02 ±41.27**	**535.90 ±38.19**

ANOVA

SV	df	During experiment (g)		During digestion trial (g)	
		MSS	Cal. F	MSS	Cal. F
Treatment	1	39704.7137	9.89**	9653.5060	0.76 NS
Error	14	4013.1849	-	12648.1490	-
Total	15	-	-	-	-

NS= Non significant, **= (P<0.01)

The results revealed that the average daily DM consumed by kids was 536.84±23.21 and 437.21±21.55 g under T_1 and T_2, respectively during the experimental period and the treatment differences were highly significant (P<0.01). However, the daily DMI observed during the digestion trial was 585.02±41.27 and 535.90±38.19 g under T_1 and T_2, respectively. and the treatment differences were non significant.

Ramaprasad *et al.* (2000) observed the higher values for total daily DMI (616, 573 and 537 g) in lambs fed complete rations containing groundnut haulms at 50, 60 and 70% levels, respectively. The DM intake (g/d) was significantly higher (P<0.01) in lambs fed 50% groundnut haulms than those fed 70%. In another study, Ramaprasad *et al*. (1999) fed four isonitrogenous complete rations containing *subabul* leaf meal, sunnhemp hay, *Stylo hamata* hay and groundnut haulms each at 60% level in rams for 28 days and reported the daily dry matter intake of 903, 882, 863 and 868 g (P>0.05) for respective groups. The data for daily DMI reported by these research workers are higher than those observed in the present study.

Rajmane and Deshmukh (2000) also reported higher values for daily DMI of 615, 924 and 782 g in Osmanabadi goats under respective groups fed three complete rations containing 60% either sorghum straw, soybean straw or corn cobs and 40% concentrate mixture in comparison to present study. Similarly, higher values for daily DMI (743.94 g) were also observed by Raut *et al.* (2002) in local non descript male goats fed pelleted complete feed containing 60% *arhar* (*Cajanus cajan*) straw and 40% concentrate mixture.

Chopade *et al.* (2010) fed untreated soybean straw and 4% urea treated soybean straw in the form of pelleted complete ration to non-descript local kids and reported the average DMI of 702.28 and 680.10 g/d, respectively. These values are slightly higher than the values observed under the present study. Comparatively, higher DMI (989.3 and 835.4 g) in non descript local goats fed pelleted complete feed of varying protein levels (12% CP, 65.81% TDN and 14% CP, 67.44% TDN, respectively) containing *arhar* straw as a sole roughage was also reported earlier (Bhadane *et al*., 2004).

In contrast to present findings lower values for daily DMI (431, 409 and 415 g under T_1, T_2 and T_3, respectively) were observed by Samanta *et al.* (2003) in Barbari goats fed complete diets consisting of natural grass hay and concentrate mixture in the ratio of 60:40 on DM basis.

The DMI was 504.4, 559.0, 591.4 and 510.4 g/d under R_1, R_2, R_3 and R_4, respectively as reported by Prakash *et al*. (2003) in Osmanabadi bucks fed either untreated ground maize stover and lucerne hay (R_1), untreated ground maize stover and concentrate mixture (R_2), urea treated ground maize stover and concentrate mixture (R_3) or urea treated chopped maize stover and concentrate mixture (R_4). These findings were at par with the values observed under present study. Similarly, Dhore *et al.* (2006) reported daily DMI of 471.38, 578.77 and 625.69 g under T_1, T_2 and T_3, respectively in local kids offered tree leaves of *apta* (*Bauhinia racemosa*), *anjan* (*Hardwickia binata*) and *subabul* (*Leucaena leucocephala*) (T_1); urea treated sugarcane bagasse based pelleted complete ration (T_2) and urea treated wheat straw based pelleted complete ration (T_3). Mane *et al.* (2006) also observed the similar values for daily dry matter intake (417.1±8.2 and 536.6±9.6g) in growing goats fed either conventional feed or complete feed, respectively.

Higher daily DMI (885, 898, 908 and 932 g) in goats fed complete feed mixture supplemented with fungus (*Trichoderma viride*) fermented sugar beet pulp at 0.0 (T_1), 0.3 (T_2), 0.6 (T_3) and 0.9% (T_4) (w/w), respectively was reported by Salman *et al.* (2008) in comparison to the daily DMI observed under the present study in Surti kids.

Chobtang *et al.* (2009) observed the daily dry matter intake of 563.41, 567.31, 562.76 and 603.30 g in Thai indigenous male goats fed total mixed rations containing 8, 10, 12 and 14% CP, respectively. Similar values were observed under the present study. However, higher values were observed by Dhore *et al*. (2005) when they assessed the effect of different protein and energy levels and reported 726.1 and 739.1 g of daily DMI in local kids fed pelleted complete feed containing either 7% DCP and 60% TDN or 9% DCP and 55% TDN, respectively.

Wadhwani *et al*. (2010) reported daily DMI as 570.50, 831.02 and 895.16 g for the lambs fed TMR-I, TMR-II and TMR-III, respectively. The value observed under the conventional group (TMR-I) was in the range of the values under the present study.

4.3.2 Dry matter intake (kg/100 kg BW)

The data for per cent dry matter intake of individual kids during the experimental period and digestion trial under both the treatments are given in Table 4.7 along with ANOVA.

Table 4.7: Average daily dry matter intake (kg/100 kg BW) during the experimental period and digestion trial of Surti kids fed total mixed ration

Kid No.	During experiment		During digestion trial	
	Treatments		Treatments	
	T_1	T_2	T_1	T_2
1	4.07	4.42	3.90	3.61
2	3.84	3.81	4.62	4.16
3	4.36	4.54	4.51	5.19
4	3.90	3.23	3.81	4.85
5	4.49	4.67	4.77	5.57
6	3.85	3.98	3.58	4.27
7	4.35	3.19	4.04	4.19
8	5.67	3.90	4.50	3.60
Av. ±SE	**4.31±0.21**	**3.97±0.20**	**4.22±0.15**	**4.43±0.25**

ANOVA

SV	Df	During experiment		During digestion trial	
		MSS	Cal. F	MSS	Cal. F
Treatment	1	0.4840	1.43 NS	0.1806	0.52 NS
Error	14	0.3382	-	0.3493	-
Total	15	-	-	-	-

NS= Non significant

The result given in Table 4.7 revealed that dry matter intake during the experimental period was 4.31±0.21 and 3.97±0.20 kg/100 kg BW in T_1 and T_2, respectively with non significant treatment differences. Though, the kids under control group (T_1) consumed little more dry matter in comparison to treatment group (T_2). However, during the digestion trial comparatively higher (P>0.05) value was observed for T_2 (4.43±0.25 kg/100 kg BW) as compared to T_1 (4.22±0.15 kg/100 kg BW). Similar values for DMI were reported by Ramaprasad *et al*. (2000) when three isonitrogenous complete rations containing groundnut haulms at 50 (4.1 kg/100kg BW), 60 (4.0 kg/100kg BW) and 70% (3.9 kg/100kg BW) levels were fed to lambs. The DM intake (per cent of body weight) was significantly higher (P<0.01) in lambs fed CR_1 than those fed CR_3. Similar data for DMI (4.20±0.28 kg/100 kg BW) were also observed by Raut *et al.* (2002) in non descript male goats fed pelleted complete feed containing 60% *arhar* (*Cajanus cajan*) straw and 40% concentrate mixture.

The non-descript local goats were fed complete feed pellets based either on *arhar* straw (ASCF), gram straw (GSCF) or exclusive *arhar* straw pellets supplemented with concentrate pellets (AS-CONC) by Rekhate *et al*. (2004). The DMI as per cent of body weight was 4.3, 4.5 and 5.3 kg in goats under ASCF, GSCF and AS-CONC groups, respectively. The values under ASCF and GSCF are similar with the values observed under the present study.

Bhadane *et al.* (2004) reported per cent DMI as 4.6 and 4.9 kg in non descript local goats fed pelleted complete feed having either 12% CP and 65.81% TDN or 14% CP and 67.44% TDN on DM basis. These values are more or less in agreement with the values observed under the present study. Dhore *et al.* (2005) observed slightly lower values for per cent DMI kg/100 kg BW (3.3 and 3.7) in local kids under respective groups in comparison to values observed under the present study.

Contrary to the present findings Ramaprasad *et al*. (1999) reported lower values for DMI of 3.0 – 3.1 kg expressed as per cent of body weight in all the rams fed four different complete rations containing *subabul* leaf meal, sunnhemp hay, *Stylo hamata* hay and groundnut haulms each at 60% level and treatment differences were non-significant. Similarly lower values were also reported by Mandal *et al*. (1999) in rams fed gram straw and concentrate mixture in the ratio of 60:40 (2.32 kg/100 kg body weight) and groundnut haulms and paddy straw silage as sole ration (3.17 kg/100 kg body weight). Lower values for per cent DMI in Osmanabadi goats fed complete rations containing 60% either sorghum straw (2.19 kg/100kg BW), soybean straw (3.33 kg/100kg BW) or corn cobs (2.76 kg/100kg BW) and 40% concentrate mixture were reported by Rajmane and Deshmukh (2000). Similar data for per cent DMI (2.5 – 2.9 kg) were also reported by Prakash *et al*. (2003) in Osmanabadi bucks.

Slightly higher values were observed by Dhore *et al.* (2006) for % DMI (4.36 to 5.12 kg/100 kg BW) in local kids offered tree leaves of *apta* (*Bauhinia racemosa*), *anjan* (*Hardwickia binata*) and *subabul* (*Leucaena leucocephala*); urea treated sugarcane bagasse based pelleted complete ration and urea treated wheat straw based pelleted complete ration.

Fungus (*Trichoderma viride*) fermented sugar beet pulp was supplemented in goats at 0.0, 0.3, 0.6 and 0.9% (w/w) to complete feed mixture and mixed well just before feeding for treatments T_1, T_2, T_3 and T_4, respectively (Salman *et al*., 2008). The respective values for DMI as per cent of body weight were 3.97, 4.00, 4.00 and 4.05 which were having similar values as observed under present study.

The DMI as per cent of body weight was found to be 3.06, 2.90 and 2.95 kg under groups T_1, T_2 and T_3, respectively in Barbari goats (Samanta *et al*., 2003). These values are also lower than the values observed under present study.

Wadhwani *et al*. (2010) reported the per cent DMI as 2.50, 3.53 and 4.27 kg for the lambs fed TMR-I, TMR-II and TMR-III, respectively. The value observed under the TMR-III supplemented non conventional group II (azolla 20%) was in the range of the values under the present study. Mane *et al.* (2006) reported the similar values for DMI as per cent of body weight in growing goats fed conventional feed (3.5) and complete feed (4.0).

4.3.3 Dry matter intake (g/kg $W^{0.75}$)

The data for dry matter intake on metabolic body weight basis (g/kg $W^{0.75}$) of individual kids during the experimental period and digestion trial under both the treatments are given in Table 4.8 along with ANOVA.

Table 4.8: Average daily dry matter intake (g/kg $W^{0.75}$) during the experimental period and digestion trial of Surti kids fed total mixed ration

Kid No.	During experiment		During digestion trial	
	Treatments		Treatments	
	T_1	T_2	T_1	T_2
1	74.95	74.04	73.42	61.56
2	74.82	71.59	92.36	79.98
3	84.01	81.42	88.66	96.32
4	76.44	60.06	76.62	92.01
5	84.96	81.85	92.46	101.19
6	70.18	75.69	66.96	82.18
7	83.34	58.76	79.83	78.02
8	96.80	72.48	79.18	68.55
Av. ±SE	**80.69 ±2.96**	**71.99 ±3.05**	**81.19 ±3.27**	**82.48 ±4.80**

ANOVA

SV	df	During experiment		During digestion trial	
		MSS	Cal. F	MSS	Cal. F
Treatment	1	302.9465	4.18 NS	6.6320	0.05 NS
Error	14	72.3998	-	134.8429	-
Total	15	-	-	-	-

NS= Non significant

The result revealed that average dry matter intake was 80.69±2.96 and 71.99±3.05 g/kg $W^{0.75}$ for kids in T_1 and T_2, respectively. The DMI during digestion trial was 81.19±3.27 and 82.48±4.80 g/kg $W^{0.75}$ under T_1 and T_2, respectively. The treatment differences were statistically non significant (P>0.05). Similar values were observed for DMI by Ramaprasad *et al.* (2000) in lambs fed complete rations containing groundnut haulms at 50 (82 g/kg $W^{0.75}$), 60 (78 g/kg $W^{0.75}$) and 70% (66 g/kg $W^{0.75}$) levels. The DM intake was significantly higher (P<0.01) in lambs fed CR_1 than those fed CR_3.

Almost similar values for daily DMI (83.5, 83.1, 82.4 and 84.5 g/kg $W^{0.75}$, respectively) were reported by Aasharekha *et al.* (2006) in sheep fed complete rations containing groundnut haulms and concentrates in 60:40 or 70:30 ratios with or without yeast culture product (YCP). However, Ramratan (1999) reported higher values for DMI (113.32 g/kg $W^{0.75}$) in rams fed groundnut haulms *ad libitum* along with mineral mixture and common salt.

Lower values were observed for daily DMI (70.0 – 72.3 g/kg $W^{0.75}$) by Ramaprasad *et al*. (1999) in rams fed four isonitrogenous complete rations containing *subabul* leaf meal, sunnhemp hay, *Stylo hamata* hay and groundnut haulms each at 60% level. Lower values were also observed for DMI (59.28, 56.23 and 57.17 g/kg$W^{0.75}$ under groups T_1, T_2 and T_3, respectively) by Samanta *et al.* (2003) in Barbari goats fed complete diets containing natural grass hay and concentrate mixture in the ratio of 60:40. Rajendiran and Kadirvel (2002) incorporated the dried casuarina leaf meal (CLM) as a roughage component in complete diets of male kids. The DM intake ranged from 32 g/kg $W^{0.75}$ in 60% CLM diet to 45 g/kg $W^{0.75}$ on basal diet. These values are comparatively lower than the values observed under the present study. Wadhwani *et al*. (2010) reported the DMI on metabolic body weight basis as 54.64, 77.74 and 91.41 g/kg $W^{0.75}$ for the lambs fed TMR-I, TMR-II and TMR-III, respectively. Lower and higher values were observed for lambs fed TMR-I and TMR-III, respectively. However, the value observed for lambs fed TMR-II (supplemented non conventional group I- azolla 10%) was in the range of the values observed under the present study.

4.3.4 Organic matter intake

The organic matter intakes of individual kids during the experimental period under both the treatments are given in Table 4.9 along with ANOVA.

Table 4.9: Organic matter intake during the experimental period of Surti kids fed total mixed ration

Kid No.	Organic matter intake					
	g/d		kg/100 kg BW		g/kg $W^{0.75}$	
	T_1	T_2	T_1	T_2	T_1	T_2
1	405	306	3.51	3.86	64.60	64.68
2	479	417	3.31	3.33	64.49	62.55
3	521	416	3.76	3.96	72.41	71.14
4	500	341	3.36	2.82	65.89	52.47
5	499	389	3.87	4.08	73.23	71.51
6	369	457	3.32	3.48	60.49	66.13
7	509	321	3.75	2.79	71.83	51.34
8	419	409	4.88	3.41	83.43	63.33
Av. ±SE	**462.70 ±20.01**	**381.99 ±18.83**	**3.72 ±0.18**	**3.47 ±0.17**	**69.54 ±2.55**	**62.89 ±2.67**

ANOVA

SV	df	g/d		kg/100 kg BW		g/kg $W^{0.75}$	
		MSS	Cal. F	MSS	Cal. F	MSS	Cal. F
Treatment	1	26057.81	8.63*	0.26	1.01 NS	176.97	3.24 NS
Error	14	3019.33	-	0.25	-	54.55	-
Total	15	-	-	-	-	-	-

NS= Non significant; *= (P<0.05)

The data given in Table 4.9 revealed that Surti kids fed *jowar* hay based TMR (T_1) daily consumed significantly higher (P<0.05) organic matter (462.70 and 381.99g under T_1 and T_2, respectively) than kids fed *jowar* hay + groundnut haulms based TMR (T_2). The organic matter intake as per cent of body weight was 3.72 and 3.47 kg under T_1 and T_2, respectively which was statistically non significant (P>0.05). Similarly non significant differences were also observed for organic matter intake on metabolic body weight basis (69.54 and 62.89 g/kg $W^{0.75}$ under T_1 and T_2, respectively). Similar data for organic matter intake for kids fed TMR are not available in literature.

The values of DMI and OMI in Surti kids suggested that both TMR were palatable and kids consumed sufficient dry matter and organic matter to meet their requirement.

4.4 RUMEN FERMENTATION PATTERN:

For studying the rumen fermentation pattern in the rumen of Surti kids fed TMR, the rumen liquor samples were collected before feeding and at different post feeding time intervals. The changes occurring in rumen pH, total volatile fatty acids, ammonia nitrogen, total nitrogen and non protein nitrogen concentrations were determined from the strained rumen liquor (SRL) samples.

4.4.1 Rumen SRL pH

The average pH values of SRL under different treatments and at different hours of feeding are given in Table 4.10 along with ANOVA. The same data are also depicted in Figure 4.6.

Table 4.10: Average periodical changes in strained rumen liquor pH of Surti kids fed total mixed ration

Hours of sampling	Treatments		Average ±SE
	T_1	T_2	
0	6.44	6.72	**6.58±0.14**
3	6.09	6.22	**6.15±0.07**
6	6.07	6.37	**6.22±0.15**
Average ±SE	**6.20±0.12**	**6.44±0.15**	**6.32±0.12**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment (T)	1	0.2568	0.2568	20.50**
Periods (P)	2	0.6302	0.3151	25.15**
T x P	2	0.0255	0.0127	1.02 NS
Error	12	0.1503	0.0125	-
Total	17	-	-	-

NS= Non significant; **= (P<0.01)

The average SRL pH values were 6.20 and 6.44 under T_1 and T_2, respectively. The differences for treatment as well as hours of feeding for SRL pH were highly significant (P<0.01). However, the differences for treatment and period interaction were non significant.

It is apparent from the data that SRL pH dropped at 3 hrs after post feeding under both the treatments. The drop in rumen pH is attributed to the increased concentration of TVFA during same period of post feeding as evident from Figure 4.6 and data of TVFA given in Table 4.11.

Aasharekha *et al*. (2006) reported ruminal pH values ranging from 6.6 to 6.7 (P>0.05) in sheep fed complete rations containing groundnut haulms and concentrates in 60:40 or 70:30 ratios with or without yeast culture product. Chopade *et al*. (2010) reported the higher (P<0.01) ruminal pH in kids fed pelleted complete ration containing 4% urea treated soybean straw (6.70) as compared to kids fed pelleted complete ration containing untreated soybean straw (6.62). The values observed by different research workers were higher than the values observed under the present study. Similarly, higher value for rumen pH (6.88) was also observed by Raut *et al*. (2002) after 4 hrs of post feeding in goats consumed pelleted complete feed containing 60% *arhar* straw and 40% concentrate mixture.

4.4.2 Total volatile fatty acids (TVFAs)

The average periodical changes in TVFAs concentrations of Surti kids under different treatments are given in Table 4.11 along with statistical analysis. The average periodical changes in TVFAs production under different treatments are depicted in Figure 4.6.

Table 4.11: Average total volatile fatty acids concentration (mEq/L) in strained rumen liquor of Surti kids fed total mixed ration

Hours of sampling	Treatments		Average ±SE
	T_1	T_2	
0	101.33	139.33	**120.33±19.00**
3	262.67	223.00	**242.83±19.83**
6	180.33	230.67	**205.50±25.17**
Average ±SE	**181.44±46.58**	**197.67±29.25**	**189.56±8.11**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment (T)	1	1184.2222	1184.2222	1.70 NS
Periods (P)	2	47306.7778	23653.3889	33.88**
T x P	2	7142.1111	3571.0556	5.12*
Error	12	8377.3333	698.1111	-
Total	17	-	-	-

NS= Non significant; *= (P<0.05); **= (P<0.01)

The average concentration of TVFAs in SRL was 181.44 and 197.67 mEq/L (P>0.05) under T_1 and T_2, respectively. However, there was a sharp increase in TVFA concentration after 3 hrs of post feeding (Figure 4.6) under both treatments 262.67 (T_1) and 223.00 (T_2) mEq/L of SRL which is associated with drop in rumen pH. The SRL pH slightly dropped after 3 hrs of post feeding under T_1, while it was further increased under T_2 and reached at peak at 6 hrs post feeding as there was increase in TVFA level under T_2 (230.67 mEq/L). These periodical changes were found to be highly significant (P<0.01). The average TVFA concentration was found to be slightly lower in T_1 than T_2 group. The statistical differences due to treatments were found to be non significant. However, the differences for treatment and period interaction (P<0.05) were significant.

Lower value for TVFA concentration (60.9 to 62.4 mEq/L) were reported by Aasharekha *et al*. (2006) in sheep fed complete rations containing groundnut haulms and concentrates in 60:40 or 70:30 ratios with or without yeast culture product (P>0.05). Lower value was also observed by Raut *et al*. (2002) for TVFA concentration (7.28 mEq/dl SRL) after 4 hrs of post feeding in goats consumed pelleted complete feed containing 60% *arhar* straw and 40% concentrate mixture. The highest (P<0.01) TVFA production was observed by Rekhate *et al*. (2004) in the rumen liquor of goats fed *arhar* straw based complete feed pellets (9.4 mEq/dl) as compared to GSCF and AS-CONC (5.3 and 7.0 mEq/dl, respectively) groups. Chopade *et al*. (2010) reported the higher (P<0.01) ruminal TVFA concentration in kids fed pelleted complete ration containing 4% urea treated soybean straw (9.48 mEq/dl) as compared to kids fed pelleted complete ration containing untreated soybean straw (9.16 mEq/dl). These values observed by different research workers were lower than the values observed under the present study.

These data suggested that incorporation of groundnut haulms favored TVFAs production and increased availability of energy to kids under the present study.

4.4.3 Rumen Ammonia -N

The average hourly changes in ammonia–N (NH_3-N) concentrations taking place in rumen of Surti kids under T_1 and T_2 treatments are given in Table 4.12 along with statistical analysis and the same are also shown in Figure 4.7.

Table 4.12: Average rumen ammonia nitrogen concentration (mg/dl) in strained rumen liquor of Surti kids fed total mixed ration

Hours of sampling	Treatments		Average ±SE
	T_1	T_2	
0	17.55	17.64	**17.59±0.05**
3	26.69	23.89	**25.29±1.40**
6	21.28	28.75	**25.01±3.73**
Average ±SE	**21.84±2.66**	**23.43±3.21**	**22.63±0.79**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment (T)	1	11.3288	11.3288	0.60 NS
Periods (P)	2	228.8496	114.4248	6.04*
T x P	2	84.0709	42.0355	2.22 NS
Error	12	227.2555	18.9380	-
Total	17	-	-	-

NS= Non significant; *= (P<0.05)

The average SRL ammonia-N concentrations of kids were 21.84 and 23.43 mg/dl under T_1 and T_2, respectively. These values for ammonia-N concentrations were almost same under T_1 and T_2 and the differences between treatments were non significant (P>0.05). The peak concentration of ammonia-N in SRL reached at 3 hrs of post feeding under T_1 while in T_2 ammonia-N concentration steadily increased upto 6 hrs and reached at peak. Hourly changes in ammonia-N concentration were found to be significant. However, average values for ammonia-N observed under both treatments were within the normal range.

The significantly (P<0.01) lower NH_3-N concentration in the rumen liquor of goats fed AS-CONC diet (19.5 mg/dl) as compared to ASCF and GSCF diets (20.5 and 20.2 mg/dl, respectively) was observed by Rekhate *et al*. (2004). Chopade *et al*. (2010) reported the higher (P<0.01) ruminal NH_3-N concentration in kids fed pelleted complete ration containing 4% urea treated soybean straw (19.97 mg/dl) as compared to kids fed pelleted complete ration containing untreated soybean straw (19.02). The values observed by these research workers are slightly lower than the values observed under the present study.

Lower values for NH_3-N concentration (13.8, 13.6, 14.0 and 13.4 mg/dl, respectively) were also reported by Aasharekha *et al*. (2006) in sheep fed complete rations containing groundnut haulms and concentrates in 60:40 or 70:30 ratios with or without yeast culture product (YCP). Similarly, Raut *et al*. (2002) also observed lower value for rumen NH_3-N concentration (12.50 mg/dl SRL) after 4 hrs of post feeding in goats consumed pelleted complete feed containing 60% *arhar* straw and 40% concentrate mixture.

4.4.4 Rumen Total-N

The average changes in total–N contents of Surti kids at different hours after feeding are summarized in Table 4.13 along with ANOVA and the same are depicted in Figure 4.7.

Table 4.13: Average total nitrogen concentration (mg/dl) in strained rumen liquor of Surti kids fed total mixed ration

Hours of sampling	Treatments		Average ±SE
	T_1	T_2	
0	99.87	78.40	**89.13±10.73**
3	100.80	154.93	**127.87±27.07**
6	88.67	91.47	**90.07±1.40**
Average ±SE	**96.44±3.90**	**108.27±23.64**	**102.36±5.91**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment (T)	1	628.9422	628.9422	0.74 NS
Periods (P)	2	5859.9644	2929.9822	3.43 *
T x P	2	4469.6711	2234.8356	2.62 NS
Error	12	10244.2667	853.6889	-
Total	17	-	-	-

NS= Non significant; *= (P<0.05)

The data given in Table 4.13 indicated that average total–N concentration in SRL of kids was 96.44 and 108.27 mg/dl under T_1 and T_2, respectively. The value of total-N concentration under T_2 was higher than that of T_1, however, the treatment differences (P>0.05) for the same were non significant. The data for periodical changes in total–N concentrations (Figure 4.7) showed that peak concentration reached at 3 hrs of post feeding in both treatments. The hourly changes in total–N concentration were found to be significant. In both treatments there was a periodical fluctuation in the concentration of total–N.

Chopade *et al*. (2010) reported the higher (P<0.01) ruminal total nitrogen concentration in kids fed pelleted complete ration containing 4% urea treated soybean straw (98.40 mg/dl) as compared to kids fed pelleted complete ration containing untreated soybean straw (91.07 mg/dl). These values more or less match with the values observed under the present study.

Rekhate *et al*. (2004) reported the total nitrogen concentration (P>0.05) of 82.8, 92.8 and 88.1 mg/dl in goats fed complete feed pellets based either on *arhar* straw, gram straw or exclusive *arhar* straw pellets supplemented with concentrate pellets, respectively. Aasharekha *et al*. (2006) also reported the concentration of total nitrogen in the range from 84.6 to 91.2 mg/dl in sheep fed complete rations containing groundnut haulms and concentrates in 60:40 or 70:30 ratios with or without yeast culture product (P>0.05). The values observed by different research workers for total-N concentrations are in agreement with the values observed under the present study.

4.4.5 Rumen Non Protein Nitrogen (NPN)

The average concentration of NPN in SRL of Surti kids fed TMR are given in Table 4.14 along with statistical analysis and the same data are depicted in Figure 4.7.

Table 4.14: Average non protein nitrogen concentration (mg/dl) in strained rumen liquor of Surti kids fed total mixed ration

Hours of sampling	Treatments		Average ±SE
	T_1	T_2	
0	50.03	56.75	**53.39±3.36**
3	59.55	65.71	**62.63±3.08**
6	57.68	70.93	**64.31±6.63**
Average ±SE	**55.75±2.91**	**64.46±4.14**	**60.11±4.36**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment (T)	1	341.4756	341.4756	17.44**
Periods (P)	2	414.8928	207.4464	10.59**
T x P	2	46.6567	23.3284	1.19 NS
Error	12	234.9909	19.5826	-
Total	17	-	-	-

NS= Non significant; **= (P<0.01)

The average concentration of NPN in SRL was 55.75 and 64.46 mg/dl under T_1 and T_2, respectively. The treatment differences were highly significant. The average periodical changes of NPN concentration in SRL of kids under different treatments as depicted in Figure 4.7 were found to be significantly different but simultaneously not exhibiting a definite trend. The peak concentration of NPN in SRL was found to be at 3 and 6 hrs of post feeding under T_1 and T_2, respectively.

Chopade *et al*. (2010) reported the higher (P<0.01) non protein nitrogen concentration in rumen liquor of kids fed pelleted complete ration containing 4% urea treated soybean straw (56.37 mg/dl) as compared to kids fed pelleted complete ration containing untreated soybean straw (53.05 mg/dl). These values are more or less in agreement with the values observed under the present study.

The significantly (P<0.01) lower NPN concentration in the rumen liquor of goats fed AS-CONC diet (44.5 mg/dl) as compared to ASCF and GSCF diets (51.1 and 51.2 mg/dl, respectively) was observed by Rekhate *et al*. (2004). These values are lower than the values observed under the present study.

4.4.6 Rumen Protein-N

The average periodical changes in protein–N concentration in SRL of kids under both treatments are given in Table 4.15 along with statistical analysis. The same data are also graphically presented in Figure 4.7.

Table 4.15: Average protein nitrogen concentration (mg/dl) in strained rumen liquor of Surti kids fed total mixed ration

Hours of sampling	Treatments		Average ±SE
	T_1	T_2	
0	49.84	65.52	**57.68±7.84**
3	41.25	89.23	**65.24±23.99**
6	30.99	20.53	**25.76±5.23**
Average ±SE	**40.69±5.45**	**58.43±20.14**	**49.56±8.87**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment (T)	1	1415.1200	1415.1200	1.67 NS
Periods (P)	2	5269.4208	2634.7104	3.11*
T x P	2	2569.7429	1284.8715	1.52 NS
Error	12	10152.0683	846.0057	-
Total	17	-	-	-

NS= Non significant; *= (P<0.05)

The average protein-N concentrations in SRL of kids under T_1 and T_2 were 40.69 and 58.43 mg/dl, respectively. The treatment differences were non significant. The periodical differences were found to be significant. However, the differences for treatments and periods interaction were non significant. The peak of protein-N reached at 3 hrs of post feeding under T_2 while there was steadily decrease in the concentration of protein-N upto 6 hrs of post feeding under T_1.

The significantly higher (P<0.01) TCA-N concentration in the rumen liquor of goats fed AS-CONC diet (43.5 mg/dl) as compared to ASCF and GSCF diets (31.6 and 41.8 mg/dl, respectively) was observed by Rekhate *et al*. (2004). Chopade *et al*. (2010) also reported higher (P<0.01) ruminal TCA-ppt-N in kids fed pelleted complete ration containing 4% urea treated soybean straw (42.20 mg/dl) as compared to kids fed pelleted complete ration containing untreated soybean straw (38.25 mg/dl). These values are more or less similar to the values observed under the present study.

The data of different rumen metabolites for Surti kids fed *jowar* hay and *jowar* hay + groundnut haulms based TMR were within the normal range. These data suggested that Surti kids utilized these ration efficiently without any adverse effect on rumen metabolites.

4.5 DIGESTIBILITY AND NUTRIENTS INTAKE:

4.5.1 Digestibility of proximate nutrients

Digestion trial was conducted on all (16) kids once during the experimental period following conventional method. The collection period was of 5 days. The digestibility coefficients for various proximate nutrients were calculated for whole ration.

4.5.1.1 *Dry matter digestibility*

The average digestibility of dry matter for individual kids fed TMR is presented in Table 4.16 and the same data are also depicted in Figure 4.8.

Table 4.16: Average digestibility (%) of dry matter for Surti kids fed total mixed ration

Kid No.	Treatments	
	T_1	T_2
1	57.24	58.86
2	60.37	61.77
3	53.39	60.57
4	51.36	62.31
5	62.35	61.42
6	59.47	69.33
7	61.16	61.51
8	51.37	53.74
Av. ±SE	**57.09±1.58**	**61.19±1.52**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment	1	67.2211	67.2211	3.50 NS
Error	14	269.1141	19.2224	-
Total	15	-	-	-

NS= Non significant

The values for dry matter digestibility were found to be 57.09 and 61.19 per cent in treatment T_1 and T_2, respectively. Though the value for digestibility of DM was higher in T_2 as compared to T_1, the differences between the treatments were statistically non significant (P>0.05). Similar values for DM digestibility (P>0.05) were also reported by Durgaprasad *et al*. (1986) in lambs fed four complete rations by blending groundnut haulms with a conventional concentrate mixture in ratios of 80:20 (56.48%), 60:40 (60.39%), 40:60 (61.13%) and 20:80 (63.37%).

Non significant differences were observed for DM digestibility (52.5 to 59.8%) by Ramaprasad *et al*. (1999) in rams fed four isonitrogenous complete rations and by Aasharekha *et al.* (2005) in lambs fed groundnut haulms. Non significant differences were also observed by Aasharekha *et al.* (2006) for DM digestibility (53.0 – 55.1%) in sheep fed complete rations containing groundnut haulms and concentrates in 60:40 or 70:30 ratios with or without yeast culture product.

Significantly higher (P<0.05) DM digestibility was observed in lambs fed groundnut haulms at 50% (61.8%) or 60% (60.4%) than those fed 70% (58.6%) level in complete rations (Ramaprasad *et al.*, 2000). These values match with the values observed under the present study. Digestibility of DM (60.10 – 64.10%) were reported by Samanta *et al*. (2003) among treatment groups which did not differ significantly when *Leucaena* leaf meal was included by replacing mustard cake in the ration of Barbari goats and by Ramratan (1999) in lambs (61.97%) fed groundnut haulms *ad libitum*. However, slightly lower value for DM digestibility (56.43%) was observed by Raut *et al.* (2002) in non descript male goats fed pelleted complete feed containing 60% *arhar* straw and 40% concentrate mixture in comparison to present study.

In contrast to the present findings, the digestibility of DM was significantly (P<0.01) lower in rams fed groundnut haulms and paddy straw (4:1) based silage (42.87%) than those observed in conventional concentrate and gram straw-based ration (53.47%) fed group (Mandal *et al*., 1999).

4.5.1.2 *Organic matter digestibility*

The average digestibility of organic matter for kids fed TMR is presented in Table 4.17 and the same data are also depicted in Figure 4.8.

Table 4.17: Average digestibility (%) of organic matter for Surti kids fed total mixed ration

Kid No.	Treatments	
	T_1	T_2
1	60.23	62.64
2	63.09	65.41
3	56.80	64.00
4	55.03	65.87
5	65.60	65.00
6	63.98	71.99
7	64.22	64.54
8	55.95	59.94
Av. ±SE	**60.61±1.48**	**64.92±1.21**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment	1	74.2819	74.2819	5.07*
Error	14	205.0427	14.6459	-
Total	15	-	-	-

*= (P<0.05)

The organic matter digestibility was 60.61 and 64.92 % under T_1 and T_2, respectively which showed significantly higher (P<0.05) value in T_2 group as compared to T_1 group. Similar values (P>0.05) for OM digestibility (63.88 – 66.94%) were reported by Samanta *et al*. (2003) in Barbari goats. Rekhate *et al.* (2004) reported significantly higher (P<0.05) OM digestibility (58.4%) in goats fed gram straw based pelleted complete feed in comparison to goats fed *arhar* straw based pelleted complete feed (55.9%) or exclusive *arhar* straw pellets supplemented with concentrate pellets (51.3%) based feed.

Reddy *et al*. (1998) also reported higher values (P<0.01) for OM digestibility (73.53 to 68.59%, respectively) in lambs fed increasing level of sunnhemp hay from 0 to 45% in place of groundnut haulms in complete rations. Higher value for OM digestibility (67.21%) was reported by Ramratan (1999) in rams fed groundnut haulms *ad libitum* in comparison to present study.

In contrast to the present findings, significantly lower OM digestibility was observed in rams fed groundnut haulms and paddy straw (4:1) based silage (57.10%) than those observed in conventional concentrate and gram straw-based ration (60.70%) fed group (Mandal *et al*., 1999).

4.5.1.3 *Crude protein digestibility*

The average digestibility of crude protein for kids fed TMR is presented in Table 4.18 and the same data are also depicted in Figure 4.8.

Table 4.18: Average digestibility (%) of crude protein for Surti kids fed total mixed ration

Kid No.	Treatments	
	T_1	T_2
1	76.46	76.15
2	74.42	72.69
3	65.30	72.13
4	67.94	73.17
5	71.87	73.97
6	86.07	81.04
7	73.27	80.91
8	66.58	72.82
Av. ±SE	**72.74±2.36**	**75.36±1.30**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment	1	27.4800	27.4800	0.95 NS
Error	14	406.2279	29.0163	-
Total	15	-	-	-

NS= Non significant

The crude protein digestibility was found to be 72.74 and 75.36 % in treatment T_1 and T_2, respectively. Though CP digestibility is higher in T_2 than T_1, the differences between the treatments were statistically non significant (P>0.05). Ramaprasad *et al*. (1999) also reported non significant differences for CP digestibility (62.6 to 69.7%) in rams fed four isonitrogenous complete rations. The finding of Aasharekha *et al.* (2006) also revealed non significant differences for CP (55.7 – 57.3%) digestibility in sheep fed complete rations containing groundnut haulms and concentrates in 60:40 or 70:30 ratios with or without yeast culture product. However, Rekhate *et al.* (2004) reported significantly higher (P<0.01) digestibility of CP (72.8%) in goats fed gram straw based pelleted complete feed.

In contrast to the present findings, lower value for CP digestibility (64.88%) was reported by Ramratan (1999) in rams fed groundnut haulms *ad libitum*. Lower values for CP digestibility (P>0.05) was also observed (Ramaprasad *et al.*, 2000) in lambs fed groundnut haulms at 50% (62.3%), 60% (62.1%) or 70% (60.5%) level in complete rations. Similarly, lower values for CP digestibility (P>0.05) were also reported by Durgaprasad *et al*. (1986) in lambs fed four complete rations formulated by blending groundnut haulms with a conventional concentrate mixture in ratios of 80:20 (54.30%), 60:40 (61.12%), 40:60 (59.88%) and 20:80 (57.69%). Reddy *et al*. (1998) also observed similar findings in lambs for CP digestibility (65.29 to 67.53%, respectively). Lower values for digestibility of CP (63.84 – 66.16%) were also reported by Samanta *et al*. (2003) in Barbari goats.

The digestibility of CP was significantly (P<0.01) lowered in rams fed groundnut haulms and paddy straw (4:1) based silage (47.59%) than those fed conventional concentrate and gram straw (57.64%) based ration (Mandal *et al*., 1999). Lower value for CP digestibility (66.37%) was also observed by Raut *et al.* (2002) in non descript male goats fed pelleted complete feed containing 60% *arhar* straw and 40% concentrate mixture. Higher CP digestibility (P>0.05) was reported by Aasharekha *et al.* (2005) in lambs under GNH-YC (37.9%) than those of GNH (31.0%) group. However, significantly higher (P<0.05) CP digestibility was observed by Chopade *et al.* (2010) in kids fed 4% urea treated soybean straw (74.18%) than those fed untreated soybean straw (64.91%) in pelleted complete ration.

4.5.1.4 *Ether extract digestibility*

The average digestibility of ether extract for kids fed TMR is presented in Table 4.19 and the same data are also depicted in Figure 4.8.

Table 4.19: Average digestibility (%) of ether extract for Surti kids fed total mixed ration

Kid No.	Treatments	
	T_1	T_2
1	69.92	78.85
2	75.01	73.01
3	69.97	55.00
4	65.09	60.35
5	73.06	81.41
6	68.14	84.23
7	75.50	82.87
8	71.42	82.62
Av. ±SE	**71.01±1.24**	**74.79±3.96**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment	1	57.0769	57.0769	0.83 NS
Error	14	965.6090	68.9721	-
Total	15	-	-	-

NS= Non significant

The ether extract digestibility was 71.01 and 74.79% under T_1 and T_2, respectively. Though the value for digestibility for EE is higher in T_2 than T_1, the differences between the treatments (P>0.05) were statistically non significant. Slightly lower values for digestibility of EE was observed (Ramaprasad *et al.*, 2000) in lambs fed groundnut haulms at 50% (66.8%), 60% (70.4%) or 70% (72.8%) level in complete rations (P>0.05). Similar value for EE digestibility (74.96%) was observed by Raut *et al.* (2002) in non descript male goats fed pelleted complete feed containing 60% *arhar* straw and 40% concentrate mixture. Lower value for EE digestibility (42.87%) was reported by Ramratan (1999) in rams fed groundnut haulms *ad libitum*. Similarly, lower values for EE digestibility (P>0.05) were reported by Durgaprasad *et al*. (1986) in lambs fed four complete rations formulated by blending groundnut haulms with a conventional concentrate mixture in ratios of 80:20 (59.74%), 60:40 (64.81%), 40:60 (71.98%) and 20:80 (69.47%).

Ramaprasad *et al*. (1999) observed significantly higher (P<0.05) EE digestibility in rams fed groundnut haulms based complete ration (68.8%) than those of *subabul* leaf meal (55.4%) and *Stylo hamata* hay (49.9%) based complete rations. Rekhate *et al.* (2004) also reported significantly higher (P<0.05) digestibility of EE (76.3%) in goats fed gram straw based pelleted complete feed.

Significantly higher (P<0.05) EE digestibility was observed by Chopade *et al.* (2010) in kids fed 4% urea treated soybean straw (84.00%) than those fed untreated soybean straw (75.59%) based pelleted complete ration.

4.5.1.5 *Crude fiber digestibility*

The average digestibility of crude fiber for kids fed TMR is presented in Table 4.20 and the same data are also depicted in Figure 4.8.

Table 4.20: Average digestibility (%) of crude fiber for Surti kids fed total mixed ration

Kid No.	Treatments	
	T_1	T_2
1	46.73	39.37
2	48.66	47.24
3	41.38	47.23
4	43.35	48.02
5	54.84	50.87
6	47.97	61.74
7	46.75	51.32
8	43.46	38.84
Av. ±SE	**46.64±1.48**	**48.08±2.56**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment	1	8.2580	8.2580	0.24 NS
Error	14	489.4393	34.9599	-
Total	15	-	-	-

NS= Non significant

The crude fiber digestibility was 46.64 and 48.08% in treatment T_1 and T_2, respectively. The value of CF digestibility is slightly higher in T_2, but the differences between the treatments were non significant. Lower values for CF digestibility (39.8 – 43.8%) were observed (Ramaprasad *et al.*, 2000) in lambs fed groundnut haulms at different levels (50 – 70%) in complete rations (P>0.05). However, higher value for CF digestibility (53.60%) was reported by Ramratan (1999) in rams fed groundnut haulms *ad libitum*. Higher value for CF digestibility (67.56%) was also observed by Raut *et al.* (2002) in non descript male goats fed pelleted complete feed containing 60% *arhar* straw and 40% concentrate mixture.

Higher values (58.54 to 53.69%, respectively) were also observed in lambs fed complete rations (Reddy *et al*., 1998). The digestibility of CF was lowered linearly (P<0.01) as the level of groundnut haulms decreased in the ration. Higher values for digestibility of CF (55.26 – 61.26%) were reported by Samanta *et al*. (2003) among treatment groups of Barbari goats.

Significantly higher (P<0.05) CF digestibility was observed by Ramaprasad *et al*. (1999) in rams fed groundnut haulms based complete ration (58.3%) than those fed sunnhemp hay (44.6%) and *Stylo hamata* hay (48.1%) based complete rations.

The crude fibre digestibility was also lowered significantly (P<0.05) in lambs fed different levels of groundnut haulms in complete rations as reported earlier by Durgaprasad *et al*. (1986).

4.5.1.6 *NFE digestibility*

The average digestibility of nitrogen free extract for kids fed TMR is presented in Table 4.21 and the same data are also depicted in Figure 4.8.

Table 4.21: Average digestibility (%) of nitrogen free extract for Surti kids fed total mixed ration

Kid No.	Treatments	
	T_1	T_2
1	54.18	58.60
2	59.01	61.64
3	51.18	61.13
4	48.00	63.43
5	61.35	60.13
6	59.98	67.69
7	60.67	58.68
8	49.43	54.61
Av. ±SE	**55.47±1.92**	**60.74±1.36**

ANOVA

SV	df	SS	MSS	Cal. F
Treatment	1	110.8985	110.8985	5.01*
Error	14	310.1064	22.1505	-
Total	15	-	-	-

*= (P<0.05)

The NFE digestibility for treatment T_1 and T_2 was found to be 55.47 and 60.74%, respectively. Significantly higher (P<0.05) value was observed for T_2 as compared to T_1. Similar values for digestibility of NFE (59.67 – 64.12%) were reported by Samanta *et al*. (2003) in Barbari goats fed complete rations. Higher value for NFE digestibility (73.06%) was reported by Ramratan (1999) in rams fed groundnut haulms *ad libitum*. Higher values were also reported by Durgaprasad *et al*. (1986) in lambs fed groundnut haulms based four complete rations formulated by blending with a conventional concentrate mixture in ratios of 80:20 (70.60%), 60:40 (78.37%), 40:60 (79.69%) and 20:80 (82.09%). Significantly higher (P<0.05) digestibility of NFE was observed (Ramaprasad *et al.*, 2000) in lambs fed groundnut haulms at 50% (75.9%) or 60% (74.3%) than those fed 70% (71.9%) level in complete rations. Non significant differences were observed for NFE digestibility (58.5 to 69.1%) by Ramaprasad *et al*. (1999) in rams fed four isonitrogenous complete rations.

In contrast to the present findings, the digestibility of NFE was significantly (P<0.01) lowered in rams fed groundnut haulms and paddy straw (4:1) based silage (59.82%) than those observed in conventional concentrate and gram straw-based ration (67.94%) fed group (Mandal *et al*., 1999). Lower value for NFE digestibility (45.64%) was also observed by Raut *et al.* (2002) in non descript male goats fed pelleted complete feed containing 60% *arhar* straw and 40% concentrate mixture.

The present findings suggested that Surti kids fed *jowar* hay + groundnut haulms based TMR (T_2) digested nutrients more efficiently as there was improvement in digestibility of all nutrients.

4.5.2 Nutrients intake

4.5.2.1 *Crude protein intake*

The average data on daily CP intake during experimental period and during digestion trial by kids fed TMR under two treatment groups are presented in Table 4.22. The same data are depicted in Figure 4.9.

Table 4.22: Average daily crude protein intake for Surti kids fed total mixed ration

Kid No.	During experimental period				During digestion trial			
	g		g/kg $W^{0.75}$		g		g/kg $W^{0.75}$	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
1	54	44	8.65	9.25	65	43	9.65	8.71
2	64	60	8.63	8.94	89	77	11.10	10.83
3	70	60	9.70	10.17	83	81	10.91	12.70
4	67	49	8.82	7.50	76	85	9.36	12.40
5	67	56	9.80	10.22	79	78	10.81	12.98
6	49	65	8.10	9.45	56	75	8.53	10.54
7	68	46	9.62	7.34	77	65	10.03	10.12
8	56	58	11.17	9.05	50	64	9.14	9.25
Av. ±SE	**61.95 ±2.68**	**54.61 ±2.69**	**9.31 ±0.34**	**8.99 ±0.38**	**71.67 ±4.81**	**71.01 ±4.72**	**9.94 ±0.33**	**10.94 ±0.57**

ANOVA

SV	df	During experimental period				During digestion trial			
		g		g/kg $W^{0.75}$		g		g/kg $W^{0.75}$	
		MSS	Cal.F	MSS	Cal.F	MSS	Cal.F	MSS	Cal.F
Treatment	1	215.73	3.74NS	0.41	0.39NS	1.73	0.01NS	4.00	2.31NS
Error	14	57.68	-	1.05	-	181.74	-	1.73	-
Total	15	-	-	-	-	-	-	-	-

NS= Non significant

The average daily CPI (Table 4.22) during the experimental period was 61.95 and 54.61 g under T_1 and T_2, respectively, being higher in T_1 as compared to T_2 but statistically the differences were non significant (P>0.05). Non significant differences were also observed for CPI on metabolic body weight basis (9.31 and 8.99 g/kg $W^{0.75}$ under T_1 and T_2, respectively) during the experimental period. During digestion trial, the daily CPI was 71.67 and 71.01 g (P>0.05) under T_1 and T_2, respectively. Slightly higher value for CPI on metabolic body weight was observed for T_2 (10.94 g/kg$W^{0.75}$) than T_1 (9.94 g/kg$W^{0.75}$) during digestion trial, but the differences were statistically non significant (P>0.05).

Higher values were observed for daily CP intake (12.20 g/kg $W^{0.75}$) by Ramratan (1999) in rams (29.8 kg body weight) fed groundnut haulms *ad libitum*. The groundnut haulms and paddy straw (4:1) based silage fed rams consumed significantly (P<0.01) higher CP (7.79 g/kg $W^{0.75}$) than the corresponding value on conventional concentrate and gram straw-based ration (5.03 g/kg $W^{0.75}$) as reported by Mandal *et al*. (1999).

4.5.2.2 *Digestible crude protein (DCP) intake*

The average data on daily DCP intake during experimental period and during digestion trial by kids fed TMR under two treatments are presented in Table 4.23. The same data are depicted in Figure 4.9.

Table 4.23: Average daily digestible crude protein intake for Surti kids fed total mixed ration

Kid No.	During experimental period				During digestion trial			
	g		g/kg $W^{0.75}$		g		g/kg $W^{0.75}$	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
1	39	33	6.29	6.97	49	33	7.38	6.63
2	47	45	6.28	6.74	66	56	8.26	7.87
3	51	45	7.05	7.66	54	59	7.13	9.16
4	49	37	6.42	5.65	52	62	6.36	9.07
5	49	42	7.13	7.70	57	58	7.77	9.60
6	36	49	5.89	7.12	48	61	7.34	8.54
7	50	35	7.00	5.53	57	53	7.35	8.18
8	41	44	8.13	6.82	33	46	6.09	6.73
Av. ±SE	**45.06 ±1.95**	**41.15 ±2.03**	**6.77 ±0.25**	**6.78 ±0.29**	**51.90 ±3.33**	**53.39 ±3.40**	**7.21 ±0.25**	**8.22 ±0.39**

ANOVA

SV	df	During experimental period				During digestion trial			
		g		g/kg $W^{0.75}$		g		g/kg $W^{0.75}$	
		MSS	Cal.F	MSS	Cal.F	MSS	Cal.F	MSS	Cal.F
Treatment	1	61.19	1.93NS	0.00002	0.00004NS	8.83	0.10NS	4.14	4.85*
Error	14	31.65	-	0.58	-	90.63	-	0.85	-
Total	15	-	-	-	-	-	-	-	-

*= (P<0.05), NS= Non significant

The daily DCP intake for Surti kids fed TMR was 45.06 & 41.15 g and 6.77 & 6.78 g/kgW$^{0.75}$ under T_1 and T_2, respectively during experimental period (P>0.05). However, during digestion trial the daily DCP intake was 51.90 & 53.39 g (P>0.05) and 7.21 & 8.22 g/kgW$^{0.75}$ (P<0.05) under T_1 and T_2, respectively.

Significantly higher (P<0.05) intake of DCP was observed (Ramaprasad *et al.*, 2000) in lambs (14.2 kg) fed groundnut haulms at level 50% (47.5 g/d) than those fed 60% (40.3 g/d) or 70% (39.7 g/d) in complete rations. Aasharekha *et al.* (2005) reported higher (P<0.01) DCP intake in rams under GNH-YC (45.2 g/d) than those of GNH (27.7 g/d) group. Similar values were observed in lambs (16.7 kg) for DCP intake (42.22 to 43.77 g/d, respectively; P>0.05) when they gradually increased the level of sunnhemp hay from 0 to 45% in place of groundnut haulms in complete rations (Reddy *et al*., 1998).

The daily DCP intake (88.9, 82.6, 81.2 and 86.4 g under 60:40, 70:30, without YCP and with YCP supplementation, respectively) was higher (P<0.01) in sheep fed 60:40 diet without YCP and was also higher (P<0.05) in YCP supplemented group, however, the daily DCP intake on metabolic body weight basis (6.5 – 6.8 g/kgW$^{0.75}$) was comparable among the treatments as reported by Aasharekha *et al*. (2006). Higher value was also observed for DCP intake (66.58 g/d) by Raut *et al.* (2002) in non descript male goats (8.42 months; 17.18 kg BW) fed pelleted complete feed containing 60% *arhar* straw and 40% concentrate mixture. Higher values for DCP intake may be because of higher body weight of the animals under these studies.

The groundnut haulms and paddy straw (4:1) based silage fed rams consumed significantly (P<0.01) higher DCP 3.71g/kg $W^{0.75}$ (Mandal *et al*., 1999) than the corresponding value on conventional concentrate and gram straw-based ration (2.90g/kg $W^{0.75}$). Samanta *et al*. (2003) also reported the lower value for DCP intake as 3.14 – 3.41 g/kg $W^{0.75}$ when *Leucaena* leaf meal was included by replacing mustard cake in the ration of Barbari goats. These research workers reported lower values for DCP intake in comparison to the values observed under the present study.

4.5.2.3 *Total digestible nutrients (TDN) intake*

The average data on daily TDN intake during experimental period and during digestion trial by kids fed TMR under two treatments are presented in Table 4.24. The same data are depicted in Figure 4.9.

Table 4.24: Average daily total digestible nutrients intake for Surti kids fed total mixed ration

Kid No.	During experimental period				During digestion trial			
	g		g/kg $W^{0.75}$		g		g/kg $W^{0.75}$	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
1	242	198	38.58	41.87	253	173	37.87	34.66
2	286	270	38.52	40.48	401	323	50.07	45.63
3	311	269	43.25	46.05	318	338	41.95	52.74
4	299	221	39.35	33.96	287	356	35.37	52.06
5	298	252	43.74	46.29	379	348	52.09	58.00
6	220	296	36.13	42.80	244	380	37.36	53.37
7	304	208	42.90	33.23	336	296	43.70	45.87
8	250	265	49.83	40.99	206	253	37.76	36.71
Av. ±SE	**276.37 ±11.95**	**247.24 ±12.19**	**41.54 ±1.53**	**40.71 ±1.73**	**303.01 ±24.01**	**308.31 ±23.83**	**42.02 ±2.20**	**47.38 ±2.93**

ANOVA

SV	df	During experimental period				During digestion trial			
		g		g/kg $W^{0.75}$		g		g/kg $W^{0.75}$	
		MSS	Cal.F	MSS	Cal.F	MSS	Cal.F	MSS	Cal.F
Treatment	1	3392.6	2.91NS	2.76	0.13NS	112.5	0.02NS	114.89	2.14NS
Error	14	1165.3	-	21.23	-	4576.9	-	53.60	-
Total	15	-	-	-	-	-	-	-	-

NS= Non significant

The average daily TDN intake for kids fed TMR was 276.37 & 247.24 g (P>0.05) and 41.54 & 40.71 g/kgW$^{0.75}$ (P>0.05) under T_1 and T_2, respectively during experimental period. During digestion trial, the daily TDN intake was 303.01 & 308.31 g and 42.02 & 47.38 g/kgW$^{0.75}$ under T_1 and T_2, respectively which did not differ significantly. However, significantly higher (P<0.05) intake of TDN was observed by Ramaprasad *et al*. (2000) in lambs (14.2 kg) fed groundnut haulms at 50% (37.6 g/kgW$^{0.75}$) or 60% (34.0 g/kgW$^{0.75}$) level than those fed 70% (30.1 g/kgW$^{0.75}$) in complete rations. These values are slightly lower than the values observed under the present study.

Higher values for daily TDN intake (66.94 g/kg W$^{0.75}$) were observed by Ramratan (1999) in rams (29.8 kg body weight) fed groundnut haulms *ad libitum*. Higher values for TDN intake (332 to 356 g/d, respectively) were also observed in lambs (16.7 kg) when Reddy *et al*. (1998) gradually increased the level of sunnhemp hay from 0 to 45% in place of groundnut haulms in complete rations. Raut *et al.* (2002) also reported higher value for TDN intake (410.06 g/d) in non descript male goats (8.42 months; 17.18 kg BW) fed pelleted complete feed containing 60% *arhar* straw and 40% concentrate mixture. However, Samanta *et al*. (2003) reported the lower value for TDN intake as 31.82 – 34.33 g/kg W$^{0.75}$ when *Leucaena* leaf meal was included by replacing mustard cake in the ration of Barbari goats.

These findings suggested that CP, DCP and TDN intake in Surti kids were within the normal range reported in literature.

4.6 FEED CONVERSION EFFICIENCY:

4.6.1 Dry matter and organic matter intake (kg) per kg weight gain

Minimum requirement of nutrient per kg gain along with optimum growth rate in animals is a desirable feature of livestock production. For the calculation of feed intake per kg body weight gain, the total dry matter intake was calculated. It was divided by total weight gain and DM intake per kg gain was worked out. In the same way, OM intake per kg gain was worked out. The data for dry matter and organic matter required per kg gain in weight are presented in Table 4.25 along with ANOVA.

Table 4.25: Dry matter and organic matter intake kg per kg weight gain for Surti kids fed total mixed ration

Kid No.	DM intake kg/kg gain		OM intake kg/kg gain	
	T_1	T_2	T_1	T_2
1	10.31	7.82	8.88	6.83
2	7.54	5.83	6.49	5.10
3	8.86	6.42	7.63	5.61
4	7.31	6.14	6.30	5.37
5	9.99	6.33	8.61	5.53
6	7.60	9.76	6.55	8.53
7	8.90	7.24	7.67	6.32
8	9.81	7.47	8.45	6.52
Av. ±SE	**8.79±0.42**	**7.13±0.45**	**7.57±0.36**	**6.23±0.39**

ANOVA

SV	df	DM intake kg/kg gain		OM intake kg/kg gain	
		MSS	Cal. F	MSS	Cal. F
Treatment	1	11.0406	7.26*	7.2666	6.34*
Error	14	1.5206	-	1.1462	-
Total	15	-	-	-	-

*= (P<0.05)

The data given in Table 4.25 revealed that kids required 8.79 & 7.13 kg dry matter and 7.57 & 6.23 kg organic matter per kg weight gain under treatments T_1 and T_2, respectively. The treatment differences were found to be significant (P<0.05). These data suggested that kids fed *jowar* hay + groundnut haulms based TMR (T_2) required 1.66 kg less (18.89%) DM and 1.34 kg less (17.70%) OM per kg gain in weight in comparison to kids fed *jowar* hay based TMR (T_1).

Lambs fed complete rations containing groundnut haulms at 50% (10.41 kg) or 60% (10.80 kg) level required less DM (Ramaprasad *et al*., 2000) per unit gain (P>0.05) in comparison to lambs fed 70% (11.80 kg). Durgaprasad *et al*. (1986) reported average feed/gain ratio of 14.66, 11.65, 9.94 and 7.53, respectively in lambs (11.16 kg BW) fed four complete rations prepared by blending groundnut haulms with a conventional concentrate mixture in ratios of 80:20, 60:40, 40:60 and 20:80. The average feed/gain ratio was superior (P<0.05) in lambs fed 40:60 or 20:80 than those fed 80:20.

The feed conversion efficiency (DMI kg/kg gain) in non-descript local goats (21.8 kg BW) was 16.7, 15.2 and 19.0 kg under ASCF, GSCF and AS-CONC groups, respectively as observed by Rekhate *et al.* (2004). The data observed by Ravi and Ramaprasad (2005) for feed conversion efficiency (DMI/kg gain) in kids under C, GH, LL, SG, GM and FB were 13.6, 13.7, 13.3, 11.7, 12.5 and 16.4 kg, respectively and the same values for SIS and IS were 11.6 and 15.4 kg, respectively.

The feed conversion efficiency (DMI kg/kg gain) was significantly (P<0.01) higher in local kids (16.35 kg BW) fed pelleted complete feed containing 9% DCP and 55% TDN (9.9) than those containing 7% DCP and 60% TDN (10.8) as observed by Dhore *et al*. (2005). Similar data for feed conversion efficiency were also reported by Dhore *et al*. (2006) in local kids. Significantly higher (P<0.01) feed conversion efficiency (DMI kg/kg gain) was also observed by Bhadane *et al.* (2004) in local goats (122 d old) fed pelleted complete feed having 12% CP (13.4 kg) than those having 14% CP (11.8 kg) and containing *arhar* straw as a sole roughage. Wadhwani *et al*. (2010) reported higher (P<0.05) DM intake (kg/kg gain) for lambs under non conventional group (10.90 and 13.16 under TMR-II and TMR-III, respectively) than that of conventional group (8.10 for TMR-I).

The values observed by different workers for feed conversion efficiency are higher than the values observed under the present study.

4.6.2 CP, DCP and TDN intake (kg) per kg weight gain

The crude protein intake (kg) per kg gain was calculated from the average weekly feed intake and average crude protein contents of TMR fed to the kids. Likewise, the DCP and TDN intake (kg) per kg weight gain was worked out. These data are presented in Table 4.26 along with statistical analysis.

Table 4.26: Crude protein, digestible crude protein and total digestible nutrients intake kg per kg weight gain for Surti kids fed total mixed ration

Kid No.	CPI kg/kg gain		DCPI kg/kg gain		TDNI kg/kg gain	
	T_1	T_2	T_1	T_2	T_1	T_2
1	1.19	0.98	0.87	0.74	5.31	4.42
2	0.87	0.73	0.63	0.55	3.88	3.30
3	1.02	0.80	0.74	0.60	4.56	3.63
4	0.84	0.77	0.61	0.58	3.76	3.47
5	1.15	0.79	0.84	0.60	5.14	3.58
6	0.88	1.22	0.64	0.92	3.91	5.52
7	1.03	0.90	0.75	0.68	4.58	4.09
8	1.13	0.93	0.82	0.70	5.05	4.22
Av. ±SE	**1.01 ±0.05**	**0.89 ±0.06**	**0.74 ±0.04**	**0.67 ±0.04**	**4.52 ±0.22**	**4.03 ±0.25**

ANOVA

SV	df	CPI kg/kg gain		DCPI kg/kg gain		TDNI kg/kg gain	
		MSS	Cal. F	MSS	Cal. F	MSS	Cal. F
Treatment	1	0.0616	2.78 NS	0.0179	1.47 NS	0.9758	2.18 NS
Error	14	0.0221	-	0.0122	-	0.4472	-
Total	15	-	-	-	-	-	-

NS= Non significant

The data presented in Table 4.26 revealed that 1.01 and 0.89 kg crude protein was required per kg gain in weight by Surti kids under treatment T_1 and T_2, respectively. The kids fed *jowar* hay + groundnut haulms based TMR (T_2) required 11.88% less CP per kg gain in weight in comparison to kids fed only *jowar* hay based TMR (T_1), but the treatment differences were non significant (P>0.05). The DCP (kg) required per kg weight gain was 0.74 and 0.67 under T_1 and T_2, respectively. The kids under T_2 group required 9.46% less DCP per kg gain in weight in comparison to kids under T_1 group and the treatment differences were also non significant (P>0.05). However, the TDN (kg) required per kg weight gain was 4.52 and 4.03 under T_1 and T_2, respectively. Similarly, the kids under T_2 group required 10.84% less TDN per kg gain in weight in comparison to kids under T_1 group and the treatment differences were non significant (P>0.05).

Durgaprasad *et al*. (1986) reported values for gain per kg protein intake as 0.71, 0.84, 0.93 and 1.14 kg in lambs (11.16 kg body weight) fed 80, 60, 40 and 20% level of groundnut haulms in complete ration, respectively. The DCP and TDN intake (kg/kg gain) was 1.11 & 5.09; 1.14 & 5.83 and 1.35 & 7.13 in lambs fed TMR-I, TMR-II and TMR-III, respectively and the treatment did not differ from each other as reported by Wadhwani *et al*. (2010).

The present findings suggested that Surti kids required less DM, OM and nutrients per unit gain in weight as the kids utilized nutrients efficiently especially when groundnut haulms was incorporated along with *jowar* hay.

4.7 ECONOMICS OF FEEDING:

In present study, the economics of feeding in terms of `/d/kid and `/kg gain was calculated from the records of TMR consumption and considering the actual price of feeds and fodder used to prepare TMR and total gain in body weight during experimental period.

4.7.1 Cost of feeding (`/d/kid and `/kg gain)

The results of average cost of feeding `/d/kid and `/kg gain are given in Table 4.27 along with ANOVA and the same are depicted in Figure 4.10.

Table 4.27: Cost of feeding (`/d/kid and `/kg gain) for Surti kids fed total mixed ration

Kid No.	`/d/kid		`/kg gain	
	T_1	T_2	T_1	T_2
1	4.81	3.06	105.43	68.27
2	5.67	4.15	76.81	50.75
3	6.17	4.15	90.39	55.89
4	5.93	3.41	74.70	53.69
5	5.92	3.87	102.10	55.04
6	4.39	4.55	77.87	84.88
7	6.03	3.20	91.01	62.96
8	4.99	4.07	100.56	64.85
Av. ±SE	**5.49±0.23**	**3.81±0.19**	**89.86±4.33**	**62.04±3.90**

ANOVA

SV	df	`/d/kid		`/kg gain	
		MSS	Cal. F	MSS	Cal. F
Treatment	1	11.3199	31.55**	3095.2457	22.74**
Error	14	0.3588	-	136.1050	-
Total	15	-	-	-	-

**= (P<0.01)

The data given in Table 4.27 revealed that average daily feed cost was ` 5.49 and 3.81 respectively, under $T_1$ and $T_2$. The treatment differences were highly significant (P<0.01) with 30.60% less cost per day in kids fed groundnut haulms based TMR ($T_2$) in comparison to kids fed control TMR ($T_1$). The average cost of feed (`) per kg gain was 89.86 and 62.04 under treatment T_1 and T_2, respectively. Similarly, the treatment differences were highly significant (P<0.01) with 30.96% less cost per kg gain in kids fed groundnut haulms based TMR (T_2) in comparison to kids fed control TMR (T_1).

More or less similar values for the cost of feeding (`/kg gain) were observed by Ravi and Ramaprasad (2005) in kids under C (80.5), GH (60.2), LL (57.9), SG (51.5), GM (55.2) and FB (76.3) groups and the same under SIS and IS was 48.1 and 79.1, respectively. The values under C and FB groups were significantly (P<0.05) higher than the other groups.

Durgaprasad *et al*. (1986) evaluated the feed cost (`/kg gain) as 9.44, 9.18, 9.27 and 8.10 (P>0.05) for the lambs fed complete rations containing 80, 60, 40 and 20% level of groundnut haulms. It was concluded that a complete ration formulated with groundnut haulms and a conventional concentrate mixture in the ratio of 40:60 was superior and economical to other complete rations. Wadhwani *et al*. (2010) reported the feed cost (`/kg live weight) in lambs was having significantly higher (P<0.05) value for TMR-I (63.26) than those of TMR-II (35.90) and TMR-III (39.72). Lambs fed non conventional feed based TMR had similar live weights in comparison to those fed conventional TMR but cost less to achieve those weights.

The findings of present experiment suggested that kids fed *jowar* hay + groundnut haulms based TMR (T_2) required 18.89% less dry matter, 17.70% less organic matter, 11.88% less CP, 9.46% less DCP and 10.84% less TDN per kg gain in weight in comparison to kids fed control TMR (T_1). The data on economics of feeding revealed that kids fed groundnut haulms based TMR can be raised economically as there is 30.96% reduction in feed cost per kg gain in weight in comparison to kids fed control TMR (T_1).

Therefore it is concluded that feeding of groundnut haulms based TMR is found economical in raising Surti kids under the present study.

Chapter- V

SUMMARY AND CONCLUSIONS

The present study on Surti kids was conducted at Animal Nutrition Research Department, College of Veterinary Science and Animal Husbandry, Anand Agricultural University, Anand, to know the effect of feeding *jowar* hay and *jowar* hay + groundnut haulms based TMR on their growth performance with following objectives:

- To study the effect of TMR based on *jowar* hay and *jowar* hay + groundnut haulms on **voluntary feed intake**.
- To study the effect of TMR based on *jowar* hay and *jowar* hay + groundnut haulms on **body weight gain**.
- To study the effect of TMR based on *jowar* hay and *jowar* hay + groundnut haulms on **rumen fermentation pattern**.
- To study the effect of TMR based on *jowar* hay and *jowar* hay + groundnut haulms on **digestibility of nutrients.**
- To study the effect of TMR based on *jowar* hay and *jowar* hay + groundnut haulms on **nutrient utilization** and **feed conversion efficiency**.
- To workout **cost of feeding**.

The present experiment was conducted on sixteen growing Surti kids of 4.5 – 9 months of age in the beginning of the experiment. The kids were randomly divided into two groups (T_1 and T_2) of eight each following completely randomized design considering their age, body weight and body measurements. The kids under control group (T_1) were fed *jowar* hay based TMR whereas the kids under treatment group (T_2) were fed *jowar* hay + groundnut haulms based TMR. The kids were adopted for respective feed for minimum fifteen days. Individual feeding of all the kids was carried out during the study period of 12 weeks. Quantity of TMR offered was adjusted at weekly interval according to change in body weight and growth rate of kids. The required quantity of TMR was offered in two installments *i.e.* half in morning and half in evening. The nutrient requirements of kids in term of DCP and TDN were met as per ICAR (1998) feeding standards.

During the experimental feeding period, observations for body weight at weekly interval and body measurement at biweekly interval were recorded for three consecutive days before feeding and watering. The data for daily dry matter intake, DCP intake, TDN intake, feed conversion efficiency and cost of feeding were calculated. The digestion trial was conducted on all the kids once during the experimental period. Rumen liquor samples were collected from three kids in each treatment once at the end of experiment to know the effect of feeding *jowar* hay and *jowar* hay + groundnut haulms based TMR on rumen metabolites.

5.1 GROWTH STUDIES:

The total body weight gain and average daily weight gain of kids during 12 weeks of experimental period were similar under both the treatment groups. The differences between the treatment groups for body weight gain and average daily weight gain ($P>0.05$) were non significant. Similarly, the average gain in height at withers, body length and heart girth for both the groups were almost similar and differences were non significant. The results indicated that feeding of *jowar* hay + groundnut haulms based TMR have not shown any adverse effect on the growth of Surti kids.

5.2 DRY MATTER AND ORGANIC MATTER INTAKE:

The dry matter intake of kids under T_1 (536.84 g/d) group was significantly higher ($P<0.01$) than T_2 (437.21 g/d) group. The dry matter intake as % of body weight and on metabolic body weight basis was higher in T_1 group than T_2 group, but the differences were statistically non significant. The daily organic matter intake was also higher ($P<0.05$) for T_1 (462.70 g) than T_2 (381.99 g). The values for organic matter intake as % of body weight and on metabolic body weight basis were higher ($P>0.05$) under T_1 than T_2.

5.3 RUMEN FERMENTATION PATTERN:

The results for rumen fermentation pattern revealed that average pH value was significantly higher ($P<0.01$) for T_2 (6.44) as compared to T_1 (6.20). However, there was non significant difference for the average TVFA values in both the groups. The average values of ammonia-N, total-N and protein-N concentrations under T_2 (23.43, 108.27 and 58.43 mg/dl) were higher than that of T_1 (21.84, 96.44 and 40.69 mg/dl), however, the treatment differences ($P>0.05$) for the same were non significant. The average concentration of NPN in SRL was significantly higher ($P<0.01$) in T_2 (64.46 mg/dl) as compared to T_1 (55.75 mg/dl).

5.4 DIGESTIBILITY AND NUTRIENTS INTAKE:

The digestibilities of dry matter, crude protein, ether extract and crude fiber were found to be somewhat higher under treatment group (T_2) than control group (T_1), however, the treatment differences were non significant. The digestibilities of organic matter and nitrogen free extract were significantly higher ($P<0.05$) under T_2 group (64.92 and 60.74%, respectively) as compared to T_1 group (60.61 and 55.47%, respectively).

The data on nutrients intake indicated that kids under T_1 group consumed more amount of nutrients (CP, DCP and TDN) than T_2 group, however, the treatment differences were non significant. The nutrients intakes on metabolic body weight basis were almost similar under both the treatments with statistically non significant differences.

5.5 FEED CONVERSION EFFICIENCY:

Feed conversion efficiency was calculated as dry matter and nutrients required per kg weight gain. The DM required per kg weight gain was 8.79 and 7.13 kg in T_1 and T_2, respectively. The feed conversion efficiency was superior under T_2 than T_1 and the treatment differences were statistically significant ($P<0.05$). The values for CP, DCP and TDN intake per kg weight gain were 1.01, 0.74 and 4.52 kg in control group (T_1) and 0.89, 0.67 and 4.03 kg in treatment group (T_2), respectively, however, the treatment differences were statistically non significant. These data suggested that kids fed *jowar* hay + groundnut haulms based TMR required less nutrients per gain in comparison to kids fed *jowar* hay based TMR.

5.6 ECONOMICS OF FEEDING:

Economics of feeding was worked out from the data of feed consumption and unit price of different feeds and fodder and the cost of feed per day and per kg gain were calculated. The daily feed cost was ` 5.49 and 3.81 under $T_1$ and $T_2$, respectively ($P<0.01$) which was 30.60% lower in $T_2$ in comparison to $T_1$. The cost of feed ` per kg gain was 89.86 and 62.04 under T_1 and T_2 respectively ($P<0.01$). The cost of feed ` per kg gain was reduced to the value of 30.96% by incorporation of groundnut haulms at 30% in TMR.

CONCLUSIONS:

The groundnut haulms are available in enormous quantities in Gujarat state as well as throughout the country. Feeding of groundnut haulms may be useful for kids to attain slaughter weight at cheaper cost and to get better economic returns.

The following conclusions are drawn:

1) The results indicated that the growth rate and total increase in body weight were similar under control (T_1) and treatment (T_2) groups, hence *jowar* hay + groundnut haulms based TMR can be fed to Surti kids.

2) The kids under treatment (T_2) group consumed significantly less ($P<0.01$) DM than the kids under control (T_1) group.
3) The concentrations of rumen metabolites were almost similar for control (T_1) and treatment (T_2) groups, expect for pH and NPN, which were significantly higher ($P<0.01$) under T_2 group.
4) Digestibility of nutrients (OM and NFE) was improved significantly ($P<0.05$) by feeding *jowar* hay + groundnut haulms based TMR under present feeding experiment. However, non significant differences were observed for the digestibilities of the other nutrients. Non significant differences were also observed for the nutrients intake.
5) Feed and nutrient utilization efficiency in kids fed *jowar* hay + groundnut haulms based TMR (T_2) was superior to that of kids fed control TMR (T_1). The findings of present experiment suggested that kids fed *jowar* hay + groundnut haulms based TMR (T_2) required 18.89% less dry matter, 17.70% less organic matter, 11.88% less CP, 9.46% less DCP and 10.84% less TDN per kg gain in weight in comparison to kids fed control TMR (T_1).
6) The daily feed cost and cost per kg gain were lower in kids (T_2) fed *jowar* hay + groundnut haulms based TMR than control (T_1) suggesting that feeding of *jowar* hay + groundnut haulms based TMR is economically beneficial.

The daily feed cost was 30.60% less in T_2 in comparison to T_1. The cost of feed ` per kg gain was reduced 30.96% by incorporation of groundnut haulms at 30% in TMR by replacing *jowar* hay.

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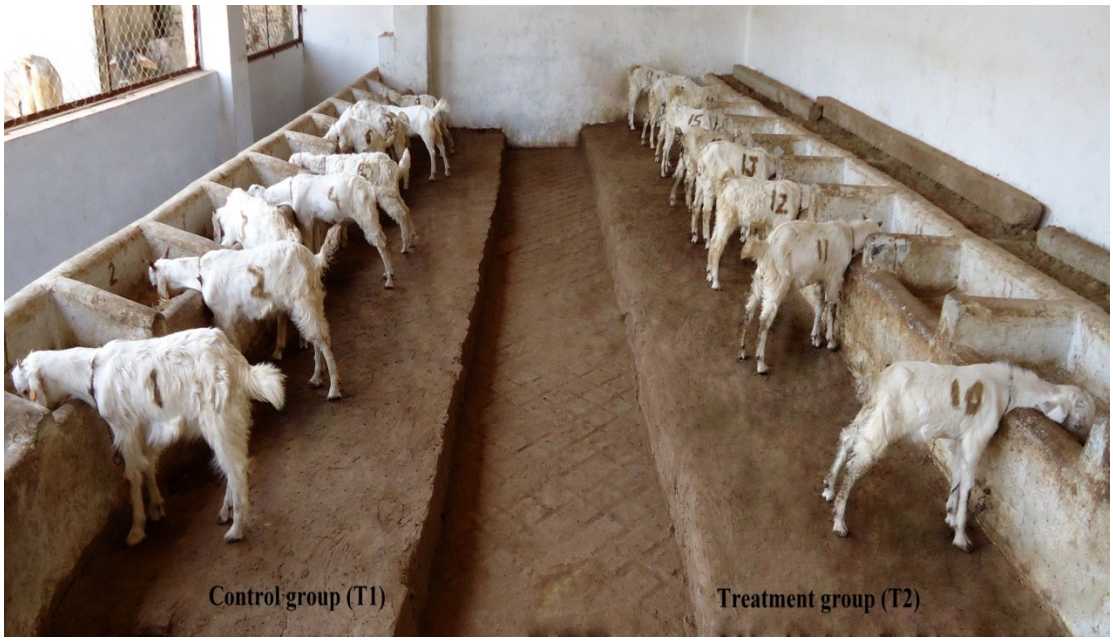
Plate 3.3: Recording of body weight and body measurements of Surti kids fed TMR

Recording body weight

Recording body measurement

Plate 3.1: Surti kids under TMR feeding experiment



Before experiment

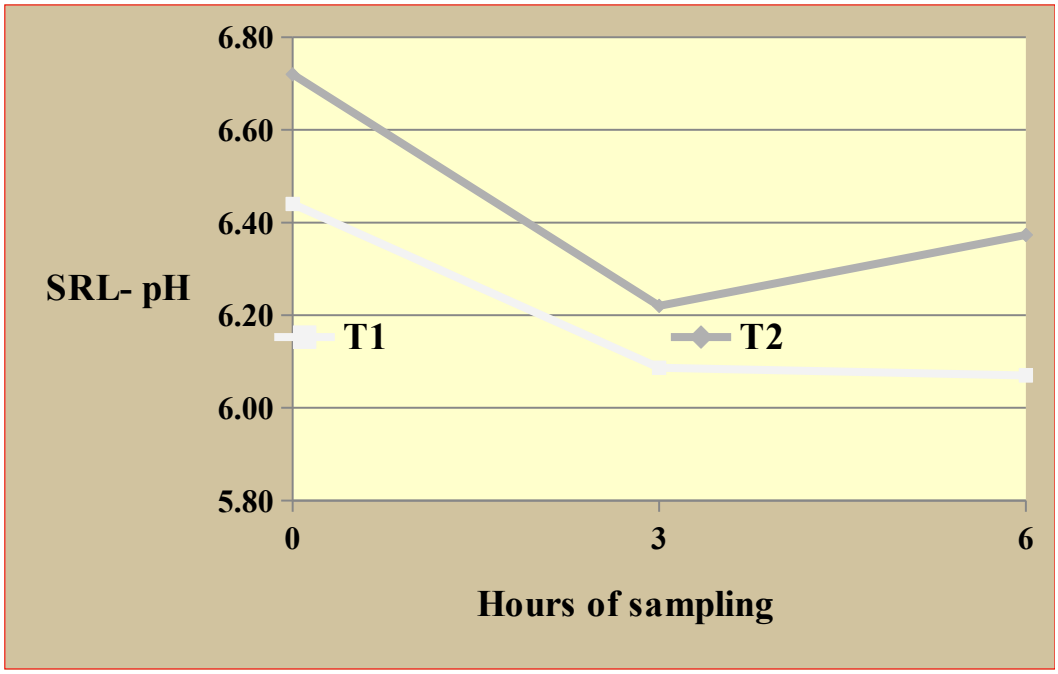
After experiment

Plate 3.2: Feeding of Surti kids

Plate 3.5: Rumen liquor collection from Surti kids fed TMR

Plate 3.4: Digestibility trial of Surti kids fed TMR

Figure 4.6: Average periodical changes in SRL- pH and TVFA of Surti kids fed TMR



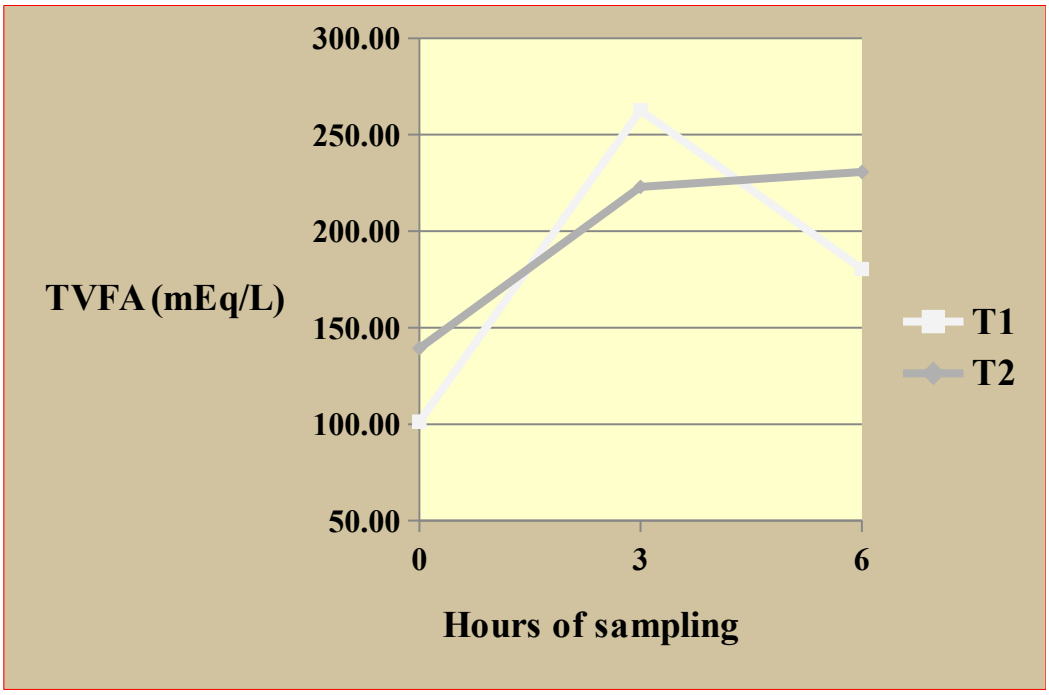
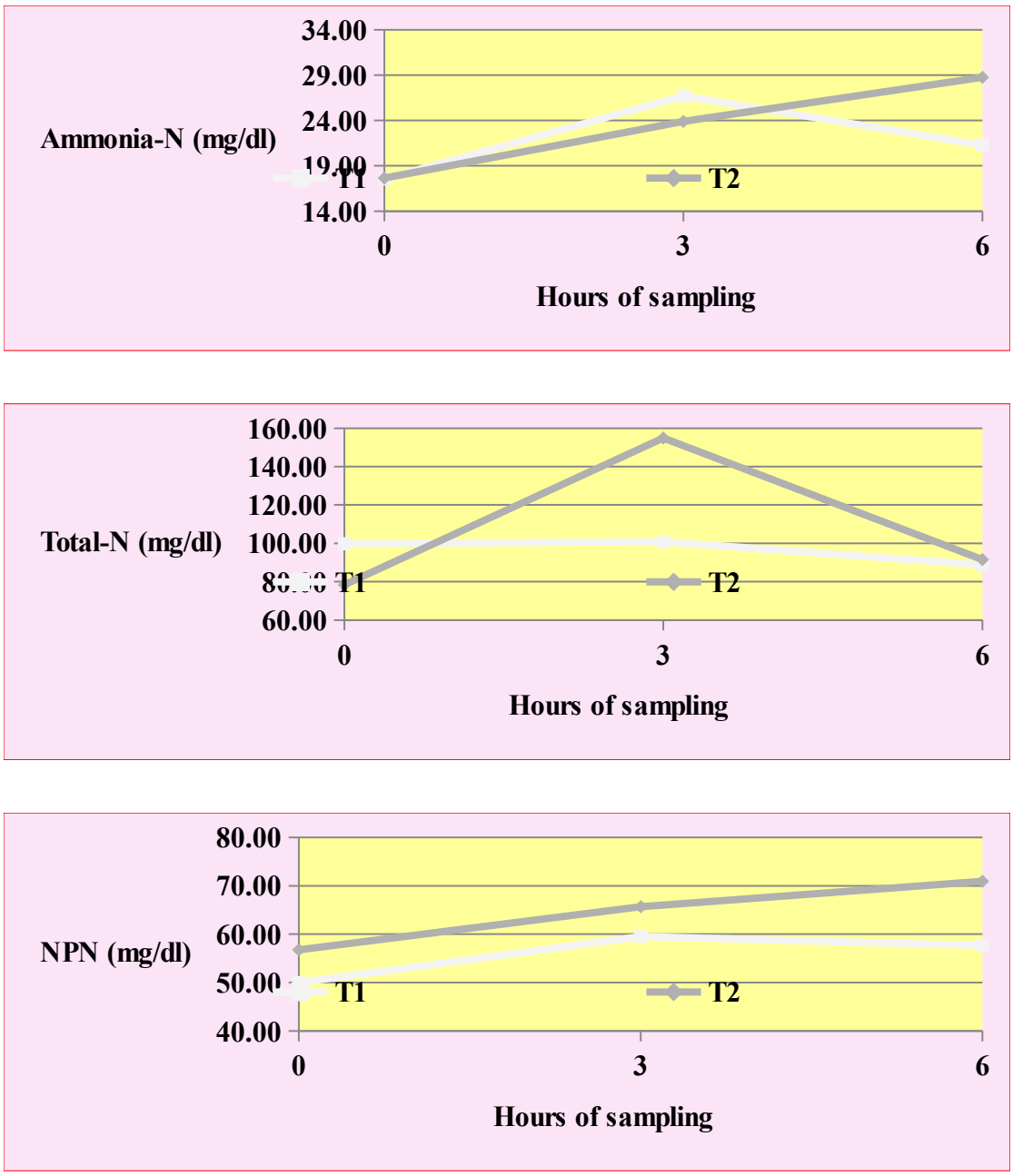
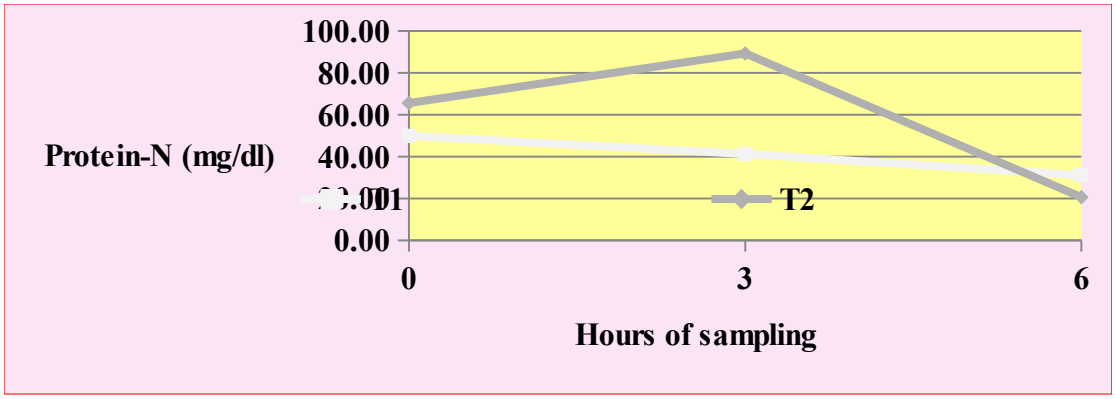


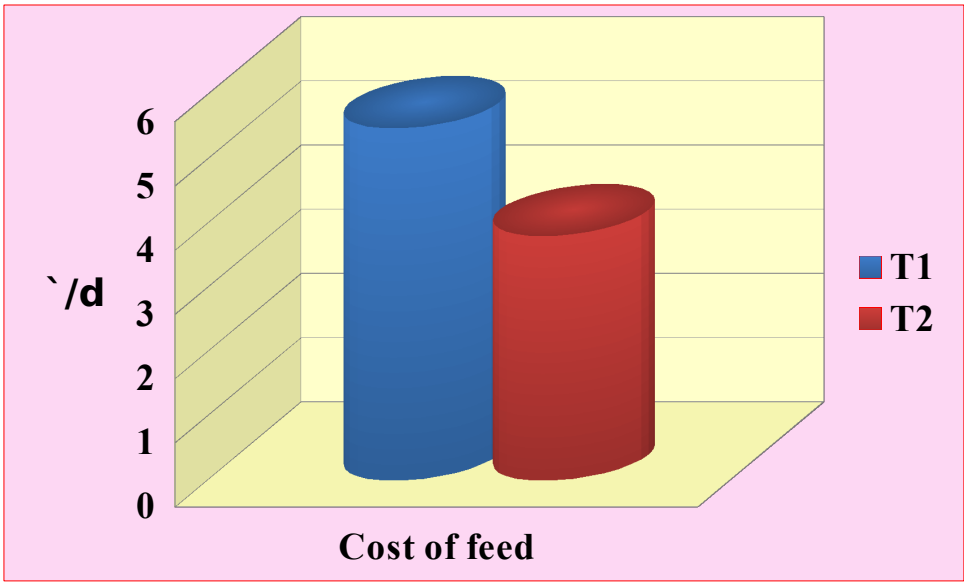
Figure 4.7: Average periodical changes in SRL nitrogen fractions of Surti kids fed TMR

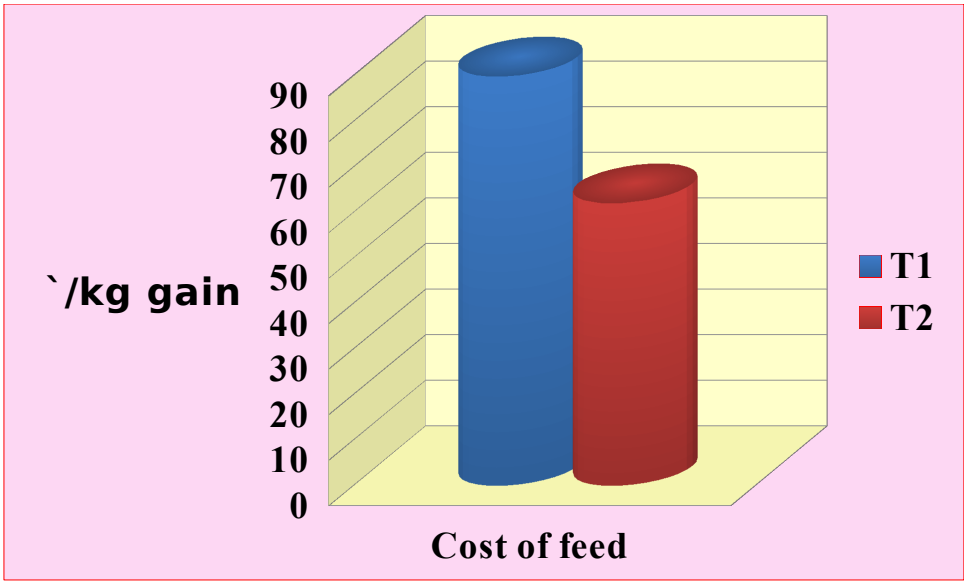




72a

Figure 4.10: Economics of feeding TMR in Surti kids




90
80
70
60
50
40
30
20
10
0
`/kg gain
Cost of feed
T1
T2

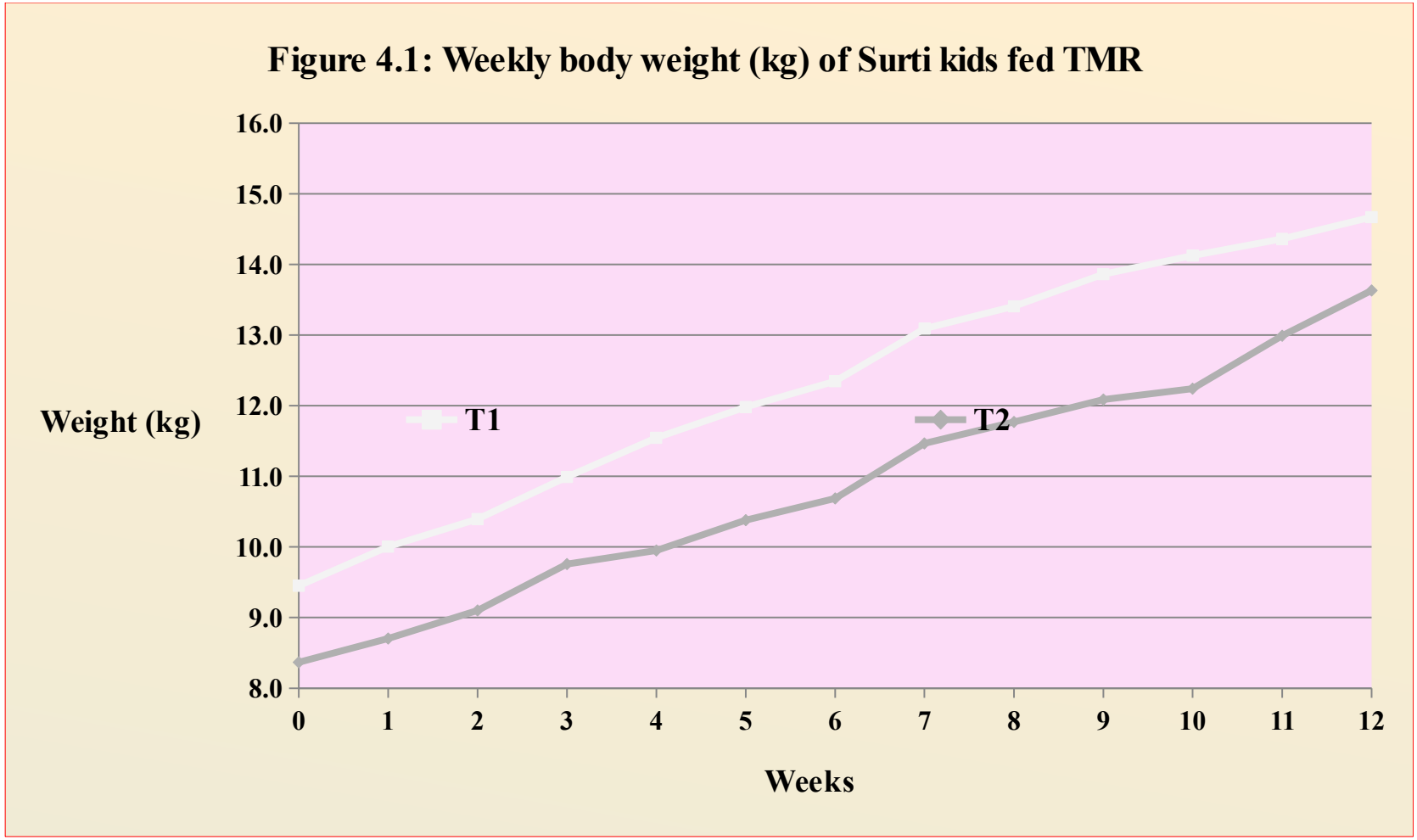
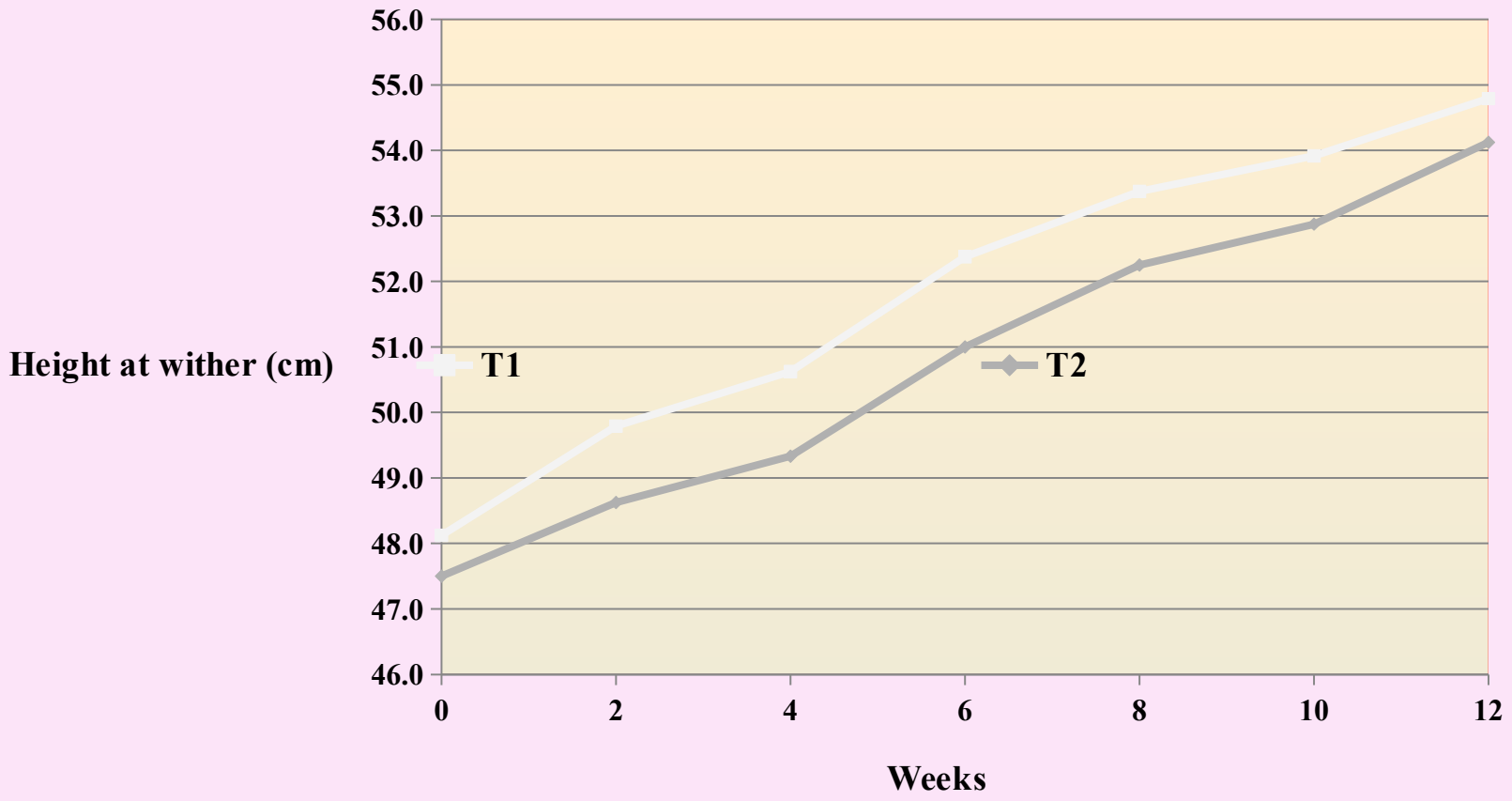


Figure 4.1: Weekly body weight (kg) of Surti kids fed TMR
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
Weight (kg)
T1
T2
0
1
2
3
4
5
6
7
8
9
10
11
12
Weeks

Figure 4.2: Biweekly increase in height at wither (cm) of Surti kids fed TMR



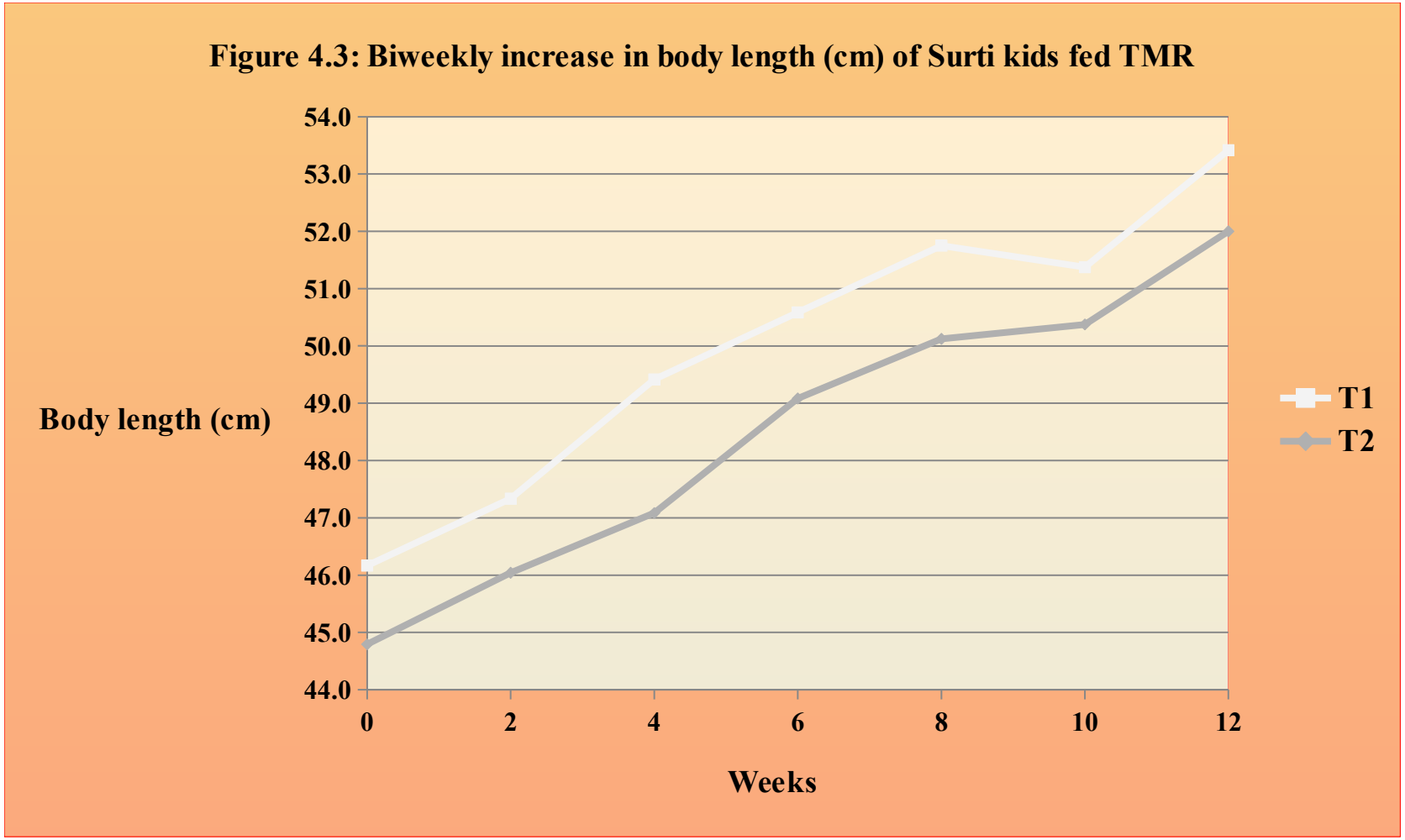


Figure 4.3: Biweekly increase in body length (cm) of Surti kids fed TMR
Body length (cm)
54.0
53.0
52.0
51.0
50.0
49.0
48.0
47.0
46.0
45.0
44.0
0
2
4
6
8
10
12
Weeks
T1
T2

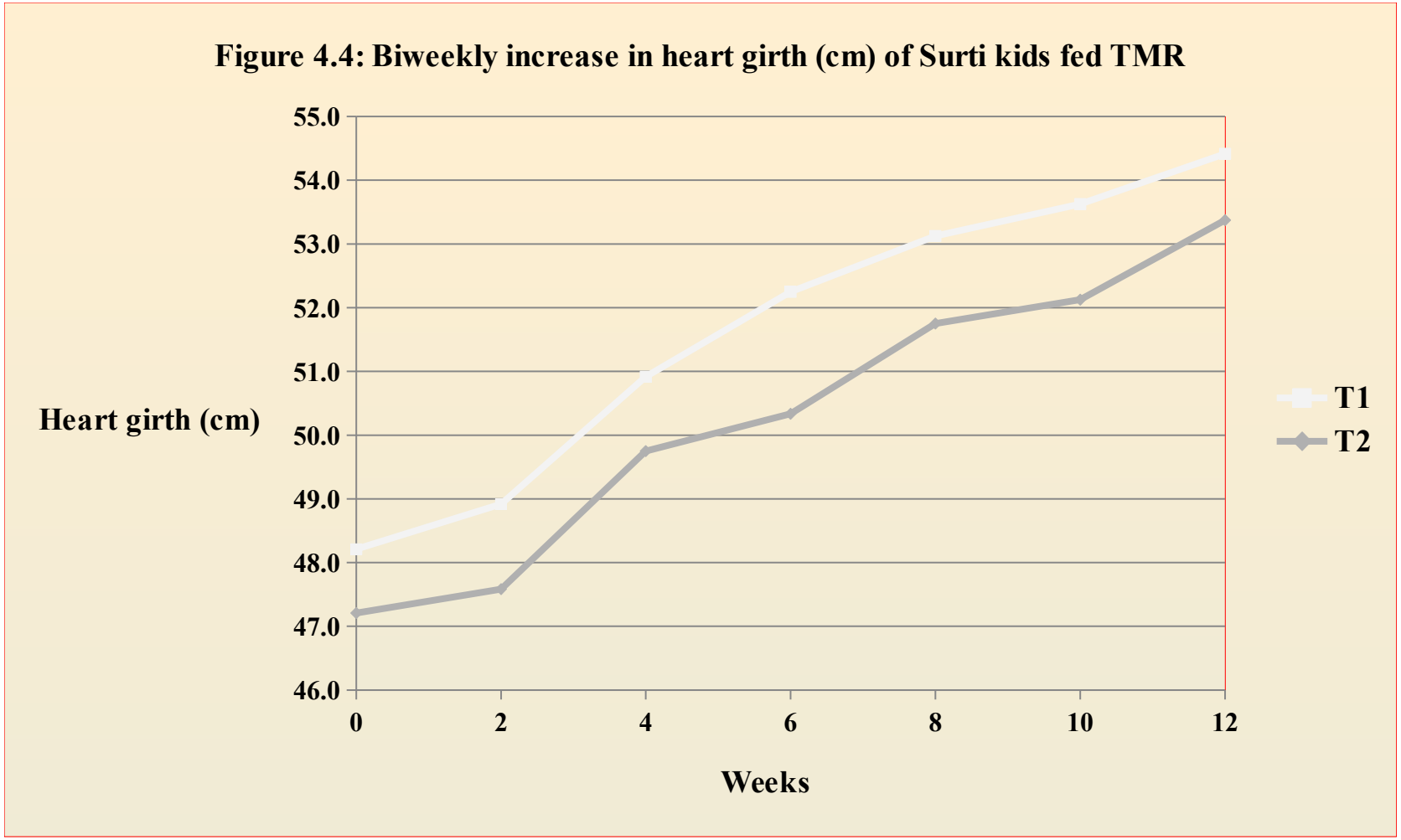
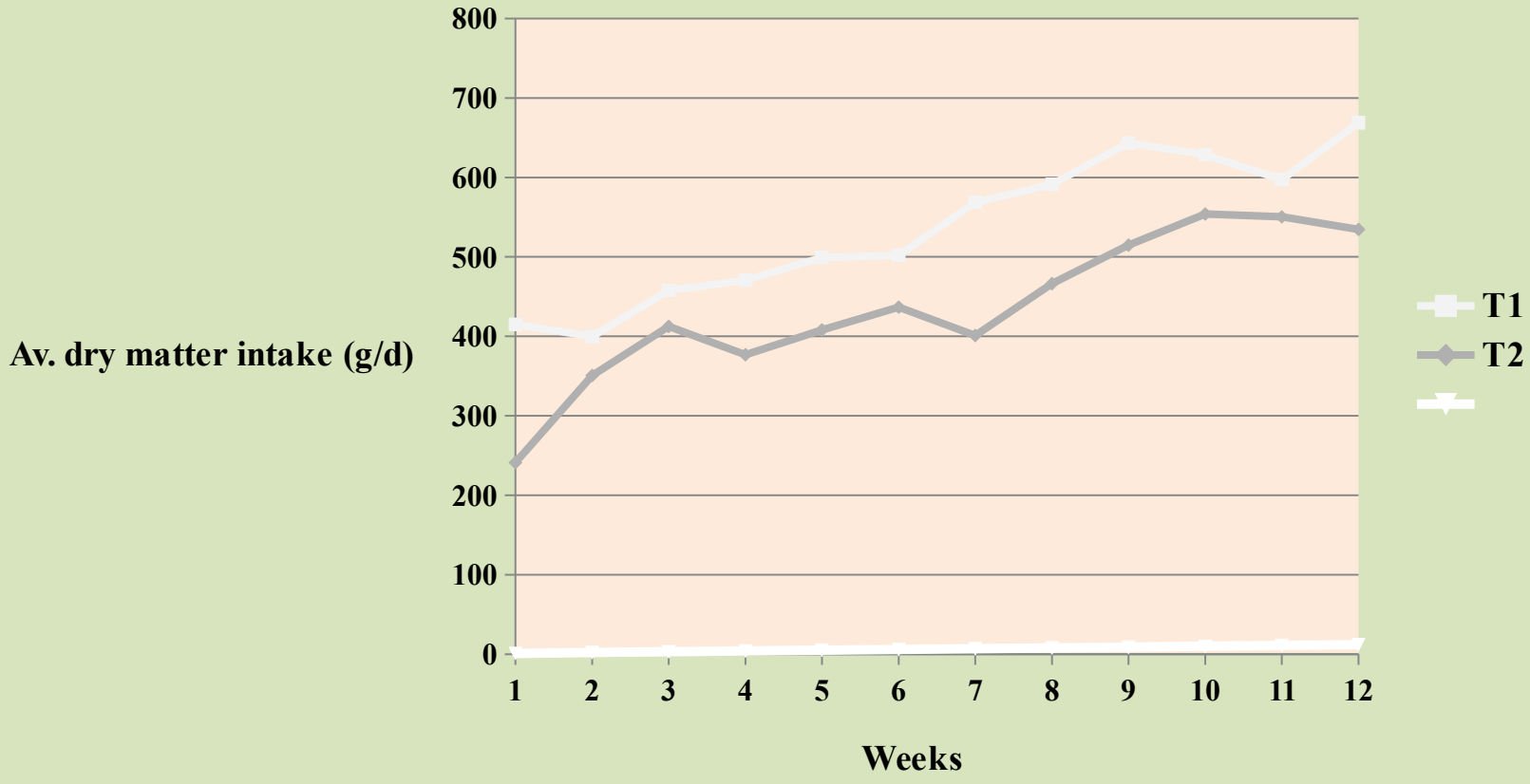


Figure 4.4: Biweekly increase in heart girth (cm) of Surti kids fed TMR
Heart girth (cm)
55.0
54.0
53.0
52.0
51.0
50.0
49.0
48.0
47.0
46.0
0
2
4
6
8
10
12
Weeks
T1
T2

Figure 4.5: Average dry matter intake (g/d) of Surti kids fed TMR



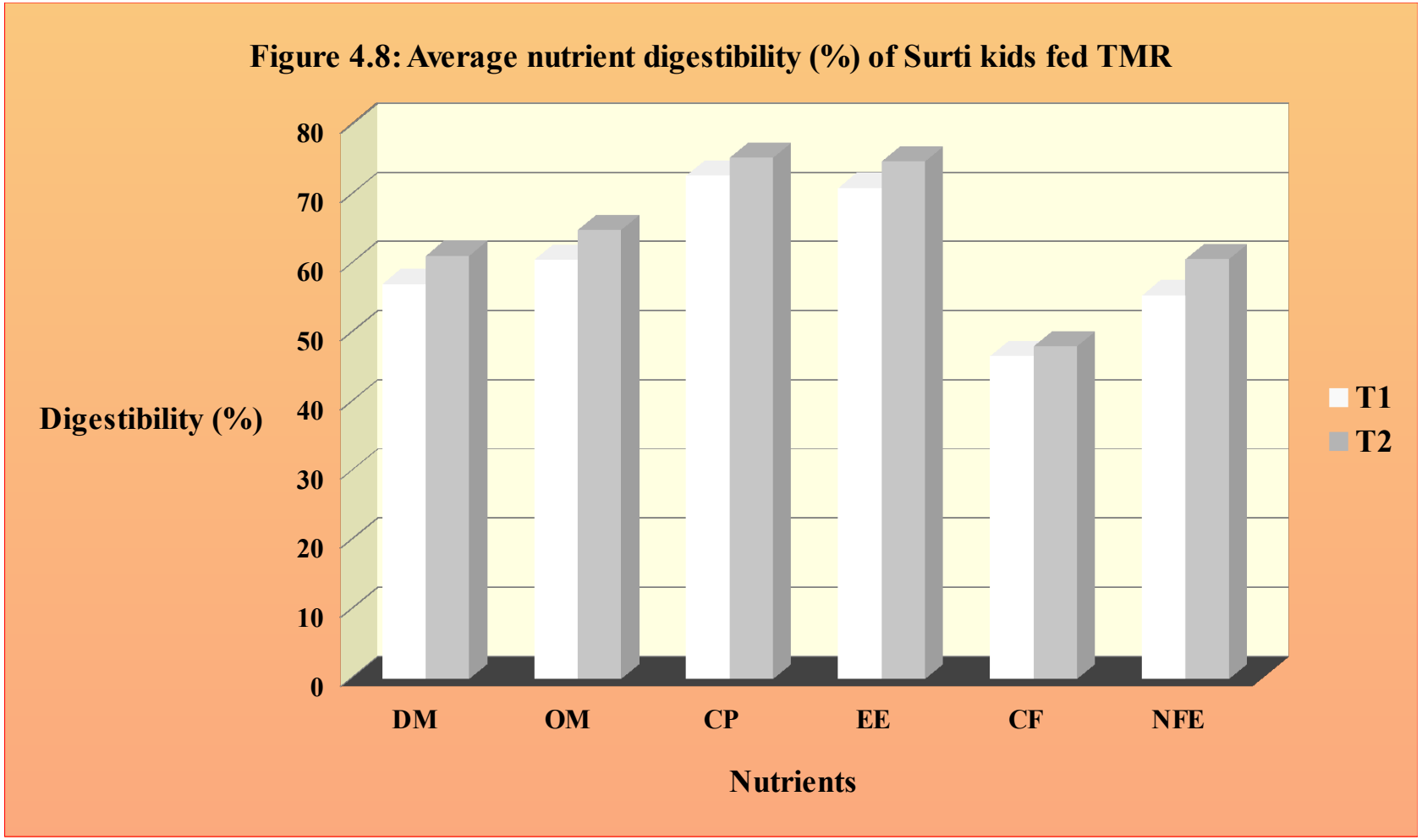


Figure 4.8: Average nutrient digestibility (%) of Surti kids fed TMR
Digestibility (%)
80
70
60
50
40
30
20
10
0
DM
OM
CP
EE
CF
NFE
Nutrients
T1
T2

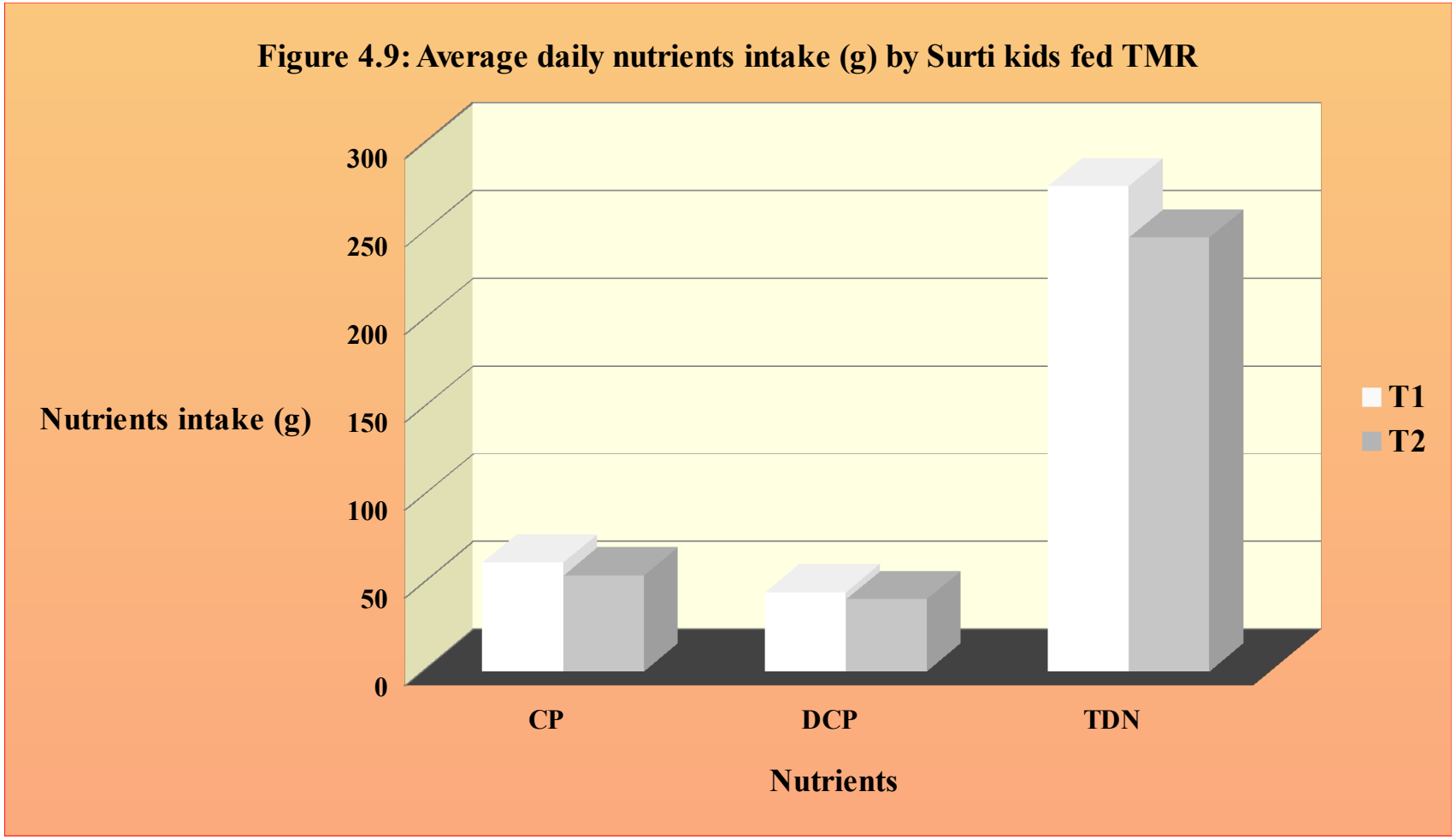


Figure 4.9: Average daily nutrients intake (g) by Surti kids fed TMR
Nutrients intake (g)
300
250
200
150
100
50
0
CP
DCP
TDN
Nutrients
T1
T2