SUPPLEMENTATION OF FIBRE DEGRADING ENZYMES AND *Saccharomyces cerevisiae* IN GRAM STRAW BASED PELLETED COMPLETE FEED OF GROWING GOATS

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Submitted

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MASTER OF VETERINARY SCIENCE

IN

ANIMAL NUTRITION

BY

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(INDIA)

2021

DECLARATION OF STUDENT

I hereby declare that the experimental research work and interpretation of the thesis entitled **"SUPPLEMENTATION OF FIBRE DEGRADING ENZYMES AND *Saccharomyces cerevisiae* IN GRAM STRAW BASED PELLETED COMPLETE FEED OF GROWING GOATS"** or part thereof has not been submitted for any other degree or diploma of any University, nor the data have been derived from any thesis/publication of any University or scientific organization. The sources of materials used and all assistance received during the course of investigation have been duly acknowledged.

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INGLE OMSATYA PRAKASH has satisfactorily prosecuted his course of research for a period of not less than two semester and that the thesis entitled **"SUPPLEMENTATION OF FIBRE DEGRADING ENZYMES AND *Saccharomyces cerevisiae* IN GRAM STRAW BASED PELLETED COMPLETE FEED OF GROWING GOATS"** submitted by him is the result of research work is sufficient to warrant its presentation to the examination in the subject of **ANIMAL NUTRITION** for the award of **MASTER OF VETERINARY SCIENCE** degree by the Maharashtra Animal and Fishery Sciences University, Nagpur.

We also certify that the thesis or part thereof has not been previously submitted by him for a degree of any other University.

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CERTIFICATE

This is to certify that the thesis entitled, **"SUPPLEMENTATION OF FIBRE DEGRADING ENZYMES AND** *Saccharomyces cerevisiae* **IN GRAM STRAW BASED PELLETED COMPLETE FEED OF GROWING GOATS"** submitted by **INGLE OMSATYA PRAKASH** to the Maharashtra Animal and Fishery Sciences University in partial fulfillment of the requirement for the degree of **Master of Veterinary Science** has been approved by the Student's Advisory Committee after examination in collaboration with the External Examiner.

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Date- ***Omsatya Prakash Ingle***

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ABBREVIATIONS

Abbreviations		Full Form
%	:	Percent
&	:	And
*	:	Significant
/	:	Per
<	:	Less Than
>	:	Greater Than
ADF	:	Acid Detergent Fibre
ADG	:	Average Daily Gain
AOAC	:	Association of Official Analytical Chemicals
AVG	:	Average
B.wt.	:	Body Weight
CF	:	Crude Fibre
CP	:	Crude Protein
d	:	Day
DF	:	Degree of Freedom
dl	:	Deciliter
DM	:	Dry Matter
DMI	:	Dry Matter Intake
EE	:	Ether Extract
et. al.	:	Ethically All
FCE	:	Feed Conversion Efficiency
FCR	:	Feed Conversion Ratio
Fig.	:	Figure
g	:	Gram
g/d	:	Gram Per Day
kg	:	Kilogram
Mcal	:	Mega Calorie
mEq/L	:	Milli Equivalent Per Liter
mg	:	Milli Gram

ml	:	Milliliter
MSS	:	Mean sum of Squares
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
P<0.01	:	Significant At 1% Level
P<0.05	:	Significant At 5% Level
pH	:	Hydrogen Ion Concentration
Rs.	:	Rupees
SE	:	Standard Error
SRL	:	Strained Rumen Liquor
SS	:	Sum of Squares
TCA-ppt-N	:	Tri Chloro Acetic Acid-Precipitate-Nitrogen
TDN	:	Total Digestible Nutrient
TMR	:	Total Mixed Ration
TVFA	:	Total Volatile Fatty Acids
Viz.	:	Videlicet Namely

INTRODUCTION

Goat plays an important role in providing subsidiary income and livelihood to millions of landless laborers, marginal farmers, and small farmers of India. As per 20th Livestock Census, the goat population of India is 148.88 million, second in the world, and constitute 27.74% of the total livestock population of the country. The total goat meat production of India is 942.91 thousand tons, contributing 19 % of total meat production. India is leading goat milk producer, share 3% of total milk production in India, and 26.31% of goat milk production of the world. DAHD (2020).

At the National level, out of total of dry matter available, 62.5 percent is accounted by crop residues (Raju, 2011). Land allocation to the cultivation of green fodder crops is limited and has hardly ever exceeded 5 percent of the gross cropped area (GOI, 2009). Hence, the supply of feed has always remained short of normative requirement and there is a deficiency of 44% for concentrate feed ingredients, 35.6% for green fodders, and 10.95% for dry roughages in India (IGFRI, Vision 2050). Birthal *et al.* (2005) have found feed scarcity as the main limiting factor in the task of improving livestock productivity.

Goats mostly thrive on grazing of natural grasses as well as browsing on shrubs and various tree leaves. These feed resources are characterized by low digestibility, low ME, and low CP besides poor availability of minerals and vitamins. Moreover, there is a scarcity of grazing land due to the ever-growing human population, industrialization, deforestation, etc, hence there is a need to adopt scientific goat management. Scarcity of feeds and unbalanced feeding practices leads to lower livestock productivity in our country. The main feeds comprised of crop residues and byproducts which is 40% of total feed, contribution from green fodder is 20% and concentrate is 3% and rest comes from grazing.

Grazing systems in semi-arid areas offer only limited potential for intensification, and hence livestock production is becoming increasingly crop-based. Crop residues along with agro-industrial byproducts can play an important

role in the feeding of sheep and goats under different management systems. Such residues can supply a substantial part of the maintenance requirements of small ruminants in the Asian region (Jayasuriya,1985).

However it is desired to improve the nutritive value and utilization of crop residues and agro industrial by-products by suitable treatments, due to its low bulk density and low nutritive value. Such treatments may be breaking of ligno-cellulosic bond, better rumen fermentation or densification, which will reduce the cost of feed per unit gain, increase the palatability and promotes use of unconventional feed resources.

Further the utilization of crop residue and by-products in the complete feed system ensures a consistent rumen environment, lower fermentation losses, and less variation in ammonia emission. A promising strategy appears to be blending roughage and concentrate into a homogenous mixture and converting it to complete feed pellets to ensure supply of diet with the same composition. It was previously observed that complete pelleted feeds incorporating bean straw improved nitrogen balance and growth response (Bonsi et al., 1994). In underdeveloped nations like India, feeding goats entire feed made out of crop leftovers appears to be a promising feeding technique for increasing productivity (Reddy, 1989; FAO, 2012).

In view of above, research was planned to make use of abundantly available and low nutritive value roughage source i.e., gram straw with *saccharomyces cerevisiae* in goat diet and its incorporation in the complete pellet feed. The present study was aimed to evaluate the effect of inclusion of gram straw with *saccharomyces cerevisiae* on growth performance and nitrogen balance.

In the recent years, the concept of feeding complete rations comprising of fibrous crop residues to animals become accepted between the farmers. Supplementation of concentrate only is not sustainable economically, while use of only roughage supplements leads to poor performance due to insufficient energy supply from the diet (Ravi and Prasad, 2005). The objective of complete rations is

to provide a blend of all the feed ingredients including roughages without giving any choice to the animal for selection of specific ingredients (Khan et al., 2010). The concept of feeding complete rations or Total Mixed Ration (TMR) with use of locally available crop residues seems to be ideal (Jadhav and Deshmukh, 2001). The complete feed feeding system is a promising method of ensuring supply of diet of same composition by mixing roughage and concentrate to form a uniform mixture. Further fortifying it with fibre degrading enzymes and yeast may add to the additional benefits. Hence the conventional roughage such as gram straw generally used in feeding of goats will be tried in pelleted complete feed with or without addition of enzymes and yeast with the following objectives.

Ruminants are foregut fermenters with ability of cellulose digestion, unique efficiency to utilize low quality feed proteins and other non-protein nitrogenous substances in order to meet their protein requirement and production of vitamin-B complex by microbial action, and ruminal ecosystem plays a major role in this, which can be manipulated by altering the feeding pattern, genetic manipulation of rumen microbes, incorporation of variety of feed additives and also by altering the site of digestion of nutrients.

The experiment on inclusion and utilization of gram straw with *saccharomyces cerevisiae* in pelleted complete feed in growing goats was undertaken with following objectives –

1. To study the effect on growth performance of growing goats.
2. To study the effect on rumen fermentation.
3. To study the effect on digestibility of nutrients.
4. To study the effect on economics of goat production.

REVIEW OF LITERATURE

Goats are multipurpose animals, producing meat, milk, skin and hair. Chevon (goat meat) is most preferred and widely consumed meat in the country. Goat is important livestock species for sustenance of rural poor in India as well as other countries of world. Goats significantly contribute to the agrarian economy. Among all species of farm animals, Goat plays a significant role in providing supplementary income and livelihood to millions of landless labourers of India.

Advance studies of the stall-feeding system can be a good way to meet the growing demands for country meat in the future, as the current scenario forecasts a continuing decline in natural pastures. The intense feeding system is superior than the extensive system from the point of view of growth, production, health and sustainability.

Feeding goats with a complete feed system is a better option than feeding concentrates and roughages separately or grazing with supplementation. Nearly 8.95 million tonnes of gram straw is produced annually in the country. Gram straw could appear to be a valuable edible bio mass due to its high nutritive value and feeding qualities and can serve as potential feed resource during the lean period of May-July when even grasses and vegetation are highly scarce. The benefits of comprehensive feeding include providing a balanced diet for the goat and assisting in the better exploitation of locally available feed resources, resulting in higher growth rates as well as lower feed costs and As a result, converting gram straw into animal feed can provide the needed value addition for farmers. Chopping, grinding, and pelleting are examples of physical processing that boost the nutritional content of gram straw.

Pelleting agglomerated feeds made by compacting and pressing individual ingredients or mixes of all elements through die openings using any mechanical method. Pelleting low-grade roughage-based feed improves consistency, increases bulk density, simplifies handling, and lowers waste, all of which contribute to better animal nutrition (Stevens, 1981). The full pelleted feed is a precise blend of

all feed ingredients that has been completely blended to avoid separation and selection. The idea of a fully pelleted feed system that uses locally available agricultural leftovers appears to be ideal.

The literature on pertinent components of the current investigation was thoroughly evaluated. The relevant and related findings of various scientists' research work are provided below.

2.1 Effect of Complete Pelleted Feed on Body Weight

Reddy and Reddy (1985) studied the effect of anhydrous ammonia (NH_3) treatment and pelletization on the nutritional value of ground whole cotton plant (GWCP) as a sole source of roughage in complete meals, a growth cum metabolic study was done on developing cross breed bull calves. The GWCP (Gossypium spp.) was treated with NH_3 at a concentration of 3.5 percent on a dry matter basis and stored in polythene bags at room temperature for 42 days. Twenty-four cross breed male calves weighing 158 kg were chosen at random for the following four meals. Complete feed (mash) with untreated GWCP; complete feed (pellet) with untreated GWCP; complete feed (mash) with NH_3 treated GWCP; complete feed (pellet) with NH_3 treated GWCP. To make the iso-nitrogenous, rations 1 and 2 were added with 1.5 percent urea. As ammonia levels rise, the crude protein composition of GWCP rises from 7.8% to 16%. Animals fed a mash/pellet ration containing NH_3 treated GWCP gained more weight on average per day than those fed a mash/pellet ration containing untreated GWCP.

Rajmane and Desmukh (1999) evaluated Complete Rations in Goats. In this experiment 15 adult non-pregnant Osmanabadi goats through three complete meals containing 60 percent sorghum straw (C1), soyabean straw (C2) and maize cobs (C3) each with 40 percent concentrate mixture. The goats in groups C1 (27.04 Vs 28 kg), C2 (26.02 Vs 27.70 kg), and C3 (27.80 Vs 28.30 kg) maintained their body weight at the end of the experiment, suggested that comprehensive meals based on sorghum straw, soyabean straw and maize cobs could sustain adult Osmanabadi goats adequately.

Yadav and Desmukh (2001) conducted an experiment to evaluate Spent Straw in Complete Ration of Sheep, maintained wheat straw (CR-1) and spent straw (CR-2) at a 60% level. For CR-1 and CR-2, the DCP and TDN contents were 5.35, 56.10 and 7.09, 41.68 percent respectively. At the conclusion of the trial, both meals were shown to be capable of maintaining experimental sheep with an average daily gain of 50-60g.

Murthy and Prasad (2002) evaluated legume hay based complete rations in sheep. This experiment was undertaken to evaluate four iso-nitrogenous complete meals, each including 70 percent of each stylosanthus (*Stylosanthus hemata*), horse gram (*Dolichos biflorus*) and sunhemp (*Crotolaria juncea*) hay in six lambs for each diet. They found that including 70 percent horse gram (*Dolichos biflorus*) hay in complete meals of sheep (14-20 kg B.wt.) resulted in a growth rate of 80 g per day, which was considerably greater ($P<0.01$) than other hays.

Raut *et al*. (2002) evaluated arhar (*Cajanus cajan*) straw based complete feed pellets in local non-descript male goats. The goats were fed with pelleted complete diet containing 60% *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 percent). The results of the experiments demonstrated that a full meal based on pigeon pea straw could keep experimental goats gaining an average of 75.0 g per day.

Kirubanath *et al.* (2003) examined the effect of processing cotton straw based complete diet with expander-extruder on performance of crossbred calves. Eighteen crossbred calves (6-9 months, 73.48 6.52 kg) were randomly assigned to two full diets and a conventional diet (6 in each group) for 180 days in a growth trial. The complete diets were prepared with 40% cotton straw, one processed in mash form and the other pelletized using an expander-extruder (EEP). These two full meals were compared to a traditional feeding method in which cotton straw and concentrate mixture were fed separately in a 60:40 ratios. The total gain in weight under standard, mash and EEP conditions were 83.68, 112.87 and 146.74 kg respectively. In compared to calves fed conventional meals, the ADG was

considerably ($p<0.01$) higher in calves fed EEP complete feeds (815.4 g) followed by mash (627.0 g) and conventional (464.9 g).

Reddy and Reddy *et al.* (2003) conducted an experiment to evaluate the cotton stalks based complete diet on growth and carcass characteristics in sheep and goats in field condition. This trial was undertaken on 6 Nellore ram lambs and 6 local male youngsters (4–5 months old). For 180 days, they were fed an expander extruder processed pelleted complete feed prepared with cotton stalks as the only source of roughage (40%) and concentrates (60%). The ADG in lambs and goats were 102.8 and 81.1g respectively, which was considerably greater ($P\leq0.05$) in lambs than goats.

Bhadane *et al.* (2004) fed arhar straw (*cajanus cajan*) based pelleted complete feed in twelve non-descript local goats randomly divided into two treatment groups. Goats under both the treatments were fed pelleted complete feed G1 (12% CP, 65.81% TDN) and G2 (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 arhar straw contained 94.0, 11.8, 2.7, 48.5 and 8.0% OM, CP, EE, NFE and lignin, respectively. The average gain in the respective groups. was 75.7 and 72.9 g/day. They concluded that the pelleted complete feed containing 60% arhar straw and 40% concentrate having 12% CP and 65.81% TDN fulfills the requirement of goats growing at the rate of 76 g/day.

Rekhate *et al.* (2004) evaluated arhar and gram straw based pelleted complete feed in eighteen non-descript local goats (320 days old and 21.8 $\pm$ 0.8kg B.wt.) divided into three equal groups. For 110 days, they fed with pellets prepared from arhar straw complete feed (ASCF), gram straw complete feed (GSCF) and special arhar straw pellets supplemented with concentration pellets (ASCONC). In all of the diets, the roughage to concentrate ratio was kept constant at 60:40. The daily body weight gain was 83.5 g (ASCF), 108.1 g (GSCF) and 94.8 g (AS-CONC) respectively. The daily live weight gain in goats fed gram straw-based pellets was much higher.

Murthy and Prasad (2005) evaluated the legume hay based complete rations in sheep. Four isonitrogenous complete rations were formulated with stylo (Stylosanthus hemata; CR-LF), horse gram (Dolichos biflorus; CR2), cowpea (Vigna sinensis; CR-3) and sunhemp (Crotalaria juncea; CR-4) hays each at 70 percent level to compare their inclusion by using 6 lambs (3 months; average body weight 14 kg) for each diet. The appropriate full meals were supplied ad-libitum to meet the nutrient requirements during the 91-day growth experiment. ADG was 66, 81, 71, and 58g under CR-1, CR-2, CR-3, and CR-4, respectively. The lambs fed complete ration with horse gramme hay (CR-2) gained more total body weight (7.3 kg) and had a substantially greater ($P \leq 0.01$) ADG than those fed another complete ration. They determined that the ration comprising 70 percent horse gram hay (CR-2) was superior for sheep.

Rekhate *et al.* (2005) utilized gram (*cicer arietinum*) straw based pelleted complete ration in goats. Twelve nondescript local goats were used in this trial and fed two different diets with arhar straw (T1) and gram straw (T2) for 110 days affected their performance. The goats in T1 were fed arhar straw pellets with a daily allowance of 300g concentrate pellets, whereas the goats in T2 were fed complete feed pellets made up of 60% gram straw and 40% concentrate. Total gain in weight of T1 and T2 groups of goats were 12.10 and 10.62 kg with ADG of 108.1 and 94.8g respectively. They concluded that goat fed both the pelleted diet performed well with respect to daily weight gain, however feeding of gram straw based pelleted complete ration having roughage concentrate ratio 60:40 achieved daily gain of 108.1g may be beneficial under stall fed conditions.

Abd Alla and Baharel (2007) determined the effect of pigeon pea hay inclusion at different dietary levels on body weight in 24 Sudanese desert kids (3-4 months). The daily body weight gain for groups A (control), B (10 percent pigeon pea hay), C (20 percent pigeon pea hay), and D (30 percent pigeon pea hay) were 70.33, 54.83, 57.50 and 53.50g, respectively. There was a substantial variation in weight increase between the four diets ($P<0.05$).

Rekhate *et al.* (2007) studied the performance of goats fed arhar (*cajanus cajan*) straw based pelleted complete ration in twelve non-descript local goats

with average bwt. (21.61 ± 0.78 kg) & age (10.6 months) for 110 days. The goats were split into two groups at random and fed either whole arhar straw pellets supplemented with concentrate pellets @ 300g/head/day (T1) or pelleted complete diet comprising 60% arhar straw (T2). Average daily gain under T1 and T2 was 94.83 ± 18.85 and 83.52 ± 3.43 g, respectively. There was no significant difference in the ADG between the regimens. They came to the conclusion that goats can be fed arhar straw-based complete feed pellets for optimum weight gain in stall feed conditions.

Rekhate *et al.* (2008) studied the nutrient utilization and growth performance of goats on pelleted complete diets prepared from gram (*cicer arietinum*) straw and arhar (*cajanus cajan*) stalks. Eighteen local goats were divided into three groups and fed 12 percent CP and 60 percent TDN for 120 days on CMF/complete mash feed (T1), GSP gram straw pellets (T2), and ASP arhar (*Cajanus Cajan*) stalk pellets (T3). The average daily gain (ADG) in goats was found to be 58.47g (T1: CMF), 75.98g (T2: GSP) and 72.94g (T3: ASP). In comparison to the control group (T1), the ADG was significantly ($P<0.01$) higher in the T2 and T3 groups (T1).

Sihag *et al.* (2008) studied the utilization of pulses straw in complete pelleted feeds for growing lambs. In this experiment twenty Munjal male lambs (90 ± 6 days, 15.12 ± 0.237 kg B.wt.) were used for 120 days. The lambs were divided into 4 equal groups. The control group (C) was offered conventional ration maintaining roughage (4.2% CP) to concentrate (18.34% CP) ratio as 15:85. The conventional ration (C) was replaced with gram straw 60, mustard cake 12, deoiled rice bran 10 and barley 5% (GBP) or soybean straw 60, mustard cake 8, deoiled rice bran 9 and barley 10% (SBP) and black gram straw 60, mustard cake 5, deoiled rice bran 9 and barley 13% (BGBP) based pellets along with 10% molasses, 2% mineral mixture and 1% salt. All the three rations were iso-nitrogenous having roughage to concentrate ratio of 60:40 and fed ad-lib. The daily weight gain (g/d) was 128, 95, 81 and 100g for C, GBP, SBP and BGBP treatments respectively. The results indicated that black gram straw-based pellet diet (BGBP) was the best among the three-straw based pelleted diets and straw

like gram, soya and black gram can be incorporated up to 60% in pelleted diets to obtain the daily growth rate of 80-100g in lambs.

Ding *et al.* (2008) Examined the effects of monensin and live yeast supplementations on growth performance, nutrient digestibility, carcass characteristics and ruminal fermentation parameters when 45 lambs were fed steam-flaked corn-based diets. Animals were alloted to one of three treatment diets in a completely randomized design. The three treatment diets were: (1) basal diet (CON) with steam-flaked corn as a sole grain source, (2) basal diet supplemented with monensin (MO), and (3) basal diet supplemented with live yeast (LY). Total average daily intake (ADI) was unaffected by MO and LY supplementations. LY supplementation increased ($p<0.05$) average daily gain (ADG) by 13.1% compared with the CON diet. Both MO and LY supplementations resulted in a significant improvement ($p<0.05$) of feed efficiency over the CON diet (4.47, 4.68 vs. 5.05).

Yasir Afzal *et al.* (2009) conducted a growth trial on 10 male Corriedale lambs (16.7±0.75 kg Body weight; 180-210 days old) for 90 days, into two equal groups. Lambs were fed a complete feed either in block or mash form for 90 days. The formulated complete feed has 60:40, R:C. Complete feed blocks were prepared in horizontal feed block making machine at 3000 psi. Dry matter and nutrient intake, and feed conversion efficiency did not change between block or mash fed group. Densification of complete feed did not reveal any effect on digestibility of dry matter and gross nutrients, nutritive value and retention of minerals. Daily live weight gain and nitrogen retention was higher ($P<0.05$) in block fed lambs by 47g/day or 32.2% and 3.0 or 24.0% respectively. Feeding complete feed blocks compared to mash feeding markedly reduced the cost of production. The results revealed that densification of feed into blocks improved daily live weight gain, efficiency of feed utilization and cost of production in hoggets.

Nagalakshmi and Reddy (2011) carried out an experiment to assess on farm performance of lambs fed expander extruder processed cotton stalks based complete diets. Thirty Nellore ram lambs (4-5month old) of average body weights

were randomly divided into two dietary groups. For 180 days, one group was fed an EEP diet containing 38.5 percent CS, while the other was provided a standard diet consisting of concentrates mixture and ad lib sorghum stover. The average daily gain was significantly higher ($P<0.01$) of 95g in comparison to 70g when fed conventional ration. This result indicated that cotton stalks could be used as roughage source in complete diets for growing lambs.

Reddy *et al.* (2012) evaluated growth performance in kids fed expander-extruded complete feed pellets containing red gram (*cajanus cajan*) straw. Thirty-two weaned male kids of Osmanabadi breed in the age group of 4 to 5 months were divided into 4 groups of eight animals each to evaluate two iso-nitrogenous complete mash feeds in which red gram straw was incorporated at 35 and 50% level maintaining total roughage content in both the ration at 60% level. The remaining component of the forage portion comprised of *Lucaenea* leaves. The experimental feeds (T1: mash with 35% red gram straw (RGS), T2: mash with 50% RGS, T3: pellet with 35% RGS, T4: Pellets with 50% RGS) were randomly assigned to four treatment groups and animals in the respective groups were offered those feeds for 150 days. The average daily gain under T1, T2, T3 and T4 was 53.17, 44.12, 73.17 and 69.42 g, respectively. Average daily gain (ADG) in kids was also significantly ($P<0.001$) influenced by feed processing while the effect of level of inclusion of RGS was non-significant on growth rates.

Devsena and Ramaprasad (2014) evaluated the performance of goats fed crop residue based complete rations. Twelve nondescript weaning kids (13.33 ± 0.62 kg av.B.wt.) were divided randomly into two treatment groups and were fed experimental feeds made up of ground nut haulms (C1) and gram bhusa (C2) based complete diets with a roughage:concentration ratio of 70:30, with 50 percent of each crop residue and 20 percent sugarcane baggasse added in addition to the concentrate ingredient for 120 days. The average daily gain was 52.17g in C1 and 50.00 g in C2 feeding groups.

Nehra *et al*. (2014) Conducted a trial on twelve Marwari kids divided into two equal groups of six in each and fed ad libitum for 120 days green gram straw based complete feed blocks (GGS-CFB) diet. One group was supplemented with

yeast (*Saccharomyces cerevisiae*) culture (YS), while the other group (YU) without any supplementation served as control. The DM intake was similar between the two groups, which was 78.46 and 84.01 g/kg $W^{0.75}$ amounting to 3.92 and 4.12 kg/100 kg BW, respectively, in YU and YS groups. Yeast supplementation increased ($P<0.01$) digestibility of DM, OM, CP, EE NFE, CF, NDF and ADF. Average daily gain was higher ($P<0.05$) in YS group (91.89 g) as compared to YU group (82.74 g), whereas feed conversion ratio was similar between the two groups. The DCP and TDN contents were 10.45 and 58.05% in YU group and 11.12 and 61.68% in YS group, respectively and were similar between the groups.

Saijpaul *et al.* (2015) Compared the effect of two concentrate feed (20% CP, TC (Control) vs 25% CP, THP) and a crop residue based feed block (TFB) on nutrient utilization, growth and physiological performances. Eighteen Beetal kids of 3.5 months were randomly divided into three groups with 6 animals in each. Kids of TC and THP were fed with green fodder ad lib and wheat straw @ 5% of fodder offered, whereas, kids of TFB were fed only crop residue based complete feed block. After 180 days, the body weight gain of TC and THP were similar but significantly ($P<0.05$) higher than TFB.

Rashid *et al.* (2016) conducted experimental trial on twenty-four Black Bengal goats which were randomly divided into three groups with average body weight to observe the effects of feeding different forms of diet on the performance of Black Bengal goat. A ration was prepared in three different forms such as A- green grass + concentrate mixture in conventional form, B- green grass + concentrate in pellet form and C- both grass and concentrate in compound pellet form according to NRC (1981) nutrient requirements. Total gain recorded under A, B & C rations was 13.05, 14.08, and 15.68 with group C showing highest weight gain.

Singh *et al*. (2016) An experiment on Jamunapari goat kids (24), 90-day-old was carried out to assess the effect of straw type (arhar, Cajnuscajan or gram, Cicer arietinum) and form of diet (mash or pellet) on growth, feed efficiency and slaughtering performance. Two types of complete feed mixtures were prepared

using straw and concentrate in 60:40 ratio. One part of each complete feed mixture was converted to pellet form of diet while another part remained as mash. These were randomly allocated to four groups of kids, six in each and fed ad lib. The kids under present feeding and management protocol attained live weight 18 to 19 kg at 6 month, 24 to 28 kg at 9 month and 31 to 34 kg at 12 month of age, with average daily gain (ADG) 71 to 84 g during entire growth period. The feed efficiency (kg feed / kg gain) ranged from 14.5 to 21.1 kg. The diets with roughage to concentrate ration 60:40 provided daily gain up to 84 g, with FCR 14 kg and live weight 34 kg at 12 months of age.

Islam *et al.* (2017) evaluated the effect of total mixed ration (TMR) pellet feeding on growth parameters of sheep. Six Bangladeshi Garole sheep (Ovis aries) were randomly divided into two groups (BW: 8±0.5 kg; Age: 1yr). The control diet consisted of roadside grass, rice straw, wheat bran, mustard oil cake, molasses, and common salt, whereas the treatment diet consisted of a pelleted form (P-TMR) and the loose total mixed ration (L-TMR). The sheeps were provided 1.5 times their maintenance energy and protein requirements in both dietary treatments. The result showed that P-TMR had a higher live body weight and better feed conversion ratio ($p < 0.05$) than L-TMR.

Shashikumar *et al*. (2017) Compared the conventional finger millet (Eleucine coracana) straw based complete feed block (CFB) with maize (*Zea mays*) husk and cob based complete feed block on the growth performance of lambs. Twenty Mandya/Bannur lambs of about 4 to 6 months of age with body weight ranging from 8 to 14 kg were divided into two groups of ten each in a completely randomized design. The CFB with finger millet straw was fed to group T1 and maize husk and cob was fed in group T2. The ADG (g) and FCR (g DMI/g body weight gain) were similar in both the groups.

Jadhav (2019) studied the utilization of cotton stalk in complete pelleted feed in eighteen growing goats of 4- 6 months of age, divided in three equal groups and fed with three different dietary regimes as T0 (control), T1 and T2 groups. Goats in the control group was fed with pelleted feed comprising 60% gram straw and 40% concentrates, while in T1 group 25% gram straw was

replaced by cotton stalk and in T2 group 50% gram straw was replaced by cotton stalk. Each ration was maintained in 60:40 roughage to concentrate ratio having 12% CP and 60% TDN. The fortnightly body weights did not show significant variation between the groups, however ADG found to be significantly better in T1 group than that of T0 and T2 groups. He concluded that cotton stalk in complete pelleted feed of growing goats can be effectively utilized upto 50% of total roughage source without any adverse effect on growth.

Kewan *et al.* (2019) examined nutritive utilization of moringa oleifera tree stalks treated with fungi and yeast to replace clover hay in growing lambs. Twenty-four Barki lambs with an average body weight of 20.7 ± 0.17 kg were used in a complete randomized design to evaluate the effects of replacing clover (*Trifolium alexandrinum L*) hay as a traditional basal diet (C) with moringa tree stalks (MS) treated with fungi (*Trichoderma reesei*) (MF) and yeast (*Saccharomyces cervisiae*) (MY) under solid-state fermentation on nitrogen and water metabolism, rumen fermentation and economic efficiency of feeds. Lambs were divided into three groups each with eight lambs depending on their live weight. Concentrate feed mixture was similar for all groups and was offered at 2% of live weight with the basal roughage offered *ad libitum*. Average daily gains were 173, 139 and 146 g/head/day, for C, MF and MY groups, respectively.

Kedaree *et al.* (2019) conducted an experiment to evaluate performance of growing goats fed paddy straw supplemented with graded levels of *thespesia populneathe.* Twelve crossbred bucks were used in a randomized block design for duration of 4 weeks. The treatments comprised of a Portia tree leaves and paddy straw supplemented with in 15:85, 30:70 and 45:55 for the treatment groups T1, T2 and T3, respectively. Concentrate @ 200 g/buck were offered to meet the nutritional requirement of the experimental animals on a dry matter basis. All animals were allowed *ad libitum* access to water and mineral lick. Supplementation of straw with Portia tree leaves in T2 significantly increased daily weight gains 75.00 g/day ($p<0.05$).

Shembekar (2019) studied the effect of utilization of ozone treated cotton stalk in pelleted complete feed of eighteen growing goats (4 to 6 months of age)

for 90 days. The goats were randomly allotted to three dietary treatments as T0, receiving pelleted complete feed made from 60% gram straw as roughage and 40% concentrates, T1 receiving pelleted feed containing 15% ozone treated cotton stalk (OTCS) and 45% gram straw as roughages along with 40% concentrates while, T2 group received pelleted complete feed containing 30% OTCS and 30% gram straw and 40% concentrates. The roughage to concentrate ratio was maintained as 60:40 in each group. The ADG were found to be 97.22±5.91, 135.97±11.50 and 105.74±9.12 g/d in T0, T1 and T2 groups, respectively with significantly ($p \leq 0.05$) higher ADG in T1 group as compared to other groups.

Zhang *et al.* (2019) conducted an experiment on performance, rumen fermentation, and gastrointestinal microflora of lambs fed pelleted or unpelleted total mixed ration. A total of 100 crossbred (Dorper sheep × Small-tail Han Sheep, DH) ram lambs at 120 d age with similar body weight (BW, 34.9 ± 0.5 kg) were randomly allocated to 10 pens. The pens were randomly assigned to 2 treatments with 5 replicates per treatment. Dietary treatments were PTMR and un-pelleted total mixed ration (UPTMR) with the same dietary ingredients and nutritional contents. PTMR-fed lambs had a higher ADG ($P = 0.003$) than UPTMR-fed lambs.

Ahmed *et al.* (2020) conducted growth trials on growing goats to assess the influence of complete pelleted feed on animal performance in both on-station and on-farm trials. A complete pelleted feed was designed with 40% roughage (rice straw) and 60% concentrate [rice polish (50%), maize smash (16%), soybean meal (20%), molasses (10%), salt (2%), Dicalcium Phosphate (1%), vitamin–mineral premix (0.5%), and pellet binder (0.5%)] for commercial goat production. Feeding complete pelleted feeds helped in increasing the daily body weight gain of goats (36.96 and 52.46 gm, respectively) compared to traditional semi-intensive feeding (17.76 gm) with significantly ($p < 0.05$) better body condition score of goats.

Muhammad I. Malik *et al.* (2020) evaluated the effect of physical form and level of wheat straw inclusion on growth performance and blood metabolites of fattening goat. Thirty-two male Beetal goats (27.4 ± 0.28 kg body weight

(BW)) were divided randomly into the following four dietary treatments with a 2 × 2 factorial arrangement (n = 8/treatment): (1) CTMR15 (conventional TMR containing 15% WS), (2) CTMR25 (conventional TMR containing 25% WS), (3) PTMR15 (pelleted TMR containing 15% WS), and (4) PTMR25 (pelleted TMR containing 25% WS). average daily gain (ADG) (0.176 vs. 0.143 kg/day) were higher ($p < 0.05$) in pelleted vs. conventional TMR-fed goats. Irrespective of the PF of the TMR, the 15% WS-fed animals had greater ADG (0.172 vs. 0.144 kg) when compared to those fed on 25% WS diets.

Muktiani *et al.* (2020) calculated the feed efficiency and income over feed cost of ettawa crossbred goats fed different quality of dry complete feed supplemented with mineral. Sixteen weaned female goats aged 4-month-old were used in this study. The experiment was conducted in factorial 2x2 in a completely randomized design with 4 replications and 2 factors. The first factor was different levels of energy and protein in the diets: 14% CP + 63% TDN (T1); and 16% CP + 67% TDN (T2). The second factor was the Zn-Se supplementation (treatment and control). The concentration of Zn and Se in the supplement were 20 mg/kg and 0.2 mg/kg, respectively. Results showed that goats in T1 group lost the body weight (BW) by 11.07 g, whereas T2 group gained 10.48 g of BW within 6 weeks of experimental period. Supplementation of Zn and Se in the T2 diets prevented the BW lost and resulted in the highest BW gain (7.15 kg) within 14 weeks.

Raju *et al.* (2021) The complete diets containing different dual-purpose sorghum stovers were evaluated for their comparative effect on nutrient utilization and growth performance of ram lambs. Twenty four Nellore x Deccani cross ram lambs of 4–6 months old (body weight, 14.39 ± 0.24 kg) were divided into four groups of six animals each in a completely randomized design. Experimental rations containing different sorghum stovers and concentrate ingredients were processed into mash and offered in the form of complete rations viz. local sorghum, Phule chitra, IS 12015 and IS 23143-based diets. No significant differences were noticed for the initial weights ($P = 0.85$). The final body weight tended to be lower ($P = 0.06$) in local sorghum stover-based diet. Compared to other cultivars, feeding local sorghum stover showed lower ($P = 0.05$) the body

weight gain, average daily gain, and total dry matter intake (g/d) of ram lambs. The lambs fed local sorghum stover-based complete rations required higher (P = 0.05) cost per kg gain compared to the other those fed on other cultivar-based diets.

2.2 Effect of Complete Pelleted Feed on Dry Mater Intake

Reddy and Reddy (1985) studied the effect of anhydrous ammonia (NH_3) treatment and pelletization on the nutritional value of ground whole cotton plant (GWCP) as a sole source of roughage in complete meals, a growth cum metabolic study was done on developing cross breed bull calves. The GWCP (Gossypium spp.) was treated with NH_3 at a concentration of 3.5 percent on a dry matter basis and stored in polythene bags at room temperature for 42 days. Twenty-four cross breed male calves weighing 158 kg were chosen at random for the following four meals. Complete feed (mash) with untreated GWCP; complete feed (pellet) with untreated GWCP; complete feed (mash) with NH_3 treated GWCP; complete feed (pellet) with NH_3 treated GWCP. To make the iso-nitrogenous, rations 1 and 2 were added with 1.5 percent urea. As ammonia levels rise, the crude protein composition of GWCP rises from 7.8% to 16%. Voluntary intake of dry matter was enhanced ($P<0.05$) by ammonia but not affected by pelletization. Dry matter consumption per kg live weight gains was highest with ration 1 and lowest with ration 4.

Durga Prasad *et al.* (1986) conducted growth study on 32 Nellore Brown weaned lambs (11.16 kg) for 84 days to evaluate four different diets. The four diets were formulated complete rations by blending groundnut haulm (10.38% CP) with a conventional concentrate mixture (14.75% CP) in the ratios of 80:20 (CR-1), 60:40 (CR-2), 40:60 (CR-3) and 20:80 (CR-4). The daily feed intake was 535.13, 595.38, 656.19 and 593.40 g, respectively in CR-1, CR-2, CR-3 and CR-4 and the treatment differences were non-significant. They concluded that feeding of complete ration containing groundnut haulm and concentrate mixture in a ratio of 40:60 (CR-3) improved dry matter intake in lambs.

Rajmane and Desmukh (2000) conducted trial on fifteen adult non-pregnant goats of Osmanabadi breed to evaluate three complete rations containing sorghum straw (C1), soyabean straw (C2) and corn cobs (C3) each at 60% level with 40% of concentrate mixture. The daily DMI in soyabean straw fed group was 924 g as compared to sorghum straw (615 g) and corn cobs (782 g). However, lower DMI in group C1 and C3 than recommended values indicated lesser palatability of these rations compared to group C2 (soyabean straw group).

Jadhav and Deshmukh (2001) evaluated of complete rations containing black gram straw and wheat straw in sheep. Ten synthetic Deccani non-pregnant, dry sheep of equal age (10 months) and body weight (23 kg) were divided and tested two complete meals containing wheat straw (CR1) and black gram straw (CR2), each at 60% level. In CR1 and CR2, the daily DMI was 0.84 and 0.89 kg, respectively, and the effect was non-significant. The DMI was not significantly different across the groups. The results showed that complete ration based on wheat straw (CR1) and black gram straw (CR2) were able effectively to maintain the sheep.

Yadav and Desmukh (2001) evaluated two complete ration containing wheat straw (CR-1) and spent straw (CR-2) each at 60% level in crossbred sheep. The DCP and TDN contents were 5.35, 56.10 and 7.09, 41.68% for CR-1 and CR-2, respectively. The daily DMI was 0.842 and 0.892 kg for wheat and spent straw fed groups, respectively.

Khirwar *et al.* (2002) determined the nutritive value of green gram bhusa (straw) in adult non-lactating Beetal goats and crossbred sheep with an average B.wt. of 27 and 19 kg. The maintenance requirement of sheep and goat were met as per ICAR feeding standards (1998). The daily DMI was 845 and 654 g for goat and sheep, respectively. The DMI (kg/100kg) was 3.16 ± 0.14 and 3.42 ± 0.06 in goat and sheep, respectively. The difference between the species for the DMI was statistically non-significant.

Murthy and Prasad (2002) evaluated four isonitrogenous complete ration containing *Stylosanthus hemata*, *Dolichos biflorus*, *Vigna sinensis* and *Crotolaria*

juncea hays each at 70% level in complete rations using 6 lambs for each diet. They reported that daily DMI was higher ($P<0.05$) with diet containing *Stylosanthus hemata* as well as *Vigna sinensis* hay as compared to other.

Raut *et al.* (2002) Performed an experimental trial on local non-descript male goats to evaluate the pelleted complete feed nutritionally containing 60% *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%). On local nondescript goats the daily DM intake was 743.94±41.56 g. The DMI per 100 kg B.wt. was 4.20±0.28 kg.

Kirubanath *et.al*. (2003) examined the effect of processing cotton straw based complete diet with expander-extruder on performance of crossbred calves. Eighteen crossbred calves (6-9 months, 73.48 6.52 kg) were randomly assigned to two full diets and a conventional diet (6 in each group) for 180 days in a growth trial. The complete diets were prepared with 40% cotton straw, one processed in mash form and the other pelletized using an expander-extruder (EEP). These two full meals were compared to a traditional feeding method in which cotton straw and concentrate mixture were fed separately in a 60:40 ratios. In traditional, mash and EEP the DM consumption (kg) was 3.38, 4.13 and 4.76 kg whereas DMI per 100 kg body weight was 2.98, 3.20 and 3.25 kg respectively. In comparison to the other two groups, the calves on the EEP full diet consumed more DM ($p<0.01$).

Reddy and Reddy (2003) observed the effect of cotton stalks-based complete diet on growth characteristics in sheep and goats in field conditions. An experiment was undertaken on six Nellore ram lambs and six local male kids (4–5 months old). For 180 days, they were fed an expander extruder pressed pelleted complete feed prepared with cotton stalks as the only source of roughage (40%) and concentrates (60%). The DMI per animal (kg) was 138 and 121 for lambs and goats which were comparable.

Bhadane *et al.* (2004) investigated the effects of nutrient utilization in goats fed arhar straw (*cajanus cajan*) based pelleted complete feed. Twelve non-descript local goats were randomly divided into two treatment groups. Goats

under both the treatments were fed pelleted complete feed G1 (12% CP, 65.81% TDN) and G2 (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 arhar straw contained 94.0, 11.8, 2.7, 48.5 and 8.0% OM, CP, EE, NFE and lignin, respectively. Under T1 and T2, daily dry matter intake was 4.6 and 4.9 percent of B.wt., respectively. They concluded that the pelleted complete feed T1 met the nutritional needs of goats.

Rekhate *et al.* (2004) evaluated arhar and gram straw based pelleted complete feed in eighteen non-descript local goats (320 days old and 21.8 0.8 kg B.wt.), divided into three equal groups. For 110 days, they fed with pellets made from arhar straw complete feed (ASCF), gram straw complete feed (GSCF) and special arhar straw pellets supplemented with concentration pellets (ASCONC). In all of the diets, the roughage to concentrate ratio was kept constant at 60:40. The average daily dry matter intake was 1213.4g (ASCF), 1298.5g (GSCF) and 1425.2g (AS-CONC) respectively. However, under ASCF, GSCF, and AS-CONC percent DMI was 4.3, 4.5 and 5.3 kg respectively. The DMI was similar in goats fed complete feed pellets containing arhar or gram straw but was enhanced ($P<0.01$) in group fed arhar straw pellet supplemented with concentrate pellets.

Murthy and Prasad (2005) compared the inclusion level of stylo (*Stylosanthus hemata*; CR-1), horse gram (*Dolichos biflorus*; CR-2), cowpea (*Vigna sinensis*; CR-3) and sunhemp (*Crotolaria juncea*; CR-4) hays each at 70% level using 6 lambs (3 month; av. B.wt. 14 kg). During growth trial of 91 days, the respective complete rations were offered ad-libitum to meet the nutrient requirements as per ICAR (1985). Daily feed intakes during trial were recorded. Dry matter intake under CR-1, CR-2, CR-3 and CR-4 was 671, 575, 659 and 562 g/d, respectively. The dry matter intake was significantly lower ($P<0.05$) in lambs fed CR-2 (horse gram) 575g/d and CR-4 (sun hemp) 562g/d as compared to those fed other complete rations.

Rekhate *et al.* (2005) utilized gram (*cicer arietinum*) straw based pelleted complete ration in goats. Twelve nondescript local goats were used in this trial to assess two different diets with arhar straw (T1) and gram straw (T2) for 110 days.

The goats in T1 were fed arhar straw pellets with a daily allowance of 300g concentrate pellets, whereas the goats in T2 were fed complete feed pellets comprised of 60%-gram straw and 40% concentrate. The T1 had a higher dry matter intake (1425.19 g/d) than T2 (1298.44 g/d). Under T1 and T2, DMI/100 kg body weight was 5.25 and 4.45 kg respectively.

Abd Alla and Baharel (2007) observed the effect of inclusion of pigeon pea hay at different dietary levels on body weight on twentyfour male (3-4 months) Sudanese desert kids. Average daily dry matter intake was 508.75, 468.82, 487.89 and 478.50g for groups A, B, C and D, respectively.

Dhuria *et al.* (2007)[a] conducted trial to assess the effect of feeding three iso-nitrogenous complete feeds containing 40, 50and 60%-gram straw on dry matter intake on eighteen marwari rams. The dry matter intake was 87.9, 84.1 and 80.1 g/kg $W^{0.75}$ for three different rations respectively.

Dhuria *et al*. (2007)[b] evaluated three iso-nitrogenous complete feeds containing bajra straw at 40 (T1), 50 (T2) and 60 (T3) per cent levels in eighteen Marwari rams used for 28 days followed by a 7-day metabolism trial. T1, T2, and T3 had DMIs of 87.7, 85.4 and 81.8 g/kg $W^{0.75}$ respectively with no significant differences. They concluded that sheep could be effectively maintained on feeding complete feed containing bajra straw up to 60% level.

Rekhate *et al.* (2007) studied the performance of goats fed arhar (*cajanus cajan*) straw based pelleted complete ration in twelve non-descript local goats with average bwt. (21.61 ± 0.78 kg) & age (10.6 months) for 110 days. The goats were split into two groups at random and fed either *ad libitum* whole arhar straw pellets supplemented with concentrate pellets @ 300g/head/day (T1) or pelleted complete diet comprising 60% arhar straw (T2). The daily dry matter intake under T1 and T2 was 1425.19 ± 84.78 and 1213.39 ± 44.36 g respectively. They reported significant reduction in DMI in goats under T2 as compared to T1 and attributed to pelleted complete feed.

Rekhate *et al.* (2008) studied nutrient utilization and growth performance of goats on pelleted complete diets prepared from gram (*cicer arietinum*) straw and arhar (*cajanus cajan*) stalks. Eighteen local goats were divided into three groups and fed 12 percent CP and 60 percent TDN for 120 days on CMF/complete mash feed (T1), GSP gram straw pellets (T2), and ASP arhar (*cajanus cajan*) stalk pellets (T3). The daily dry matter intake was 841.5 (T1), 957.6 (T2), 921.6g (T3). The data for daily DMI revealed significant ($P<0.01$) differences among treatments.

Sihag *et al.* (2008) studied the utilization of pulses straw in complete pelleted feeds for growing lambs. In this experiment twenty Munjal male lambs (90 ± 6 days, 15.12 ± 0.237 kg B.wt.) were used for 120 days. The lambs were divided into 4 equal groups. The control group (C) was offered conventional ration maintaining roughage (4.2% CP) to concentrate (18.34% CP) ratio as 15:85. The conventional ration (C) was replaced with gram straw 60, mustard cake 12, deoiled rice bran 10 and barley 5% (GBP) or soybean straw 60, mustard cake 8, deoiled rice bran 9 and barley 10% (SBP) and black gram straw 60, mustard cake 5, deoiled rice bran 9 and barley 13% (BGBP) based pellets along with 10% molasses, 2% mineral mixture and 1% salt. All the three rations were iso-nitrogenous having roughage to concentrate ratio of 60:40 and fed ad-lib. The data for daily feed intake (g) were 736 (C), 766 (GBP), 611 (SBP), 798 (BGBP). Significantly lower feed intake was observed for SBP group as compared to other treatment groups.

Chopade *et al.* (2010) conducted study on 12 non-descript local kids (4 months age), by dividing them into two equal groups (7.85, 7.58 kg B.wt.). 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. Daily DMI was significantly ($P<0.01$) higher in TSS group (702.38g) than in UTSS group (680.08g).

Nagalakshmi and Reddy (2011) carried out an experiment to assess on farm performance of lambs and buffaloes fed expander extruder processed cotton stalks based complete diets. Thirty Nellore ram lambs (4-5month old) of average

body weights were randomly divided into two dietary groups. For 180 days, one group was fed an EEP diet containing 38.5 percent CS, while the other was provided a standard diet consisting of concentrates mixture and ad libitum sorghum stover. The lambs fed on expander extrusion pelletization diet utilized dry matter (DM) and with higher (P<0.01) feed efficiency.

Reddy *et al.* (2012) conducted trial on thirty two weaned Osmanabadi male kids of the ages 4 and 5 months and divided into four groups of eight animals each to evaluate two iso-nitrogenous complete mash feeds in which red gram straw was added at 35 and 50% levels, while total roughage content in both the rations was kept at 60%. The remaining component of the forage portion comprised of Lucaenea leaves. The experimental feeds (T1: mash with 35% red gram straw (RGS), T2: mash with 50% RGS, T3: pellet with 35% RGS, T4 pellet with 50% RGS) were randomly assigned to four treatment groups and animals in the respective groups were offered those feeds for 150 days. The data for dry matter intake for T1, T2, T3 and T4 were 432.06, 420.50, 672.69 and 670.21 g/d. The significantly (P<0.01) higher feed intake on pelleted diet might be due to soft, pliable and cooked nature of expandable extruded pellets together with natural disinclination of goats towards fines of feed.

Devsena and Prasad (2014) conducted growth trial with twelve non-descript weaned lambs (13.33 ± 0.62 kg av.B.wt.) for 120 days. During the growth trial they randomly divided the 12 lambs equally into two treatment groups. The animals were offered respective experimental feeds which comprised of ground nut haulms (C1) and gram bhusa (C2) based complete rations with roughage: concentrate ratio of 70:30, by adding 50% of each crop residue and 20% of sugarcane baggasse along with concentrate ingredient. All the experimental kids were provided feed and water ad-libitum. The average DMI during metabolism trial was 90.2 and 86.3 g/kg $W0^{0.75}$ in goat fed respective rations, which is equivalent to 3.8 and 3.6 kg/100kg body weight in groups CR-1 and CR-2, respectively. Although non-significant differences were observed, the DMI in groups I and II indicated that the palatability of complete rations was quite acceptable to the animals.

Jadhav (2019) studied the utilization of cotton stalk in complete pelleted feed in eighteen growing goats of 4- 6 months of age, divided in three equal groups and fed with three different dietary regimes as T0 (control), T1 and T2 groups. Goats in the control group was fed with pelleted feed comprising 60% gram straw and 40% concentrates, while in T1 group 25% gram straw was replaced by cotton stalk and in T2 group 50% gram straw was replaced by cotton stalk. Each ration was maintained in 60:40 roughage to concentrate ratio having 12% CP and 60% TDN. DMI (percent body weight) did not show significant variation between the groups. DMI was found to be significantly better in T1 group than that of T0 and T2 groups.

Kedaree *et al.* (2019) conducted an experiment to evaluate performance of growing goats fed paddy straw supplemented with graded levels of thespesia populneathe. Twelve crossbred bucks were used in a randomized block design for duration of 4 weeks. The treatments comprised of a Portia tree leaves and paddy straw supplemented with in 15:85, 30:70 and 45:55 for the treatment groups T1, T2 and T3, respectively. Concentrate @ 200 g/buck were offered to meet the nutritional requirement of the experimental animals on a dry matter basis. All animals were allowed *ad libitum* access to water and mineral lick. Supplementing paddy straw with Portia resulted in increased total DM intake from 636.83(T3), to 681.13 (T1), and 753.98 (T2) g/day. Intake of straw with Portia tree leaves significantly ($p>0.05$) influence the intake of straw in between the treatments T1, T2 and T3.

Shembekar (2019) studied the effect of utilization of ozone treated cotton stalk in pelleted complete feed of eighteen growing goats (4 to 6 months of age) for 90 days. The goats were randomly allotted to three dietary treatments as T0, receiving pelleted complete feed made from 60% gram straw as roughage and 40% concentrates, T1 receiving pelleted feed containing 15% ozone treated cotton stalk (OTCS) and 45% gram straw as roughages along with 40% concentrates while, T2 group received pelleted complete feed containing 30% OTCS and 30% gram straw and 40% concentrates. The roughage to concentrate ratio was maintained as 60:40 in each group. He concluded that, T1 group had significantly

($p \leq 0.01$) higher DMI than T2 group however; DMI in T0 group was comparable with T1 and T2 groups.

Ahmed *et al.* (2020) conducted growth trials on growing goats to assess the influence of complete pelleted feed on animal performance in both on-station and on-farm trials. A complete pelleted feed was d with 40% roughage (rice straw) and 60% concentrate [rice polish (50%), maize smash (16%), soybean meal (20%), molasses (10%), salt (2%), Dicalcium Phosphate (1%), vitamin–mineral premix (0.5%), and pellet binder (0.5%)] for commercial goat production. DM intake (DMI) did not differ significantly among the treatment groups (0.264, 0.245, and 0.272 kg/day for T1, T2 and T3 respectively), a numerically higher amount of DMI was observed in the pellet-feeding group (T3), which indicates that grinding and pelleting increased voluntary feed intake.

Muhammad I. Malik *et al.* (2020) evaluated the effect of physical form and level of wheat straw inclusion on growth performance and blood metabolites of fattening goat. Thirty-two male Beetal goats (27.4 ± 0.28 kg body weight (BW)) were divided randomly into the following four dietary treatments with 2 × 2 factorial arrangements (n = 8/treatment): (1) CTMR15 (conventional TMR containing 15% WS), (2) CTMR25 (conventional TMR containing 25% WS), (3) PTMR15 (pelleted TMR containing 15% WS), and (4) PTMR25 (pelleted TMR containing 25% WS). The dry matter intake (DMI) (1.265 vs. 1.044 kg/day) was higher ($p < 0.05$) in pelleted vs. conventional TMR-fed goats. Irrespective of the PF of the TMR, the 15% WS-fed animals had greater ($p < 0.05$) DMI (1.206 vs. 1.102 kg/day) when compared to those fed on 25% WS diets.

Muktiani *et al.* (2020) calculated the feed efficiency and income over feed cost of ettawa crossbred goats fed different quality of dry complete feed supplemented with mineral. Sixteen weaned female goats aged 4-month-old were used in this study. The experiment was conducted in factorial 2x2 in a completely randomized design with 4 replications and 2 factors. The first factor was different levels of energy and protein in the diets: 14% CP + 63% TDN (T1); and 16% CP + 67% TDN (T2). The second factor was the Zn-Se supplementation (treatment and control). The concentration of Zn and Se in the supplement were 20 mg/kg

and 0.2 mg/kg, respectively. feed requirement for goat weighing 10 kg and 20 of BW (with the BW gain 50 g/d) were 0.51 kg and 0.75 kg DM or equal with 3.75% and 5.10% BW, respectively.

2.3 Effect of Complete Pelleted Feed on Feed Conversion Efficiency

Durga Prasad *et al.* (1986) carried out growth study on thirty-two Nellore Brown weaned lambs (11.16 kg) for 84 days to evaluate four different diets. These four diets were formulated by blending groundnut haulm (10.38% CP) with a conventional concentrate mixture (14.75% CP) in the ratios of 80:20 (CR-1), 60:40 (CR-2), 40:60 (CR-3) and 20:80 (CR-4). 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 treatments 2 or among the treatment 2 to 4 were not significant.

Prasad *et al.* (1999) conducted trial to evaluate three iso-nitrogenous complete diets (CR) containing groundnut haulm at 50 percent (CR-1), 60 percent (CR-2), and 70 percent (CR-3) levels. Twelve growing Nellore Brown lambs (14.20 0.1 kg BW) were used in a trial Under CR-1, CR-2, and C-3. The lambs required 10.41, 10.80 and 11.80 kg DM per kg growth ($P>0.05$), respectively. According to feeding strategies used in experimental trial, lambs given CR-1 or CR-2 required less DM per unit growth than lambs fed CR-3.

Reddy and Reddy (2003) investigated the effect of a cotton stalks-based complete diet on growth characteristics in sheep and goats in field conditions. A trial was undertaken on six Nellore ram lambs and six local male kids (4–5 months old) for 180 days, and fed an expander extruder pressed pelleted complete feed formulated with cotton stalks as the only source of roughage (40%) and concentrates (60%). The feed conversion efficiency was 7.5 and 8.3 kg in sheep and goats which shows 10.6% higher DMI/kg gain in goats which might be an indication of low ADG observed in goats.

Murthy and Prasad (2005) used six lambs (3 month; av. B.wt. 14 kg) for each diet for comparing the inclusion level of stylo (*Stylosanthus hemata*; CR-1), horse gram (*Dolichos biflorus*; CR-2), cowpea (*Vigna sinensis*; CR-3) and sunhemp (*Crotolaria juncea*; CR-4) hays each at 70% level. During growth trial of 91 days, the respective complete rations were offered ad-libitum to meet the nutrient requirements as per ICAR (1985). Significantly lower feed efficiency ($P<0.05$) of 7.3 was noticed in lambs fed ration containing horse gram hay than those containing *stylohemata* (10.1), cowpea (9.3) and Sunhemp (9.6). They opined that dry matter intake and body weight gains depend upon quality of roughage source included in the rations.

Rekhate *et al.* (2007) studied the performance of goats fed arhar (*cajanus cajan*) straw based pelleted complete ration on twelve non-descript local goats with average bwt. (21.61 ± 0.78 kg) & age (10.6 months) for 110 days. The goats were split into two groups at random and fed either *ad libitum* whole arhar straw pellets supplemented with concentrate pellets @ 300g/head/day (T1) or pelleted complete diet comprising 60% arhar straw (T2). Feed conversion efficiency of goats under both the ration was 15.02 ± 2.67 and 14.52 ± 1.62 kg/kg gain for T1 and T2, respectively. Feed conversion efficiency was better in T2 group may be attributed to pelleted complete feed.

Sihag *et al.* (2008) utilized pulses straw in complete pelleted feeds for growing lambs. In this experiment twenty Munjal male lambs divided into 4 equal groups (90 ± 6 days, 15.12 ± 0.237 kg B.wt.) were used for 120 days. The control group (C) was offered conventional ration maintaining roughage (4.2% CP) to concentrate (18.34% CP) ratio as 15:85. The conventional ration (C) was replaced with gram straw 60, mustard cake 12, deoiled rice bran 10 and barley 5% (GBP) or soybean straw 60, mustard cake 8, deoiled rice bran 9 and barley 10% (SBP) and black gram straw 60, mustard cake 5, deoiled rice bran 9 and barley 13% (BGBP) based pellets along with 10% molasses, 2% mineral mixture and 1% salt. All the three rations were iso-nitrogenous having roughage to concentrate ratio of 60:40 and fed *ad libitum*. The feed intake/unit body weight gain was lowest (5.75) in diet C followed by SBCP (7.53), BGBP (7.98) and GBP (8.06). These results

indicated that black gram straw based pelleted diet was the best among the three straw based pelleted diets.

Reddy *et al.* (2012) conducted an experiment on thirty two weaned male kids of Osmanabadi breed in the age group of 4 to 5 months which were divided into 4 groups of eight animals each to evaluate two iso-nitrogenous complete mash feeds in which red gram straw was incorporated at 35 and 50% level maintaining total roughage content in both the ration at 60% level. The remaining component of the forage portion comprised of *Lucaenea* leaves. The experimental feeds (T1: mash with 35% red gram straw (RGS), T2: mash with 50% RGS, T3: pellet with 35% RGS, T4: Pellets with 50% RGS) were randomly assigned to four treatment groups and animals in the respective groups were offered those feeds for 150 days. At the end of experiment, the feed conversion efficiency (kg DM/kg gain) for T1, T2, T3 and T4 was recorded as 8.39, 9.41, 8.64 and 9.24 which were comparable among all the treatment groups.

Devsena and Prasad (2014) carried out an experiment in two phases and a metabolism trial of 7 days with four local non- descript adult bucks (32.5 ± 0.45 kg av.B.wt.) and growth trial with twelve non- descript weaned lambs (13.33 ± 0.62 kg av.B.wt.) for 120 days. During the growth trial they randomly divided the 12 lambs equally into two treatment groups. The animals were offered respective experimental feeds which comprised of ground nut haulms (C1) and gram bhusa (C2) based complete rations with roughage: concentrate ratio of 70:30, by adding 50% of each crop residue and 20% of sugarcane baggasse along with concentrate ingredient. Feed conversion efficiency was 23.52 and 23.48 for CR-1 and CR-2. The feed efficiency observed in the present study in both the groups was comparable. The proportionate intake of roughage and concentrates as complete feed causes optimum rumen environment and hence animals showed better performance.

Jadhav (2019) studied the utilization of cotton stalk in complete pelleted feed in eighteen growing goats of 4- 6 months of age, divided in three equal groups and fed with three different dietary regimes as T0 (control), T1 and T2 groups. Goats in the control group was fed with pelleted feed comprising 60%

gram straw and 40% concentrates, while in T1 group 25% gram straw was replaced by cotton stalk and in T2 group 50% gram straw was replaced by cotton stalk. Each ration was maintained in 60:40 roughage to concentrate ratio having 12% CP and 60% TDN. He concluded that FCE were found to be significantly better in T1 group than that of T0 and T2 groups.

Kewan *et al.* (2019) studied nutritive utilization of *Moringa oleifera* tree stalks treated with fungi and yeast to replace clover hay in growing lambs to measure growth performance. Twenty four Barki lambs with an average body weight of 20.7 ± 0.17 kg were used in a complete randomized design to evaluate the effects of replacing clover (*Trifolium alexandrinum L*) hay as a traditional basal diet (C) with moringa tree stalks (MS) treated with fungi (*Trichoderma reesei*) (MF) and yeast (*Saccharomyces cervisiae*) (MY) under solid-state fermentation on nitrogen and water metabolism, rumen fermentation and economic efficiency of feeds. Lambs were divided into three groups each with eight lambs depending on their live weight. Concentrate feed mixture was similar for all groups and was offered at 2% of live weight with the basal roughage offered *ad libitum*. MY diet recorded the highest (P\0.05) economical feed efficiency compared with MF and control diet. These results suggest that treatment of moringa stalks with *S.cerevisiae* for 21 days in a solid-state fermentation system improved its nutritive value and is more suitable for practical feeding in sheep rations

Kedaree *et al.* (2019) studied the performance of growing goats fed paddy straw supplemented with graded levels of *Thespesia populnea.* Twelve crossbred bucks were used in a randomized block design for duration of 4 weeks. The treatments comprised of a Portia tree leaves and paddy straw supplemented with 15:85, 30:70 and 45:55 for the treatment groups T1, T2 and T3, respectively. Concentrate @ 200 g/buck were offered to meet the nutritional requirement of the experimental animals on a dry matter basis. All animals were allowed *ad libitum* access to water and mineral lick. The treatment groups differed significantly in terms of feed conversion efficiency ($p<0.05$).

Shembekar (2019) studied the effect of utilization of ozone treated cotton stalk in pelleted complete feed of eighteen growing goats (4 to 6 months of age) for 90 days. The goats were randomly allotted to three dietary treatments as T0, receiving pelleted complete feed made from 60% gram straw as roughage and 40% concentrates, T1 receiving pelleted feed containing 15% ozone treated cotton stalk (OTCS) and 45% gram straw as roughages along with 40% concentrates while, T2 group received pelleted complete feed containing 30% OTCS and 30% gram straw and 40% concentrates. The roughage to concentrate ratio was maintained as 60:40 in each group. The FCR was significantly ($p \leq 0.01$) higher in T1 group as compared to other groups. He concluded that utilization of OTCS at 25% of total roughage source in pelleted complete feed proved to be more economical for rearing of growing goats under stall fed condition.

Ahmed *et al.* (2020) conducted growth trials on growing goats to assess the influence of complete pelleted feed on animal performance in both on-station and on-farm. A complete pelleted feed was formulated with 40% roughage (rice straw) and 60% concentrate [rice polish (50%), maize smash (16%), soybean meal (20%), molasses (10%), salt (2%), Dicalcium Phosphate (1%), vitamin–mineral premix (0.5%), and pellet binder (0.5%)] for commercial goat production. Feed Conversion Ratio was considerably lower (5.7) in the pellet feeding group than in the other groups where no pellet feed was used (8.32 and 8.03).

Muhammad I. Malik *et al.* (2020) evaluated the effect of physical form and level of wheat straw inclusion on growth performance and blood metabolites of fattening goat. Thirty-two male Beetal goats (27.4 ± 0.28 kg body weight (BW)) were divided randomly into the following four dietary treatments with a 2 × 2 factorial arrangement (n = 8/treatment): (1) CTMR15 (conventional TMR containing 15% WS), (2) CTMR25 (conventional TMR containing 25% WS), (3) PTMR15 (pelleted TMR containing 15% WS), and (4) PTMR25 (pelleted TMR containing 25% WS). Feed-to-gain ratio (F: G) was higher ($p < 0.05$) in the 25% WS-fed goats when compared with the 15% WS-fed animals.

Muktiani *et al.* (2020) calculated the feed efficiency and income over feed cost of ettawa crossbred goats fed different quality of dry complete feed

supplemented with mineral. Sixteen weaned female goats aged 4-month-old were used in this study. The experiment was conducted in factorial 2x2 in a completely randomized design with 4 replications and 2 factors. The first factor was different levels of energy and protein in the diets: 14% CP + 63% TDN (T1); and 16% CP + 67% TDN (T2). The second factor was the Zn-Se supplementation (treatment and control). The concentration of Zn and Se in the supplement were 20 mg/kg and 0.2 mg/kg, respectively The T2 diets plus Zn-Se supplement resulted in the highest feed efficiency (11.82%) as well as income over feed cost (IDR. 1,722 head/d).

2.4 Effect of Complete Pelleted Feed on Rumen Fermentation Profile

Raut *et al.* (2002) evaluated the pelleted complete feed comprised of 60% *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%) on local non-descript male goats. The rumen liquor pH on 0, 7, 14, 21 and 28th day of experiment was 7.03, 6.83, 6.83, 6.98 and 6.75, respectively, whereas the NH_3-N and TVFA concentrations in SRL on the respective days were 8.76, 13.33, 14.06, 13.01 and 13.37 mg/100 ml SRL and 4.01, 6.61, 8.74, 8.81 and 8.23 mEq/100 ml SRL, respectively.

Thirumalesh *et al.* (2003) studied the effect of feeding bajra straw based complete diet on performance of adult sheep in 3×3 Latin square design (LSD). The sheep were fed experimental diets T1 (control) containing 40% ground bajra straw and 60% concentrate mixture separately, T2 complete diet (pellet) and T3 complete diet (mash). All the diets were offered *ad libitum*. At the end of each period, the SRL samples were collected 4-times from each animal, once before feeding (0 hr) and other after feeding at 2hr intervals. The non significant differences were observed for pH (values were 6.38, 6.65 and 6.58, under T1, T2 and T3, respectively). The concentration of NH_3-N the value was 10.40, 08.71, 9.24 and 08.09 mg/100 ml at 6 hrs and TVFA concentrations in the rumen fluid were non-significant ($P>0.05$) among different period of rumen liquor collection. The concentration of total-N (for T1, T2, and T3 were 103, 118 and 89.50 mg/100 ml) differed significantly ($P>0.05$). All nitrogen fractions (at 0, 2, 4 and 6 hrs.)

were studied and the values for Total-N were 107.33, 93.55, 101.78 and 112.22 mg/100 ml, respectively. For TCA- insoluble protein N the values were 18.00, 16.22, 17.70 and 19.19 mg/100 ml. The result indicated that bajra straw can be incorporated in complete diet of sheep as a sole source of roughage at 40% level.

Rekhate *et al.* (2004) evaluated arhar (pigeon pea) and gram straw based pelleted complete feed. For this experiment eighteen non-descript local goats (320 d old and 21.8 ± 0.8 kg B.wt.) were divided into 3 equal group. They offered complete feed pellets based either on arhar straw complete feed (ASCF), gram straw complete feed (GSCF) and special arhar straw pellets supplemented with concentrate pellets (ASCONC) for 110 days. The roughage to concentrate ratio was maintained at 60:40 in all the diets. The level of NH3-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; 19.5, 7.0, 88.1, 43.5 and 44.5 under ASCF, GSCF and AS-CONC groups, respectively. The significantly ($P<0.05$) lower NH3-N and NPN concentrations in rumen liquor of goats fed AS-CONC diet were responsible for significantly ($P<0.05$) higher TCA-ppt as compared to other groups. The highest ($P<0.05$) TVFA production was observed in rumen of goats fed arhar straw based complete feed pellets as compared to other groups.

Rekhate *et al.* (2005) conducted a trial to assess the effect of supplementation of two different diets comprised of arhar straw (T1) and gram straw (T2) for 110 days. Twelve non- descript local goats with average body wt & age were used for this trial. The goats under T1 were fed arhar straw pellet and daily allowance of 300g concentrate pellet whereas the goat under T2 were offered complete feed pellets composed of gram straw 60% and 40% concentrate. The values were for pH (6.65; T1 and 6.74; T2) and NH_3-N (mg/100 ml SRL) [19.53; T1and 20.17; T2] similarly values for Total nitrogen was (mg/100 ml SRL) [88.10; T1 and 92.16; T2]. The values for TVFA were (mEq/100 ml SRL) [6.98; T1 and 5.30; T2] and values for NPN was (mg/100 ml SRL) [44.53; T1 and 51.20; T2]. Rumen liquor study revealed significant ($P<0.01$) variation for all the parameters except for TCA precipitate nitrogen between two treatments.

Raghuvanshi *et al.* (2007) assessed the influence of inclusion of dried *Azardirachta indica* (NL), Albizzia lebbaek (SL) or Alinthus excelsa (AL) leaves in pearl millet stovers (PMS) based complete feed block (CFB) diets on 48 Malpura rams, divided in four equal groups. The complete feed block (CFB) was formulated to have roughage to concentrate ratio of 70:30. The pearl millet stover (PMS) was used as basal roughage and 30 parts of PMS was replaced with dried leaves either of NL, SL, AL and the rams were offered one of the four dietary treatments. The pH of SRL was 7.03, 7.01, 7.10 in PMS, NL and SL groups, respectively and was low (6.99) in AL ($P<0.05$). But total-N (52.9 mg/dl SRL) and NH_3 –N (9.34 mg/dl SRL) concentrations were higher ($P<0.01$) for the ration containing AL in comparison to NL (46.61 mg/dl and 9.07 mg/dl, respectively), PMS (45.23 mg/dl and 7.02 mg/dl, respectively), and SL (39.07 mg/dl and 8.30 mg/dl, respectively). The values for TVFA concentrations under PMS NL, SL and AL were 9.93, 10.73, 9.94 and 10.42 mmole/100ml SRL, respectively. The TVFA levels were similar among the rams fed different types of complete feed blocks, whereas the concentrations of TVFA and NH_3-N increased up to 6 hrs post feeding and, thereafter slowly declined. Animals in the four groups had the desired concentrations of rumen metabolites required for fibrous diets which led to optimization of rumen fermentation.

Rekhate *et al.* (2007) performed an experiment on 12 non-descript local goats with average bwt. (21.61 ± 0.78 kg) & age (10.6 months) for 110 days. The goats were randomly divided into two equal groups and were fed ad lib. Sole arhar straw pellets supplemented with concentrate pellets @ 300g/head/day (T1) or pelleted complete diet containing 60% arhar straw (T2). The rumen fermentation study revealed pH (6.50± 0.095and 6.71±0.10) and NH_3-N (mg/100 ml SRL) [19.53±0.48 and 20.52±0.16], similarly TVFA values were (mg/100 ml SRL) [6.98a±0.11 and 9.40b±0.18] however, values for Total N was (mg/100 ml SRL) [88.10±3.03 and 82.80±1.62]. The values for TCAppt- N was (mg/100 ml SRL) [43.49±2.96 and 31.60±1.63] and for NPN was (mg/100 ml SRL) [44.53±0.74 and 51.13±0.62], respectively. Rumen fermentation profile conducted fortnightly indicated significant variation ($P<0.01$) for all the parameters between two treatments.

Rekhate *et al.* (2008) divided 18 local goats in 3 groups and fed CMF/complete mash feed (T1), GSP gram straw pellets (T2) and ASP arhar (pigeon pea) stalk pellets (T3) having 12% CP and 60% TDN for 120 days. The rumen liquor profile was studied fortnightly, and revealed significant ($P<0.01$) differences for pH and NPN, the values were for pH– 6.41 (T1), 6.71 (T2), 6.68 (T3) and Non protein nitrogen (NPN mg/100 ml), 44.5 (T1), 42.8 (T2), (39.95) (T3).

Chopade *et al.* (2010) conducted study on 12 non-descript local kids (4 months age), by dividing them into two equal groups (7.85, 7.58 kg B.wt.). 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-ppt and NPN values were 6.62 and 6.70; 19.02 and 19.97 mg/dl SRL; 9.16 and 9.48 mEq/dl SRL; 91.07 and 98.40 mg/dl SRL; 38.25 and 42.20 mg/dl SRL and 53.05 and 56.37 mg/dl SRL under TSS and TUSS groups, respectively which revealed significant ($P<0.05$) variation between the groups.

Mudgal *et al.* (2012) conducted a study on ten barbari growing male kids divided into two groups of 5 animals each to evaluate ammoniated (4% urea with 50% moisture level) lentil (*Lens culinaris*) straw (ALS) and its total mixed ration (TMR). They were fed either ALS *ad libitum* or ALS based TMR (ALSTMR). Rumen pH ($P<0.05$), was reduced while TVFA increased in the ALSTMR fed group over the ALS group.

Jadhav (2019) studied the utilization of cotton stalk in complete pelleted feed in eighteen growing goats of 4- 6 months of age, divided in three equal groups and fed with three different dietary regimes as T0 (control), T1 and T2 groups. Goats in the control group was fed with pelleted feed comprising 60% gram straw and 40% concentrates, while in T1 group 25% gram straw was replaced by cotton stalk and in T2 group 50% gram straw was replaced by cotton stalk. Each ration was maintained in 60:40 roughage to concentrate ratio having 12% CP and 60% TDN. There were no significant variation in pH, NH_3-N, Total-N, TCA-ppt-N and NPN, Whereas TVFA production was significantly higher in

T1 group. He concluded that cotton stalk in complete pelleted feed of growing goats can be effectively utilized upto 50% of total roughage source without any adverse effect on rumen fermentation of goats.

Kewan *et al.* (2019) studied the nutritive utilization of *Moringa oleifera* tree stalks treated with fungi and yeast to replace clover hay in growing lambs. Twenty-four Barki lambs with an average body weight of 20.7 ± 0.17 kg were used in a complete randomized design to evaluate the effects of replacing clover (*Trifolium alexandrinum* L) hay as a traditional basal diet (C) with moringa tree stalks (MS) treated with fungi (*Trichoderma reesei*) (MF) and yeast (*Saccharomyces cervisiae*) (MY) under solid-state fermentation on nitrogen and water metabolism, rumen fermentation and economic efficiency of feeds. Lambs were divided into three groups each with eight lambs depending on their live weight. Concentrate feed mixture was similar for all groups and was offered at 2% of live weight with the basal roughage offered *ad libitum*. There were no differences ($P<0.05$) among groups in N and water balance. Rumen NH_3-N concentrations for the MF and MY groups peaked ($P \leq 0.05$) at 3 h post feeding whereas for the control it peaked at 6 h post feeding. Rumen TVFA's concentrations for all treatments increased gradually from zero to 6 h post-feeding.

Shembekar (2019) studied the effect of utilization of ozone treated cotton stalk in pelleted complete feed of eighteen growing goats (4 to 6 months of age) for 90 days. The goats were randomly allotted to three dietary treatments as T0, receiving pelleted complete feed made from 60% gram straw as roughage and 40% concentrates, T1 receiving pelleted feed containing 15% ozone treated cotton stalk (OTCS) and 45% gram straw as roughages along with 40% concentrates while, T2 group received pelleted complete feed containing 30% OTCS and 30% gram straw and 40% concentrates. The roughage to concentrate ratio was maintained as 60:40 in each group. There were significant ($P\leq0.01$) variations in rumen TVFA, NH_3-N and total nitrogen while, rumen pH, TCA-ppt-N and NPN concentration were comparable. He concluded that, OTCS can be utilized up to

50% of the roughage source in pelleted complete feed of goats without any adverse effect on health and ruminal ecosystem.

Muhammad I. Malik *et al.* (2020) carried out an experiment to effect of physical form and level of wheat straw inclusion on growth performance and blood metabolites of fattening goat. Thirty-two male Beetal goats (27.4 ± 0.28 kg body weight (BW)) were divided randomly into the four dietary treatments with 2 × 2 factorial arrangements (n = 8/treatment): (1) CTMR15 (conventional TMR containing 15% WS), (2) CTMR25 (conventional TMR containing 25% WS), (3) PTMR15 (pelleted TMR containing 15% WS), and (4) PTMR25 (pelleted TMR containing 25% WS). Rumen pH was higher (p = 0.053) in the CTMR as compared to the PTMR.

Santoso *et al.* (2021) studied the nutrient digestion and ruminal fermentation of goats on a complete feed block (CFB) that incorporated agro-industrial by-products and were high in fibre and cellulolytic bacteria. Three Kacang goats, a native Indonesian breed, were used in a 3 × 3 Latin square experimental design with i) CFB without microbes (control), ii) CFB containing 1% *Pseudomonas aeruginosa* and 1% *Acinetobacter baumannii*, and iii) CFB containing 2% *Pseudomonas aeruginosa* and 2% *Acinetobacter baumannii*. Microbes in the CFBs consisted of lactic acid bacteria, yeast and cellulolytic bacteria that ranged from 106 to 108cfu/g. The goats were fed each day at 8 hrs and 16 hrs. The addition of *Pseudomonas aeruginosa* and *Acinetobacter baumannii* at 2% level increased (P <0.05) ruminal acetate and TVFA.

2.5 Effect of Complete Pelleted Feed on Digestibility

Durga Prasad *et al.* (1986) conducted growth study on thirty two Nellore Brown weaned lambs (11.16 kg) for 84 days to evaluate four different diets. The four diets were formulated by blending groundnut haulm (10.38% CP) with a conventional concentrate mixture (14.75% CP) in the ratios of 80:20 (CR-1), 60:40 (CR-2), 40:60 (CR-3) and 20:80 (CR-4). 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 CR-1 to CR-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 digestibility's of DM (56.48, 60.39, 61.13 and 63.37%), CP (54.30, 61.12, 59.88 and57.69%), 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 CR-2 and CR-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 ($P>0.05$).

Kumar *et al.* (1989) used sixteen Nellore brown weaned ram lambs (14.34 kg av. B.wt.) which were divided into 4 groups following completely randomized design for the period of 90 days growth experiment. Under second experiment, these rations were fed to 4 Nellore brown rams (25.98 kg av. B.wt.) to evaluate four iso-nitrogenous complete rations, processed into mash form by incorporating cowpea hay at 70 (CR-1), 60 (CR-2), 50 (CR-3) and 40% (CR-4) as sole source of roughage. In both experiments, the animals were fed the respective rations ad-lib. The digestibility (%) of DM, OM and CP was 63.32 ± 1.23, 63.00 ± 1.67, 64.20 ± 0.56 and 63.98 ± 3.20; 64.05± 1.53, 64.55 ± 1.56, 66.95 ± 0.96 and 66.30 ± 2.76 and72.94 ± 1.82, 73.55 ± 2.22, 73.01 ± 2.98 and 77.47 ± 2.37, respectively for CR-1, CR-2, CR-3 and CR-4. Similarly, the digestibility (%) of EE, CF and NFE was 32.84 ± 1.13, 38.4 ± 8.95, 56.67 ± 5.17 and 63.09 ± 2.87; 42.54 ± 3.06, 39.19 ± 1.60, 37.45 ± 3.29 and 33.23 ± 3.29 and 67.72 ± 2.89, 69.38 ± 4.03, 79.24 ± 2.46and 72.05 ± 3.90, respectively under CR-1, CR-2, CR-3 and CR-4. The digestibility (%) of NDF for CR-1, CR-2, CR-3 and CR-4 was 57.07 ± 2.00, 49.12 ± 3.45, 46.71 ± 1.18 and 46.86 ± 3.02, respectively. The increased digestibility of CP and EE with decreased proportion of cowpea hay from CR-1 to CR-4 indicated that these fraction from cowpea hay were less digestible compared to those from concentrate. Significantly higher digestibility recorded for NDF with increased proportion of cowpea hay in the ration indicated that these fractions were better utilised at higher levels of roughage in the rations.

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 haulm 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 was significantly ($P<0.01$) higher in conventional concentrate group (53.47, 60.70, 57.64 and 67.94%, respectively). However, the CF digestibility was higher ($P<0.01$) in silage fed group (56.06%) than the other group (42.33%). The silage fed rams consumed significantly ($P<0.01$) higher CP 7.79g and DCP 3.71g/kg W0.75 than the corresponding values on conventional concentrate and gram straw-based ration (5.03g and 2.90g/kg W0.75, respectively).

Rajmane and Desmukh (2000) tested three full meals consisting 60 percent sorghum straw (C1), soyabean straw (C2), and maize cobs (C3) each with 40 percent concentrate combination on fifteen adult non-pregnant goats of the Osmanabadi breed. They divided the goats into three groups, each containing five goats of equal body weight. The digestibility of DM, CP, CF, EE and NFE under C1, C2 and C3 was 47.31 ± 2.06, 60.16 ± 1.75 and 64.81 ± 2.78; 79.60 ± 4.26, 81.04 ± 2.01 and 85.63 ± 2.76; 49.29 ± 3.10, 58.84 ± 1.37 and 67.38 ± 3.4; 79.50 ± 2.09, 76.28 ± 2.68 and 46.81 ± 6.59 and 45.49 ± 1.41, 58.11 ± 3.45 and 63.72 ± 2.73, respectively. The digestibility of DM, NFE ($P<0.01$) and CF ($P<0.05$) was higher on CR-3 compared to C1 while the digestibility of EE was higher ($P<0.01$) on C1 compared to C3. The CP digestibility did not vary among the groups.

Yadav and Desmukh (2001) evaluated two complete ration containing wheat straw (CR-1) and spent straw (CR-2) each at 60% level in crossbred sheep. The DCP and TDN contents were 5.35, 56.10 and 7.09, 41.68% for CR-1 and CR-2, respectively. They reported that digestibility of DM, NFE, NDF and ADF was significantly higher on C1 than on C2.

Raut *et al.* (2002) conducted a trial on local non-descript male goats to evaluate the pelleted complete feed containing 60% *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%). The values for DCP and TDN content of the complete feed were 8.95 and 55.12%, 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).

Bhadane *et al.* (2004) conducted a study on twelve non-descript local goats which were randomly divided into two treatment groups to assess the effect of pelleted complete feed of varying protein levels on body weight. Goats under both the treatments were fed complete pelleted feed T1 (12% CP, 65.81% TDN) and T2 (14% CP, 67.44% TDN) containing arhar (pigeon pea) 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. . It was found that the digestibility of nutrients in the 2 diets was statistically comparable except that of (NDF) and ADF. The digestibility of NDF and ADF was 61.1 (T1) and 65.5 (T2) and 45.2 (T1) and 49.7% (T2), respectively. The values were ($P<0.05$) higher in T2 than that of T1. The reverse trend was observed for NFE digestibility 74.2 (T1) and 71.0% (T2). Dry matter digestibility was 66.9 (T1) and 66.2% (T2). The digestible crude protein (DCP) and total digestible nutrient (TDN) values were 8.5 and 65.8% in T1 and 9.9 and 67.4% in T2 group, respectively.

Rekhate *et al.* (2004) conducted a growth trial on eighteen non-descript local goats (320 d old and 21.8 ± 0.8 kg B.wt.) which were divided into 3 equal group to evaluate arhar (pigeon pea) and gram straw based pelleted complete feed. They offered complete feed pellets based either on arhar straw complete feed (ASCF), gram straw complete feed (GSCF) and special arhar straw pellets supplemented with concentrate pellets (ASCONC) for 110 days. The roughage to concentrate ratio was maintained at 60:40 in all the diets. The DM digestibility was 53.6, 56.2 and 51.3% in goat for (ASCF), (GSCF) and (AS-CONC) respectively. The digestibility of most of the nutrients (OM, CP and EE) was significantly higher in goats fed gram straw based pelleted complete feed.

Murthy and Prasad (2005) used six lambs (3 month; av. B.wt. 14 kg) for each diet for comparing the inclusion level of stylo (*Stylosanthus hemata*; CR-1), horse gram (*Dolichos biflorus*; CR-2), cowpea (*Vigna sinensis*; CR-3) and

sunhemp (*Crotolaria juncea*; CR-4) hays each at 70% level. During growth trial of 91 days, the respective complete rations were offered *ad-libitum* to meet the nutrient requirements. The nutrient digestibility for Dry matter (70.8, 73.7, 73.9 and 77.5%), Organic matter (72.3, 75.1, 75.5 and 78.8%), Crude protein (71.9, 79.3, 65.1 and 77.1%), similarly digestibility of Ether extract, crude fibre and Nitrogen free extract was 70.5, 82.8, 76.8 and 81.3%, 68.3, 69.9, 70.9 and 74.5% and 79.6, 76.8 85.5 and 80.7%, respectively under CR-1, CR-2, CR-3 and CR-4 rations. Digestibility of Neutral detergent fibre and acid detergent fibre was 71.6, 75.2, 76.7 and 80.4% and 71.2, 74.5, 76.2 and 79.5%, respectively. Higher digestibility of CP and EE in sheep fed with CR-2 was observed. Digestibility of DM, OM, CF, NDF and ADF were higher in sheep fed CR-4 having sun hemp hay as roughage source at 70% level.

Rekhate *et al.* (2005) undertaken a trial on twelve non- descript local goats with average body wt & age to assess the effect of supplementation of two different diets comprised of arhar straw (T1) and gram straw (T2) for 110 days. The goats under T1 were fed arhar straw pellet and daily allowance of 300g concentrate pellet whereas the goat under T2 were offered complete feed pellets composed of gram straw 60% and 40% concentrate. The values for digestibility (%) of DM and OM in T1 and T2 were 51.25and 56.17; 51.31 and 58.42. Similarly, digestibility of CP and CF was 59.57 and 72.77; 69.79 and 75.38, while that of EE and NFE was 67.37 and 76.33; 36.16 and39.70. Digestibility of NDF in both the group was 57.68 and 59.90 and ADF was 58.91 and 62.21. The digestibility coefficient for OM, CF, EE ($P<0.05$) and CP ($P<0.01$) were higher in T2 than T1.

Dhuria *et al.* (2007) conducted feeding trail on eighteen Marwari rams for 28 days followed by the metabolism trial for 7 days to evaluate three iso-nitrogenous complete feeds containing bajra straw at 40 (T1), 50 (T2) and 60 (T3) per cent levels. The digestibility of nutrients except NFE was comparable in all the groups. Digestibility (%) of NFE, NDF, ADF and hemicellulose was 70.5, 48.5, 42.0 and 56.6, respectively in T1; 67.1, 49.6, 43.1 and 60.1, respectively in T2; 65.6, 52.0, 46.0 and 63.5, respectively in T3. The DCP intake was 8.38, 7.60

and 6.79 g/kg $W^{0.75}$/d in ram fed T1, T2 and T3 complete feeds, respectively and differed significantly. The values for TDN intake (g/kg $W^{0.75}$/d) were 53.6 in T1, 50.0 in T2 and 47.1 in T3 and differed significantly. The result indicated that incorporation of mustard straw up to 60 % level had no adverse effect on digestibility of nutrients and sheep could be effectively maintained on 60% level.

Rekhate *et al.* (2007) conducted an experiment on 12 non-descript local goats with average bwt. (21.61 ± 0.78 kg) & age (10.6 months) for 110 days. The goats were randomly divided into two equal groups and were fed *ad-libitum*. Sole arhar straw pellets supplemented with concentrate pellets @ 300g/head/day (T1) or pelleted complete diet containing 60% arhar straw (T2). The digestibility (%) of DM was (51.25 ± 1.60 and 53.59 ± 1.31) and OM (51.31 ± 1.51 and 55.89 ± 1.45) under T1 and T2, respectively. Digestibility of CP was (59.57 ± 2.57 and 64.00 ± 1.90%) and CF (69.79 ± 1.64 and 66.36 ± 3.99%), while that of EE (67.37 ± 2.60 and 74.17 ± 2.26%) and NFE (36.16 ± 1.67 and 45.38 ± 1.03%) under T1 and T2, respectively. The digestibility coefficient for different nutrient found to be non-significant except for NFE digestibility.

Rekhate *et al.* (2008) divided eighteen local goats in 3 groups and fed CMF/complete mash feed (T1), GSP gram straw pellets (T2) and ASP arhar (pigeon pea) stalk pellets (T3) having 12% CP and 60% TDN for 120 days. The digestibility of DM was 54.29, 60.48 and 56.56%; crude protein was 67.08, 78.10 and 68.87%; NFE was 64.11, 77.35 and 64.73%; ether extract was 72.52, 82.90 and 75.81% for T1, T2 and T3, respectively. The digestibility coefficients of different nutrients revealed significant ($P<0.01$) differences for CP, NFE, EE and were higher in test diets as compared to control (T1).

Sihag *et al.* (2008) examined twenty Munjal male lambs (90 ± 6 days, 15.12 ± 0.237 kg B.wt.) for 120 days. The lambs were divided into 4 equal groups. The control group (C) was offered conventional ration maintaining roughage (4.2% CP) to concentrate (18.34% CP) ratio as 15:85. The conventional ration (C) was replaced with gram straw 60, mustard cake 12, deoiled rice bran 10 and barley 5% (GBP) or soybean straw 60, mustard cake 8, deoiled rice bran 9 and barley 10% (SBP) and black gram straw 60, mustard cake 5, deoiled rice bran

9 and barley 13% (BGBP) based pellets along with 10% molasses, 2% mineral mixture and 1% salt. All the three rations were iso-nitrogenous having roughage to concentrate ratio of 60:40 and fed ad-lib. The digestibility (%) of dry matter, ether extract and crude fibre for C, GBP, SBP, BGBP was 59.5, 49.9, 48.9and 56.7; 57.1, 50.4, 48.3 and 52.2 and 51.5, 41.4, 31.9 and 53.6, respectively. Similarly, digestibility of crude protein and nitrogen free extract was 60.7, 57.4, 53.1and 55.6% and 75.3, 62.5, 66.6 and 67.5%, respectively. Digestibility of Neutral detergent fibre and acid detergent fibre was 48.4, 38.1, 30.6 and 49.3% and 42.3, 32.5, 26.3 and 43.8%. The digestibility of all nutrients was lower ($P<0.05$) IN GBP and SBP diets compared to C diet, may be because of higher proportions of straw in GBP and SBP diets, whereas the differences for DM, NDF, ADF and CP digestibility were non-significant ($P>0.05$) between diets C and BGBP, indicating better utilization of black gram straw by the lambs.

Mudgal *et al.* (2012) evaluated ammoniated (4% urea with 50% moisture level) Lentil (Lens culinaris) straw (ALS) and its total mixed ration (TMR). Ten barbari growing male kids were divided into two groups of 5 animals each and were fed either ALS *ad libitum* or ALS based TMR (ALSTMR). Use of ALS in TMR increased soluble carbohydrate and reduced crude fibre content in the diet. The digestibility DM, OM, NFE ($P<0.01$) and NDF ($P<0.05$) increased by incorporation of ALS in TMR. Intake (g/kg $W^{0.75}$) of DM, TDN ($P<0.01$) and DCP ($P<0.05$) as well as TDN content ($P<0.01$) of the diet in ALSTMR group was superior as compared to the ALS group.

Devsena and Prasad (2014) conducted growth trial on twelve non- descript weaned lambs (13.33 ± 0.62 kg av.B.wt.) for 120 days. During the growth trial they randomly divided the lambs equally into two treatment groups. The animals were offered respective experimental feeds which comprised of ground nut haulms (C1) and gram bhusa (C2) based complete rations with roughage: concentrate ratio of 70:30, by adding 50% of each crop residue and 20% of sugarcane baggasse along with concentrate ingredient. The digestibility of DM, CP, CF, EE and NFE for CR-1 and CR-2 were 61.8 and 60.3% for DM), (60.3 and 63.4% for CP), (48.3 and 46.6% for CF), (70.1and 72.8% for E.E) and

(74.2and 73.6% for NFE), respectively. The digestibility coefficient of various nutrients was statistically similar between two groups. However, slightly higher digestibility of CP and EE were observed in group CR-2, while CF and NFE digestibility were higher ($P<0.05$) in group CR-1.

Rashid *et al.* (2016) conducted an experiment on twenty-four Black Bengal goats which were randomly divided into three groups with average body weight to observe the effects of feeding different forms of diet on the performance of Black Bengal goat. A ration was prepared in three different forms such as A- green grass + concentrate mixture in conventional form, B- green grass + concentrate in pellet form and C- both grass and concentrate in compound pellet form according to NRC (1981) nutrient requirements. Goats were fed for 100 days. Processing of feed improved CP, EE and DM, OM, CF, NFE, ADF, NDF digestibility in group C than other two groups and the lowest digestibility of the parameters was found in group A.

Jadhav (2019) studied the utilization of cotton stalk in complete pelleted feed in eighteen growing goats of 4- 6 months of age, divided in three equal groups and fed with three different dietary regimes as T0 (control), T1 and T2 groups. Goats in the control group was fed with pelleted feed comprising 60% gram straw and 40% concentrates, while in T1 group 25% gram straw was replaced by cotton stalk and in T2 group 50% gram straw was replaced by cotton stalk. Each ration was maintained in 60:40 roughage to concentrate ratio having 12% CP and 60% TDN. There were no significant differences in DM, CP, EE and ADF between T0, T1 and T2. However, CF, NFE, NDF, Hemicellulose and Cellulose digestibility was found to be significantly better in T0 and T1 groups than that of T2 group. He concluded that cotton stalk in complete pelleted feed of growing goats can be effectively utilized upto 50% of total roughage source without any adverse effect on digestibility of nutrients.

Kedaree *et al.* (2019) studied the performance of growing goats fed paddy straw supplemented with graded levels of *Thespesia populnea*. Twelve crossbred bucks were used in a randomized block design for duration of 4 weeks. The treatments comprised of a Portia tree leaves and paddy straw supplemented with

in 15:85, 30:70 and 45:55 for the treatment groups T1, T2 and T3, respectively. Concentrate @ 200 g/buck were offered to meet the nutritional requirement of the experimental animals on a dry matter basis. DM digestibility increased with supplementation with T2 recording the highest value of 57.90% which was not far higher than the T1 and T3 and shows the non-significant variation.

Shembekar (2019) studied the effect of utilization of ozone treated cotton stalk in pelleted complete feed of eighteen growing goats (4 to 6 months of age) for 90 days. The goats were randomly allotted to three dietary treatments as T0, receiving pelleted complete feed made from 60% gram straw as roughage and 40% concentrates, T1 receiving pelleted feed containing 15% ozone treated cotton stalk (OTCS) and 45% gram straw as roughages along with 40% concentrates while, T2 group received pelleted complete feed containing 30% OTCS and 30% gram straw and 40% concentrates. The roughage to concentrate ratio was maintained as 60:40 in each group. He concluded that The digestibility coefficients for different nutrients except ($P \leq 0.05$) DM and cellulose were non-significant.

Muhammad I. Malik *et al.* (2020) carried out an experiment to assess the effect of physical form and level of wheat straw inclusion on growth performance and blood metabolites of fattening goat. Thirty-two male Beetal goats (27.4 ± 0.28 kg body weight (BW)) were divided randomly into four dietary treatments with a 2×2 factorial arrangement ($n = 8$/treatment): (1) CTMR15 (conventional TMR containing 15% WS), (2) CTMR25 (conventional TMR containing 25% WS), (3) PTMR15 (pelleted TMR containing 15% WS), and (4) PTMR25 (pelleted TMR containing 25% WS). Dry matter (DM), organic matter (OM), CP, NDF, ADF and EE were similar ($p > 0.05$) in all treatments. Nitrogen balance, nitrogen intake, fecal nitrogen, urinary nitrogen, and retained nitrogen were also not influenced ($p > 0.05$) by the physical form or the straw level in the diet.

Santoso *et al.* (2021) added cellulolytic bacteria in complete feed block based on agro-industrial byproducts for kacang goats. Three Kacang goats, a native Indonesian breed, were used in a 3×3 Latin square experimental design with i) CFB without microbes (control), ii) CFB containing 1% *Pseudomonas*

aeruginosa and 1% *Acinetobacter baumannii*, and iii) CFB containing 2% *Pseudomonas aeruginosa* and 2% *Acinetobacter baumannii*. Microbes in the CFBs consisted of lactic acid bacteria, yeast and cellulolytic bacteria that ranged from 106 to 108 cfu/g. Goats fed on CFB with microbes had higher ($P < 0.01$) digestibility of organic matter (OM) and NDF compared with control.

2.6 Effect of Complete Pelleted Feed on Cost of Feeding

Durga Prasad *et al.* (1986) conducted growth study on thirty two Nellore Brown weaned lambs (11.16 kg) for 84 days to evaluate four different diets. These four diets were formulated complete rations by blending groundnut haulm (10.38% CP) with a conventional concentrate mixture (14.75% CP) in the ratios of 80:20 (CR-1), 60:40 (CR-2), 40:60 (CR-3) and 20:80 (CR-4). The feed cost/kg gain was Rs. 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 haulm ($P > 0.05$), respectively. They concluded that a complete ration made with groundnut haulm and a conventional concentrate mixture in a 20:80 ratio was superior to other complete rations in terms of quality and cost. The optimum level of groundnut haulm incorporation in the complete ration was 20%.

Kumar *et al.* (1989) divided sixteen Nellore brown weaned ram lambs (14.34 kg av. B.wt.) divided into 4 groups and fed for 90 days. Under second experiment, these rations were fed to 4 Nellore brown rams (25.98 kg av. B.wt.) to evaluate four iso-nitrogenous complete rations, processed into mash form by incorporating cowpea hay at 70 (CR-1), 60 (CR-2), 50 (CR-3) and 40% (CR-4) as sole source of roughage. In both experiments, the animals were fed the respective rations ad-lib. The cost of complete rations per 100 kg was Rs. 102.85, 133.95, 147.05 and 160.15 respectively. for CR-1, CR-2, CR-3 and CR-4. There was an increase of Rs. 13.10 for every decrease of 10 parts of cowpea hay from CR-1 to CR-4 due to corresponding increased proportion of concentrates.

Yadav and Desmukh (2001) studied the nutritional evaluation of spent straw in complete ration of sheep, containing wheat straw (CR-1) and spent straw (CR-2) each at 60% level for crossbred sheep. The DCP and TDN contents were

5.35, 56.10 and 7.09, 41.68% for CR-1 and CR-2, respectively. Feed cost (Rs/kg was 2.57 for both CR-1 and CR-2 and the feed cost/animal/day was (Rs 2.44 and 2.68, respectively in CR-1 and CR-2. Feeding costs were higher in group CR-2, indicating that spent straw raised feeding costs.

Kirubanath *et.al.* (2003) evaluated the effect of processing cotton straw based complete diet with expander-extruder on performance of crossbred calves. A growth trial was conducted on eighteen crossbred calves (6-9 months, 73.48±6.52 kg) by randomly allotting to two complete diets and a conventional diet (6 in each group) for 180 days. The complete diets were formulated containing 40 per cent cotton straw, one processed in mash form and other subjected to expander-extruder pelletization (EEP). These two complete diets were compared with conventional system of feeding under which concentrate mixture and cotton straw were fed separately in a 60:40 ratio. Expander-extrusion though increased the cost of production, it reduced the cost of feed per unit live weight gain by 12.28% in comparison to its mash form and by 16.76% when concentrate and cotton straw were fed separately. The results showed that combining cotton straw with concentrates in a complete diet improved growth performance and may be used for cost-effective ration to crossbred calves.

Reddy and Reddy (2003) evaluated effect of cotton stalks based complete diet on growth and carcass characteristics in sheep and goats in field condition. A complete diet was formulated with cotton stalks as sole source of roughage (40.0%) and processed into pellets using expander extruder and fed to 6 Nellore rant lambs and 6 local male kids (4–5 m) to record its effect on growth and meat production in sheep and goats. They were fed expander extruder pressed pelleted complete feed formulated with cotton stalks as sole source of roughage (40%) with concentrates (60%) for 180 days. The cost of feed /kg gain in sheep and goat was Rs. 24.3 and 26.9 respectively which show 10.7 % higher cost of feed/kg gain in goats than lambs.

Nagalakshmi and Reddy (2011) evaluated on farm performance of lambs and buffaloes fed expander extruder processed cotton stalks based complete diets. Thirty Nellore ram lambs (4–5-month-old) of average body weights were

randomly divided into two dietary groups to assess the effect of feeding expander extruder processed complete diet (EEP) containing cotton stalks (CS) as sole roughage source on growth performance. One group was fed with EEP diet containing 38.5% CS and other with conventional diet i.e., concentrates mixture and ad lib sorghum stover, fed separately for 180 days. The cost of feed/kg gain of lambs was lower ($P<0.05$) on EEP diet.

Rashid *et al.* (2016) examined to evaluate performance of growing black bengal goat fed compound pellet of different diameters. Twenty-four black bengal goats were randomly divided into three groups with average body weight to observe the effects of feeding different forms of diet on the performance of Black Bengal goat. A ration was prepared in three different forms such as A- green grass + concentrate mixture in conventional form, B- green grass + concentrate in pellet form and C- both grass and concentrate in compound pellet form according to NRC (1981) nutrient requirements. Goats were fed for 100 days. They concluded that in stall feeding, compound pellet feed is the greatest option for cost-effective goat production.

Jadhav (2019) studied the utilization of cotton stalk in complete pelleted feed in eighteen growing goats of 4- 6 months of age, divided in three equal groups and fed with three different dietary regimes as T0 (control), T1 and T2 groups. Goats in the control group was fed with pelleted feed comprising 60% gram straw and 40% concentrates, while in T1 group 25% gram straw was replaced by cotton stalk and in T2 group 50% gram straw was replaced by cotton stalk. Each ration was maintained in 60:40 roughage to concentrate ratio having 12% CP and 60% TDN. The cost of feed per kg body weight gain of experimental goats were less in T1 group fed with substitution of 25% gram straw by cotton stalk than that of control (T0) and T2 groups. He concluded that utilization of 25% cotton stalk of total roughage found to be more economical in rearing of goats under stall fed condition.

Shembekar (2019) studied the effect of utilization of ozone treated cotton stalk in pelleted complete feed of eighteen growing goats (4 to 6 months of age) for 90 days. The goats were randomly allotted to three dietary treatments as T0,

receiving pelleted complete feed made from 60% gram straw as roughage and 40% concentrates, T1 receiving pelleted feed containing 15% ozone treated cotton stalk (OTCS) and 45% gram straw as roughages along with 40% concentrates while, T2 group received pelleted complete feed containing 30% OTCS and 30% gram straw and 40% concentrates. The roughage to concentrate ratio was maintained as 60:40 in each group. He concluded that Feeding cost per kg body weight gain was found to be Rs. 140.71, 102.90 and 119.10 in T0, T1 and T2 groups respectively, indicating that, T1 treatment was more economical.

Ahmed *et al.* (2020) evaluated the effect of complete pelleted feed on animal performances in both on-station and on-farm trials conducted on growing goats. A complete pellet feed was formed with 40% roughage (rice straw) and 60% concentrate [rice polish (50%), maize crush (16%), soybean meal (20%), molasses (10%), salt (2%), Dicalcium Phosphate (1%), vitamin–mineral premix (0.5%), and pellet binder (0.5%)] for commercial goat production. Feeding complete pelleted feeds helped in reducing feed price per kg weight gain.

Muktiani *et al.* (2020) conducted the trails on Ettawa crossbred goats to evaluate the growth, feed efficiency and economics over feed. The experiment was conducted in factorial 2x2 in a completely randomized design with 4 replications and 2 factors. The first factor was different levels of feeds and additives in the diets: T1 [14.2% CP + 64.6% TDN + 65% concentrate + 20% corn straw + 15% Gliricedea leaves + 15.3 Zn (mg/kg) and 0.0132 Se (mg/kg)]; T2 [16.2% CP + 67.3% TDN + 70% concentrate + 17.5% corn straw + 12.5% Gliricedea leaves + 18.5 Zn (mg/kg) and 0.0176 Se (mg/kg)]. the T2 diets plus Zn-Se supplement resulted in the highest income over feed cost (IDR. 1,722 head/d).

2.7 Effect of Complete Pelleted Feed on carcass characteristics:

Reddy and Linga (2003) evaluated the effect of cotton stalks based complete diet on growth and carcass characteristics in sheep and goats in field condition. A complete diet was formulated with cotton stalks as sole source of roughage (40.0%) and processed into pellets using expander extruder and fed to 6

Nellore rant lambs and 6 local male kids (4–5 m) to record its effect on growth and meat production in sheep and goats. At the end of the experiment, 3 animals from each group were slaughtered to study carcass characteristics. The dressing percentage and proportions of wholesale cuts were within the normal limits in both the species. These results indicated that crop residues like cotton stalks can be incorporated in the rations of growing sheep and goats without any adverse effect and this type of feeding reduces the cost of feed for meat production.

Pi *et al.* (2004) studied the effect of pretreatment and pelletization on nutritive value of rice straw-based total mixed ration (TMR) (Trial 1), and to investigate growth performance, carcass traits and meat quality of growing Boer goats fed on the TMR. In Trial 1, four RS-based TMRs were designed: (1) u-TMR (untreated and unpelletized), (2) t-TMR (pretreated but unpelletized), (3) up-TMR (untreated but pelletized), and (4) tp-TMR (pretreated plus pelletized). For all the TMRs, roughage-concentrate ratio was at 60:40 (w/w, DM basis). Thirty-six growing Boer goats were used in Trial 2. They were divided into three equal groups 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 75 days with the first 15 days for adaptation. Carcass weight ($P<0.05$), dressing percentage ($P<0.05$), net meat percentage ($P<0.01$), ribeye area ($P<0.05$) and GR value ($P<0.05$) were significantly higher in TMR-2 than in TMR-1. Meat colour and marbling were not significantly affected by the diets ($P>0.05$), but they were superior in animals on TMR-2 than on TMR-1. Cooked meat ratio was significantly higher ($P<0.05$) and drip loss was lower ($P<0.05$) for goats on TMR-2.

Bhadane *et.al.* (2007) studied the carcass characteristics of non descript local goats on pelleted complete feed of two different energy and protein levels, T1(CP 12%, TDN 55%), T2(CP 14%, TDN 60%) having roughage to concentrate ratio 60:40 with Arhar straw as a basal roughage and trial was conducted upto 150 days. The initial body weights were 16.56±0.28 kg (T1) and 12.03±0.32kg(T2) and the goats were slaughtered at end of experiment after 16 to 18 hours of fasting

having body weights 26.04±0.20kg(T1) and 23.69±0.28kg(T2). The carcass weight was nearly similar in both the treatments whereas dressing percentage increased numerically as CP % increased in the ration.

Titi *et al.* (2007) studied the growth performance and carcass characteristics of awassi lambs and shami goat kids fed yeast culture in their finishing diet. Two experiments were studied to evaluate effects of inclusion of a yeast culture (YC) to a diet based on barley grain and wheat straw on digestibility, growth and meat traits of Awassi lambs and Shami goat kids. The same diet was used in both experiments and the YC was added to the diet of treated groups at the level of 12.6 kg YC/tonne of diet. YC supplementation to lambs reduced hot carcass weight, cold dressing proportion and total muscle/bone ratio, but increased empty digestive tract weight. There were no changes in back fat thickness, intermuscular fat of the leg muscle, and weights and proportions of carcass cuts. Measures of kids' carcass characteristics and quality also did not differ. Only cuts of leg and shoulder differed ($P < 0.05$) when calculated as a proportion of the whole carcass cut. Results showed that YC supplementation reduced meat/bone ratio and tissue protein content, but increased fat content in carcasses of fattening Awassi lambs, but not in fattened Shami kids.

Sang Woo Kim *et al.* (2014) investigated the effects of feeding of diets based on roughage supplemented with concentrate on the carcass and meat quality attributes of Korean black goats. Fourty male goats of 5 months age were divided into four treatment groups; and fed as T1 (1.5%), T2 (2.0%), T3 (2.5%) and T4 (*ad libitum*) feeding of concentrate with *ad libitum* rice straw. Forty bucks at the end of the feeding were fasted for 12 h before slaughter and were then slaughtered. Carcass yields were greatly affected by rate of concentrate feeding. T4 showed the heaviest live and carcass weights and the highest dressing and fat percentages ($p<0.05$). The moisture contents were lower in T4 compared with other treatments, while the crude protein and fat contents were higher ($p<0.05$). Mono unsaturated fatty acid in T4 was significantly higher than others, which showed the highest percentages of oleic acid (C18:1) For the sensory test, T4 was tenderer and produced better flavor scores than others. Increasing the level of

concentrate in the diet resulted in an improvement in growth performance, and carcass and physicochemical characteristics of goat meats.

Islam *et al.* (2017) studied the Effect of pellet from total mixed ration on growth performance, blood metabolomics, carcass and meat characteristics on Bangladeshi garole sheep. six indigenous Bangladeshi Garole sheep (*Ovis aries*) (BW: 8±0.5 kg; Age: 1yr) divided into two groups using a randomized block design. Control diet was composed of road side grass, rice straw, wheat bran, mustard oil cake, molasses, common salt which considered as loose total mixed ration (L-TMR) and treatment diet was pelleted form of L-TMR (P-TMR). In both the dietary treatments the animals were fed at 1.5 times of maintenance energy and protein requirement. Dressing percentage and eye muscle area was significantly higher ($p<0.05$) in P-TMR group but no significant difference was found between dietary treatments in term of disposition of body fat, proximate composition of mutton, all the sensory parameters except tenderness and overall acceptability. So, it could be concluded that, the P-TMR might be fed to sheep for better growth performance and higher meat production rather than production of functional mutton.

Kochewad *et al*. (2017) assessed the effect of different farming systems on productive performance, body condition score and carcass characteristics of Deccani lambs. Thirty-six weaned lambs having 3 months of age were divided into three groups with twelve lambs in each group in under intensive (T1), semi-intensive (T2) and extensive (T3) farming systems. T1 group had higher pre-slaughter weight, hot carcass weight, meat %, fat% and meat: bone ratio thanT2 and T3. The dressing yields were comparable. The weights of other offals (heart, kidney, spleen, testicles, blood, head and lung and trachea) were comparable. The findings of this study indicated that the intensive and semi-intensive system of rearing could be useful for mutton production.

Fang Chen *et al.* (2018) investigated the effect of intact rapeseed (IR) supplementation in goat total mixed ration (TMR) pellets on performance, carcass traits, serum biochemical indices and meat quality. Forty-eight healthy Boer goats with similar initial bodyweight (12.52 and 1.48 kg) were randomly assigned to

four dietary treatment groups containing 0%, 2.5%, 5.0% and 7.5% intact rapeseed (IR) respectively. There was no significant difference among all groups in carcass weight, dressing percentage, visceral fat, liver and kidney.

Gadekar *et al.* (2020) conducted an experiment to evaluate the carcass traits of Patanwadi ram lambs at 6.9 months (207 days; Gr-1) and 9.6 months (288 days; Gr-2) maintained under an intensive feeding System. The study involved ten Patanwadi ram lambs maintained on *Cenchrus ciliaris* grass and supplemented 300 g concentrate daily. The lambs were slaughtered after fasting for 18 h to assess the carcass traits. Empty body weights, hot carcass weights and dressing yields were significantly higher in Gr-2 than Gr-1. Loin eye area was significantly lower in Gr-1. In primal cuts; weights of the leg, loin, rack, neck, shoulder, breast, and foreshank were significantly different between the groups. The lean yields did not differ significantly for Gr-1 and Gr-2. The subcutaneous fat was significantly higher in loin cut in Gr-2. The intermuscular fat contents were significantly lower for Gr-1. The dissected bone yields were comparable for Gr-1 and Gr-2. Lean: fat and meat: bone ratios were comparable. They opined that Patanwadi ram lambs produce a desirable carcass with lean, fat and bone contents at 6– 7 months of age with 30 kg body weight.

Endang Purbowati *et al.* (2021) determined the effect of replacing Napier grass (NG) with agricultural by-products on the productivity and carcass characteristics of lambs. Twenty-four 3-month-old male lambs with initial body weights of 13.26±1.29 kg (coefficient of variation=9.73%) were allocated into a completely randomized design with four treatments and six replications. The treatments included: NG=100% NG; corn cobs (CCs)=50% NG and 50% CCs; bagasse (BG)=50% NG and 50% BG; and peanut shells (PSs)=50% NG and 50% PSs. All treatment diets were pelleted and consisted of 40% fibrous feed and 60% concentrate feed and contained 10.36-11.65% crude protein and 55.47-57.31% total digestible nutrients. No significant differences ($p>0.05$) were found in the carcass or meat characteristics of any diets. The averages of slaughter weight, carcass weight and carcass percentage were 20.03 kg, 8.02 kg and 40.0% respectively. The average meat bone ratio was 3.67.

Jean-Christophe Bambou *et al.* (2021) observed the effects of diet and age on finishing performances and carcass characteristics of male creole goats. A total of 91 weaned male Creole kids [84 days old ± 7 days, 9.2 kg live weight (LW) ± 0.5 kg] were randomly allocated in a 2 × 3 experimental designs. The animals were fed individually with two diets: C0: a 28-day-old *Digitaria decubens* grass alone, or C50: the same grass plus a commercial concentrate (50% of the total diet) and then slaughtered at 7, 11 and 15 months of age. The addition of concentrate improved the dressing percentage and the conformation score (1–5 scale) from 46 to 88 g/day, 52.8 to 62.4% and 2.2 to 4.9 respectively. Moreover, carcasses of the C0 group appeared lean with less developed fat than the C50 group and lighter than visceral fat. The meat color was significantly more affected by diet than age.

2.8 Effect of utilization of yeast and multienzymes in goats feeding :

Kholif and Aziz (2014) investigated the effects of adding cellulytic enzyme "Asperozym" or Tomoko® to the diets on the performance of goats. Six Baladi lactating goats after 42 days of parturition were assigned randomly into three groups of two animals each. The experimental periods were 90 days and consisted of three equal periods. The first group was fed on 50% concentrate feed mixture (CFM), 10% grounded date stone and 40% berseem clover (control diet). The second group was fed control diet (C) supplemented with Asperozym at 3.08 U/kg DM (T1). The third group was fed control diet supplemented with Tomoko® at 1.54 U/kg DM. (T2). At the last day of each experimental period, rumen liquor samples were collected at zero and 4h post-feeding. The diets supplemented with Asperozym (T1) and Tomoko® (T2) showed significantly ($P<0.05$) increased digestibility all nutrients for compared with the control diet. Rumen liquor parameters were significantly ($P<0.05$) affected. Asperozym enzyme group had the highest total ciliate densities of ruminal protozoa followed by control group and group B. Overall, the results suggest that the exogenous enzymes could be used with success as supplements in goats' diets.

P Ravikanth Reddy *et al.* (2015) studied the effect of supplementation of exogenous fibrolytic enzyme (EFE) or live yeast culture or both in total mixed

rations on digestibility of nutrients. The dietary treatments included a groundnut haulms based total mixed ration (TMR) with R: C ratio of 70: 30 (T1), T1 supplemented with EFE @ 15 g/animal/d (T2), T1 supplemented with live yeast culture @ 10 g/animal/d (T3) and T1 supplemented with EFE @ 15 g/animal/d and live yeast culture @ 10 g/animal/d (T4). Results indicated that the in vitro digestibility (%) of DM, CP, NDF and ADF were lower (P0.05). It is concluded that supplementation of either EFE or yeast culture or both increased the in vitro digestibility of nutrients.

Pradhan *et al.* (2015) studied the effect of yeast supplementation on growth, feed conversion efficiency and cost of feeding in Surti goat kids. A total of 16 male Surti goat kids of four months old were selected with average body weight of 7.53±0.13 Kg. Animals were randomly divided in to two groups with eight replications per group. Active dried yeast (S. cerevisiae CNCM I-1077) was supplemented in one experimental group at the rate of 2 % of DMI, and the second group without any supplementation was control. The feed intake was measured daily for 80 days and body weight was taken on first and eighth day of the experiment. The result shows that there was significant ($P < 0.05$) improvement in body weight gain, feed efficiency and cost economics in supplemented group without affecting the feed intake between the control and supplemented group. They concluded that supplementation of active dried yeast (S. cerevisiae CNCM I1077) at 2% of dry matter intake would improve the growth, feed conversion efficiency and cost of feeding in surti goat kids.

Alshanbari *et al*. (2020) determined the effect of SCFP on the productive performance of Ardi goats. Different inclusion rates of SCFP on 20 lactating goats by following a Randomized Complete Block Design (RCBD). Five SCFP rates namely 0 (control) 2.5, 3.5 and 4.5 g/h/day were tested with 3 to 4 replications. Two experiments were conducted on 20 adult and 20 goat kids for treatment evaluation. Milk production, feed efficiency conversion rates and milk fat increased for groups three and four with inclusion rate of 3.5 and 4.5 g/h/day of SCFP, respectively. The difference between Total Digestion Nutrients (TDN) and digestibility of Organic Matter (OM) was not significant between the control and

other treatments. However, a significant difference was found between the control and other groups in Crude Protein (CP) digestibility. Supplementation of SCFP improved the FCR and ADF digestibility improved without any effect on OM and NDF digestibility. Besides, supplementing SCFP reduced the CP digestibility. Overall, the performance of Ardi goats improved with SCFP supplementation.

Khan *et al.* (2020) conducted experiment on eighteen lactating Beetal goats of the almost same age, body weight, and parity divided into three groups (A, B and C) of six animals each. All the animals were given ad libitum fodder supplemented with 500 g concentrate per animal. The animals of group C were treated as the control group, while those of A and B were supplemented with live yeast (Saccharomyces cerevisiae) @ 1.5 and 3 gm/day per animal, respectively up to 45 days. Results showed that dry matter intake, weight gain (kg), milk yield (kg) and milk composition were ascertained better in group B followed by A and C. They concluded that the use of yeast @ 3 gm/day can improve the milk yield and its composition in Beetal goats.

Cai *et al.* (2021) studied the effects of Saccharomyces cerevisiae, and their combination on rumen fermentation and growth performance of heat-stressed goats. Twelve heat-stressed goats (20.21 ± 2.30 kg) were divided equally into four groups: control group (CG, fed the basal diet, Saccharomyces cerevisiae supplemented group (SC, 0.60% Saccharomyces cerevisiae added to the basal diet), Clostridium butyricum supplemented group (CB, 0.05% Clostridium butyricum added to the basal diet), and their combination supplemented group (COM 0.60% Saccharomyces cerevisiae and 0.05% Clostridium butyricum added to the basal diet). The results showed that rumen pH, rumen cellulolytic enzymes (avicelase, CMCaes, cellobiase, and xylanase) activities, and the concentrations of rumen total volatile fatty acid (TVFA), acetic acid, and propionic acid were significantly increased with Saccharomyces cerevisiae, Clostridium butyricum, and their combination supplementation ($p < 0.05$). Besides, the dry matter intake (DMI), average daily gain (ADG), and the digestibility of dry matter (DM), neutral detergent fiber (NDF), and acidic detergent fiber (ADF) were significantly increased ($p < 0.05$) with supplemented these probiotics. However, the ammonia

nitrogen (NH_3-N) concentration only significantly increased in CB and A/P ratio (acetic acid to propionic acid ratio) only significantly increased in SC and CB. These results indicated that the supplementation with these probiotics could ameliorate rumen fermentation and growth performance of heat-stressed goats.

MATERIALS AND METHODS

The experiment was conducted on 18 non-descript growing goats for 90 days to study the effect of gram straw based pelleted complete feed supplemented with fibre degrading enzymes and *Saccharomyces cerevisiea* on various parameters such as body weight gain, dry matter intake, feed conversion ratio, nutrient digestibility, rumen fermentation pattern, carcass characteristics and economics of goat feeding. The materials and methods used in the experiment are summarised in this chapter.

3.1 Place of work

The experiment was carried out at Cattle Breeding Farm in NVC, Nagpur, while laboratory work was carried out at Animal Nutrition Department of Nagpur Veterinary College, Nagpur.

3.2 Period of experiment

The experiment was conducted for 90 days, during 1st May to 31st July 2021. Prior to the start of the experiment, a two-week acclimatisation period was offered. During that period the growing goats were fed with maintenance diet.

3.3 Climatic condition

The climate conditions at Nagpur are harsh. The soil structure in the Nagpur region is medium dark and red, with varied depths and structures. In the summer, the maximum temperature in Nagpur can reach 47.80 degrees Celsius, while the coldest temperature in the winter can drop to 6^{0}Celsius.

3.4 Selection of experimental goats

Eighteen growing goats, ranging betweenage from four to six months of age, were randomly divided into three groups with similar body weights in group, having three males and three females in eachgroup.The average body weights of experimental growing goats is mentioned in Table 1.

Table 1 Average initial body weight of experimental groups

Experimental Groups	Avg. Initial Body weight (Kg)
T_0 (Control)	12.68±1.41
T_1	11.83±1.12
T_2	12.60±2.27

3.5 Dietary treatments

The goats in the control group (T_0) were fed complete mash feed containing 60% gram straw and 40% concentrate mixture, whereas in the T_1 group, goats were fed pelleted feed containing 60% gram straw and 40% concentrate mixture, while in T_2 group, the goats were fed pelleted feed prepared of 60% gram straw and 40% concentrate mixture supplemented with yeast (*Saccharomyces cervisea*) @ 250 g/ton of feed and NSP degrading multienzymes @ 500g/ton of feed. Iso-nitrogenous and iso-caloric diets were used in all of the groups while roughage to concentrate ratio was maintained as 60:40.

Dietary treatment groups

Groups	Experimental diet
T_0 (Control)	Mash feed comprising 60% gram straw and 40% concentrate mixture.
T_1	Pelleted feed comprising 60% Gram straw and 40% concentrate mixture
T_2	Pelleted feed comprising 60% gram straw; 40% concentrate mixture supplemented with yeast (*Saccharomyces cervisea*) at the rate of 250 g/ton and NSP degrading multienzyme at the rate of 500 g/ton.

3.6 Housing and Management of Experimental goats

The goats were kept in pens with adequate ventilation, flooringand tying arrangementsas well as feeding and watering facilities.Throughout the experimental period, all of the experimental growing goats were maintained on standard managemental practices. The goats were dewormed and vaccinated before the experiment. The experimentalgoats were weighed as every fortnightly before feeding and watering for the whole 90-day experimental period using an

electronic weighing balance. The experimental goats were fed pelleted complete feed and kept in stalls.

3.7 Preparation of feed and feeding

The goats were fed according to ICAR (2013) with 12 percent CP and 60 percent TDN, the dry roughage and concentrates were mixed together at 60:40 ratio and the composition of experimental diet is mentioned below.

Composition of Complete Pelleted Feed

Ingredients	T_0	T_1	T_2
Gram Straw	60	60	60
Maize	11.00	11.00	11.00
Cotton Seed Cake	8.00	8.00	8.00
Tur Chunni	6.00	6.00	6.00
Wheat Bran	6.00	6.00	6.00
Soya DOC	7.30	7.30	7.30
Salt	0.50	0.50	0.50
Min Mixture	1.20	1.20	1.20
Multienzymes	0	0	50 g
Yeast	0	0	25 g

3.7.2 Procurement of feed ingredients

Gram straw was utilised as roughage source in the trial, with maize, cotton seed cake, soya DOC, wheat bran, and tur chunni as concentrate sources in full pelleted feed. Gram straw was obtained from local market. Maize, cotton seed cake, soya DOC, wheat bran, tur chunni, mineral mixture, and common salt were all purchased from a nearby feed store.

3.7.3 Preparation of complete pelleted feed

All the required ingredients were grinded in hammer mill and blended in mixer, mineral mixture, salt, yeast and multienzymes were added through medicine hopper. To soften the total complete mash feed and to improve the pellet binding, it was moistened sprinkling some water and pellets of 8 mm

diameter were prepared through pellet machine. The pellets were then air dried until they reached to optimum moisture and consistency.

3.7.4 Feeding of experimental goats

Each experimental goat was fed separately for 90 days according to their dietary treatments. Changes in body weights and growth rates of growing goats were used to modify the amount of complete pelleted feed provided. The goats were fed considering 4% DM required. A measured quantity of pelleted feed was offered twice daily, in the morning and evening hours, and free access to fresh and clean drinking water was provided. If there was any leftover feed, it was recorded at 24 hrs intervals the next day morning to compute the total dry matter intake.

3.8 Proximate composition

The proximate composition of various ingredients and pellets was determined as per AOAC (2005).

3.8.1 Dry Matter (DM)

The moisture content of the sample was determined by heating it to a constant weight in an oven at 100^0-105^0 Celsius under air pressure. Dry matter was the consistent weight of a sample after it had been completely dehydrated.

$$\text{Moisture \%} = \frac{\text{Loss in weight}}{\text{Weight of sample}} \times 100$$

Dry matter % = 100 - Moisture percent

3.8.2 Crude Protein (CP)

By digesting 1 g dried sample with 30 ml concentrate $H_2SO_4$and adding 5 g of digestion mixture made of sodium sulphate and copper sulphate in a 9:1 ratio, the crude protein content was determined using Kjeldhal's method. The digestion was continued for another 2-3 hours till it was clear. After repeated washes with distilled water, the digested content was transferred to a 100 ml volumetric flask

and 100 ml volume was made. A 10ml aliquot was then fed to the distillation assembly, along with 15 ml of 40%NaOH solution. Ammonia vapours were trapped in 15 ml of Tashiros indicator, which was made by mixing 2 percent boric acid in 1000 ml with 200 ml pure alcohol, 12 ml methyl red (0.1%), and 6 ml bromocresol green (0.1%). A standard N/10 H_2SO_4 solution was used to titrate the ammonia boric acid complex (ammonium borate). The crude protein content was calculated using the formula mentioned below, with 1 mlof N/10 H_2SO_4= 0.0014 g nitrogen.

$$\text{Crude protein \%} = \frac{\text{Vol. of N/10 } H_2SO_4 \text{ x } 0.0014 \text{ x } 6.25 \text{ x Aliquot prepared}}{\text{Aliquot taken for distillation x Wt. of sample}} \text{ x } 100$$

In 100 g of protein, 16 g of nitrogen is present on average; so, 1 g of nitrogen equals 6.25 g protein. (Factor 6.25 to convert nitrogen into protein)

3.8.3 Ether Extract (EE)

The ether extract was evaluated by extracting 3 g of dried sample in Soxhlet assembly for about 7 hours with petroleum ether (60-80^{0}C). The extraction flask was placed in a hot air oven at 100°C for 1 hour after extraction, cooled in a desiccator and weighed. The weight of fat extracted by the petroleum ether is recovered in the receiver flask and the extract was computed using the formula below.

$$\text{Ether extract \%} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \text{ x } 100$$

3.8.4 Crude Fibre (CF)

Crude fibre was determined by adding 200 ml of 1.25 percent sulphuric acid to a 2 g moisture and fat free sample in a spoutless beaker for 30 minutes, timed from the start of boiling and then adding 200 ml of 1.25 percentNaOH solution. After then, the contents were filtered through a muslin cloth. The crucible residue was heated in a hot air oven overnight at 80-110^{0}C to create a consistent weight. The wastes were then burned at 600^{0}C for 2-3 hours in a muffle

furnace, cooled and weighed again. The weight lost as a result of ignition was the weight of crude fibre. The crude fibre was estimated using the formula below.

$$\text{Crude fibre \%} = \frac{\text{Weight of crude fibre}}{\text{Weight of sample}} \times 100$$

3.8.5 Total Ash (TA)

For total ash estimate, a 3g dried sample was weighed in a silica crucible, decarbonised on a heater to remove smoke and then ignited at 600^0C for 2-3 hours in a muffle furnace. With the use of metal tongs, the crucible was retrieved from the furnace, cooled in a desiccator and weighed. The weight of ash is the weight of the content in the crucible after ignition and it was determined using the formula below.

$$\text{Total Ash \%} = \frac{\text{Weight of total ash}}{\text{Weight of sample}} \times 100$$

3.8.6 Nitrogen Free Extract (NFE)

On a DM basis, the amount of NFE was determined using the formula below.

$$\text{NFE\%} = 100 - (\%\ \text{CP} + \%\ \text{EE} + \%\ \text{CF} + \%\ \text{Total ash})$$

3.9 Fractionation of fibre

The fibre fractions in feed ingredients, complete pelleted feed and faecal samples obtained during digestibility were determined as per Van Soest (1967)

3.9.1 Neutral detergent fibre (NDF)

1 g sample was placed in a spoutless beaker with 100 ml neutral detergent solution (NDS) and refluxed for 1 hour to determine NDF. The contents were filtered through the Gooch Crucible by washing them in hot water under suction and then washing them in acetone. The crucible was then dried in an oven at 100°C until it reached a consistent weight. The weight of the residue in the

crucible is equal to the weight of NDF, which is computed using the formula below.

$$\text{NDF \%} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$

3.9.2 Acid detergent fibre (ADF)

For ADF must be determination 1 g of material was placed in a spoutless beaker with 100 ml acid detergent solution (ADS) and allowed to reflux for 1 hour. The contents were filtered through the Gooch Crucible by washing them in hot water under suction and then washing them in acetone. The crucible was then dried in an oven at 100°C until it reached a consistent weight. The weight of the residue in the crucible is equal to the weight of ADF, which is computed using the formula below.

$$\text{ADF \%} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$

3.9.3 Acid detergent lignin (ADL)

For the determination of ADL, 30 ml of 72 percent H_2SO_4 was added to the weighed residues of ADF by placing the crucibles in an enamel tray. To smooth the mixture and break the lumps, the crucible was agitated with a glass rod. Glass rod was allowed to remain in the crucible whilereplenish it with 72 percent H_2SO_4 and stirred it every hour or so while the acid drains out. The contents were filtered under vacuum after three hours and washed again until it was acid-free. The crucibles were dried at 100^0C for 8 hours before being placed in a muffle furnace at 600^0C for three hours. The weight of lignin is computed as the weight loss by ashing after treatment with 72 percent H_2SO_4 using the formula below.

$$\text{ADL \%} = \frac{\text{Loss in weight by ashing after treated with 72 \% } H_2SO_4}{\text{Weight of sample}} \times 100$$

The difference between NDF and ADF; ADF and ADL, respectively, was used to identify hemicellulose; cellulose.

3.10 Feed Conversion Efficiency

The feed conversion efficiency was computed using the method below, which took into account the dry matter consumed (g) and the average daily gain (g) of each animal in the study.

$$\text{Feed conversion Ratio} = \frac{\text{Dry matter consumed (g)}}{\text{Weight gain (g)}}$$

3.11 Rumen liquor profile

3.11.1 Collection of rumen liquor

Rumen liquor samples were taken from each goat in each group using a stomach tube at monthly intervals, 2 hours post feeding. The rumen fluid was delivered to the lab in an insulated thermos and strained through a double layer muslin cloth before being tested for pH, ammonia nitrogen, total volatile fatty acids (TVFA), total nitrogen, TCA-ppt nitrogen and NPN concentrations.

3.11.2 pH of rumen liquor

The pH of strained rumen liquor (SRL) was evaluated immediately after collection using a pen type pH metre (Eutech model ECOTestrpH2).

3.11.3 Ammonia nitrogen

On the same day of collection, the ammonia nitrogen in rumen liquor was determined using Conway's micro-diffusion method (Conway, 1957).

0.5 ml SRL was poured in the outside cell of the Conway diffusion dish and 1 ml boric acid indicator was inserted in the inner central chamber of the Conway diffusion dish to estimate rumen ammonia nitrogen. In the outer cell, 0.5 ml of 45 percent potassium carbonate solution was put opposite the SRL. The contents of the outer chamber of the Conway diffusion dish were mixed (the

potassium carbonate solution with SRL) by gentle rotating/tilting the dish on a flat surface, and the dish was then kept in the incubator at 38^0C for 1-2 hours. The inner chamber's contents were then titrated with 0.001 N sulphuric acid. Total rumen ammonia nitrogen was then calculated by following formula-

3.11.4 Total volatile fatty acids (TVFA)

The total volatile fatty acids (TVFA) in rumen liquor were measured using Barnett and Reid's method (1957).

Markham's equipment was linked to a round bottom flask (2 lit.) half filled with water, kept on the heating mantle, and allowed the water to boil for TVFA estimate in SRL. In the Markham's steam distillation apparatus, 2 ml SRL and 2 ml oxalate buffer (10 percent potassium oxalate + 5 percent oxalic acid) were pipetted and left to boil. About 100 ml of distillate was collected in an ice-cold conical flask, which was then titrated with 0.01N sodium hydroxide solution and 2 drops of phenolphthalein indicator until a pink colour developed. The TVFA was then determined using the formula below.

$$\text{TVFA mEq/L SRL} = \frac{\text{Volume of NaOH used x strength of NaOH}}{\text{Volume of rumen liquor taken}} \times 1000$$

3.11.5 Total nitrogen

On the same day of collection, the total nitrogen in rumen liquor was calculated using Kjeldhal's method (AOAC, 2005).

5 ml SRL, 10 ml Conc. H_2SO_4, and 2-3 g digestion mixure (K_2SO_4 + $CuSO_4$ in a 9:1 ratio) were combined in a Kjeldhal flask and digested for 2 hours at 70^0C until the solution turned transparent blue. After cooling, it was transferred to a 100 ml volumetric flask. After that, a 100 ml aliquot was made by diluting the digested material with distilled water. The released ammonia was collected in 2 percent boric acid reagent in the conical flask and titrated against 0.01 N sulphuric acid solution after distillation on the micro Kjeldhal distillation assembly with 10 ml of

40 percent NaOH using burette. After titration total nitrogen was then calculated by following formula-

$$\text{Total nitrogen mg/dl SRL} = \frac{0.01\ \text{N}\ H_2SO_4 \text{ sol. used} \times 0.00014 \times \text{Aliquot prepared} \times 100}{\text{ml of SRL} \times \text{aliquot taken}} \times 1000$$

3.11.6 TCA-perceptible nitrogen

On the same day of collection, the TCA-ppt in rumen liquor was calculated using Kjeldhal's technique (AOAC, 2005). 5 ml SRL was placed in a centrifuge tube with 5 ml 20 percent tri-chloro acetic acid solution and maintained overnight for TCA-ppt-N determination. It was then centrifuged for 10 minutes at 2,000 rpm. Following centrifugation, the entire precipitate was rinsed with distilled water in a Kjeldhal flask before being treated for digestion, distillation, and titration as described above for total nitrogen measurement.

$$\text{TCA-ppt-N mg/dlml of SRL} \times \text{aliquot taken} = \frac{0.01\ \text{N}\ H_2SO_4 \text{ sol. used} \times 0.00014 \times \text{Aliquot prepared} \times 100}{} \times 1000$$

3.11.7 Non protein nitrogen

By deducting TCA-ppt nitrogen from total nitrogen content of SRL, the NPN content of rumen liquor was estimated.

3.12 Digestibility trial

To determine the digestibility of nutrients, a digestibility trial of 5 days collection period was conducted for each goat. During the five-day collection period, arrangements were established for quantitative faecal collection. During the trial time, a detailed record of the feed consumed, residual left, and excrement voided by each experimental goat was kept. After every 24 hours, the amount of excrement voided by each goat was collected and weighed quantitatively at 8:00 a.m., and a uniform representative sample of the residue was retained in a labeled polythene bag. The residual feed from each goat after 24 hours of consumption

was weighed to calculate the daily feed intake. In the laboratory of the Department of Animal Nutrition, Nagpur Veterinary College, Nagpur, representative samples of feed and faeces collected throughout the digestibility trial were analyzed for proximate composition according to AOAC (2005) and fibre fraction according to Van Soest (1967).

3.13 Carcass characteristics

The carcass traits were determined at the end of experiment by sacrificing the three animals in each group. Bleeding, skinning and evisceration were done as per the routine procedures. The slaughter weight and carcass measurements were taken as per Prasad *et al.* (1983). All other procedures and definitions were followed as per Prasad and Sinha (1991). The dressing percentage, loin eye are, meat percentage, bone percentage, meat and bone ratio along with weight of visceral organs were determined during the slaughter studies.

3.14 Economics of feeding

Feeding economics were computed using the current price of feed and fodder materials, as well as ancillary costs and the body weights gain, selling price and ultimately cost of feeding per unit body weight gain.

3.15 Experimental design and Statistical Analysis

The data collected during the study were analysed applying Factorial Completely Randomised Design and Completely Randomised Design as per procedure prescribed by Snedecor and Cochran (1994).

Plate 1 Feed Technology Unit of Department of Animal Nutrition, NVC, Nagpur

Plate 2 Grinding of feed ingredients

Plate 3 Pelleting of complete feed

Plate 4 Drying of complete feed pellets

Plate 5 Different experimental diets

Plate 6 Feeding of experimental goats with complete pelleted feed

Plate 7 Weighing of experimental goats through electronic weighing balance

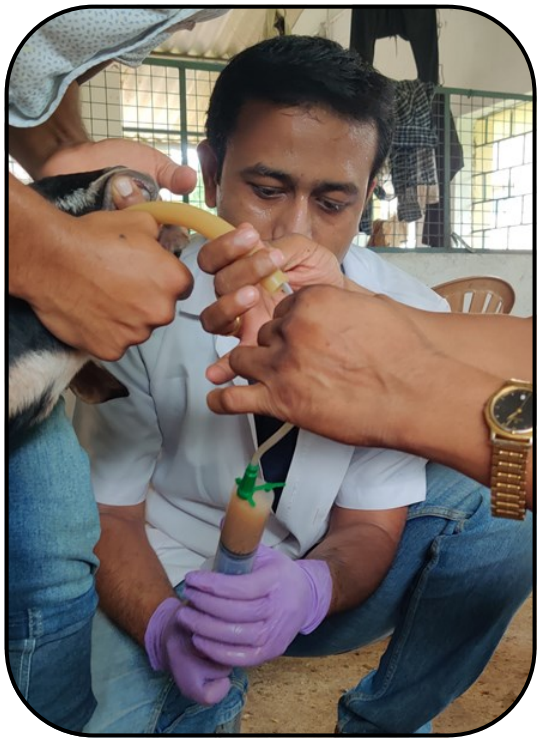

Plate 8 Rumen liquor collection of experimental goats through ryles stomach tube

Plate 9 Analytical Laboratory of Department of Animal Nutrition, NVC, Nagpur

RESULTS AND DISCUSSION

The experiment was conducted on 18 non-descript growing goats for 90 days to study the effect of gram straw based pelleted complete feed supplemented with fibre degrading enzymes and *Saccharomyces cerevisiea* on various parameters such as body weight gain, dry matter intake, feed conversion ratio, nutrient digestibility, rumen fermentation pattern, carcass characteristics and economics of goat feeding. The findings and results obtained during present study have been interpreted in this chapter.

Composition of feed ingredients

The different feed ingredients procured from market and analyzed for proximate and fibre composition. The experimental diets were formulated accordingly so as to meet the dietary requirements of goats. The proximate composition is presented in Table 2.

Table 2 Proximate and Fibre Composition of Feed Ingredients (% DM basis)

Nutrients	Ingredients					
	Maize	**CSC**	**Soya DOC**	**Arhar chunni**	**Wheat Bran**	**Gram straw**
DM	91.60	90.46	93.06	91.66	90.66	92.66
CP	9.22	27.72	45.46	15.86	14.56	5.84
EE	3.18	8.64	2.22	3.02	3.02	1.26
CF	6.44	12.86	5.69	14.72	10.12	41.66
TA	1.22	5.46	4.66	4.56	6.54	7.58
NFE	79.94	45.32	41.97	38.16	65.76	43.66
NDF	26.44	32.40	16.64	29.66	45.22	51.44
ADF	19.20	23.12	9.46	17.12	26.72	38.72
Hemicellulose	7.24	9.28	7.18	12.54	18.50	12.72
Cellulose	16.96	14.66	14.98	15.86	16.74	26.72

Composition of experimental feeds (% DM basis)

The experimental goats were offered complete mash feed and pelleted complete feed and the proximate and fibre composition of experimental diets was carried out and is presented in Table 3.

Table 3 Composition of experimental (%DM basis)

Nutrients	Treatments		
	T_0	T_1	T_2
Dry matter	91.12	91.02	92.12
Crude protein	12.56	12.64	12.72
Ether extract	2.64	2.71	2.84
Crude fibre	34.00	32.45	32.56
Nitrogen free extract	43.88	45.48	45.62
Total ash	6.92	6.72	6.26
NDF	53.00	52.71	52.44
ADF	35.00	35.68	35.00
Hemicellulose	18.00	17.03	17.44
Cellulose	21.96	22.00	22.06
TDN(Calculated)	60.82	60.86	60.78

The proximate analysis of the pelleted complete feeds revealed is-nitrogenous and iso-caloric experimental diets. The TDN was calculated considering the book values of various ingredients present in the complete feed and accordingly presented as calculated.

Table 4 Mean fortnightly body weights of goats in different groups (kg)

Fortnights	Groups			Pooled Mean
	T_0	T_1	T_2	
0^{th} day	12.68^{a}±1.41	11.83^{a}±1.12	12.60^{a}±2.27	12.37^{a}±0.91
15^{th} day	13.88^{ab}±1.56	13.14^{ab}±0.99	15.01^{ab}±2.25	14.01^{ab}±0.93
30^{th} day	15.30^{abc}±1.66	14.63^{abc}±1.03	17.08^{bc}±216	15.67^{abc}±0.95
45^{th} day	16.32^{bc}±1.72	15.88^{bcd}±0.81	18.64^{bcd}±2.20	16.94^{bcd}±0.96
60^{th} day	17.43^{bcd}±1.82	17.87^{cde}±0.80	19.78^{cde}±2.27	18.36^{cde}±0.98
75^{th} day	18.82^{cd}±1.93	18.93^{de}±0.88	21.20^{de}±2.46	19.65^{de}±1.05
90^{th} day	20.21^{d}±2.13	20.97^{e}±0.69	23.02^{e}±2.71	21.40^{e}±1.14
Pooled Mean	16.38±0.78	16.18±0.61	18.19±1.04	

CD group – Non Significant, CD periods – 3.72 (P<0.01)
Common small alphabets within the respective column indicates non significant differences

The mean fortnightly body weights in goats for different groups are presented in Table 4 and depicted graphically in fig. 1. At the beginning of experiments i.e. on 0^{th} day the average body weights in each group were statistically non significant and the body weights were 12.68±1.41, 11.83±1.12 and 12.60±2.27 kg for T_0, T_1 and T_2, respectively. The non significant differences amongst the body weights for different groups indicated homogenous distribution of animals for the experiment. The corresponding body weights at the end of experiment i.e. on 90^{th} day were 20.21±2.13, 20.97±0.69 and 23.02±1.55 kg. The overall average body weights for the groups were 16.38±0.78, 16.18±0.61 and 18.19±1.04, kg respectively for T_0, T_1 and T_2 group with non significant variations. The body weights in each group were increased linearly in positive direction with significant (P<0.01) variations and it is increased obvious that body weights tends to be increased as the period of experiment advances in each group, however the body weights on 60^{th}, 75^{th} and 90^{th} day in each group were comparable, may be summarized that the body weights at later stage of growth are bit slower than the initial stages. The body weights are in accordance with Rekhate *et al.* (2007[a]) reported comparable body weights on arhar pellets; Madavi

et al. (2006) reported on arhar and gram straw based pelleted complete feed and Madavi *et al.* (2006) reported for goats on arhar straw and concentrate pellets.

The findings of present study revealed that, the body weights were comparatively more for groups fed gram straw based pelleted complete feed supplemented with fibre degrading enzymes and *Saccharomyces cerevisiea*. Since the addition of enzymes in diets of ruminants have positive effect on carbohydrate degradation of cell walls (Krueger *et al.* 2008; Tang *et al.* 2008), co-operating in the feed hydrolysis, they also interact synergistically with rumen micro-organism to enhance the digestion of feed ingredients (Beauchemin *et al.* 2004). The results may be variable and inconsistent in terms of fibre digestibility because potential of enzymes depends upon the dose and substrate, but in the present study enzymes are acted favourably to enhance the body weights of goats.

Table 5 Mean fortnightly body weight gain of goats in different groups (kg)

Fortnights	**Groups**			**Pooled Mean**
	T_0	**T_1**	**T_2**	
1st fortnight	1.20^{A}±0.18	1.31^{A}±0.29	2.42^{B}±0.23	1.64±0.19
2nd fortnight	1.42^{A}±0.17	1.49^{A}±0.40	2.07^{B}±0.27	1.66±0.18
3rd fortnight	1.02^{A}±0.28	1.25^{AB}±0.35	1.55^{B}±0.44	1.27±0.20
4th fortnight	1.12^{A}±0.25	1.99^{B}±0.41	1.14^{A}±0.26	1.42±0.20
5th fortnight	1.38^{A}±0.38	1.06^{A}±0.36	1.42^{A}±0.23	1.29±0.18
6th fortnight	1.39^{A}±0.24	2.03^{B}±0.55	1.82^{AB}±0.32	1.75±0.22
Pooled Mean	1.25^{A}±0.10	1.52^{AB}±0.16	1.74^{B}±0.13	

CD group – 0.45 (P<0.05), CD periods – Non significant
Common capital alphabets within the respective row indicates non significant differences

The fortnightly body weight gains in goats for different groups are presented in Table 5. The body weight gains were not consistent periodically in each group, rather no concrete relationship could be established in body weight gains at different intervals of each treatment. The fortnightly body weight gain varied significantly (P<0.01) amongst the group and overall average fortnightly body weight gain of 1.25±0.10 kg was observed in control group, followed by T_1 (1.52±0.16 kg) and T_2 (1.74±0.13 kg). The average body weight gain was

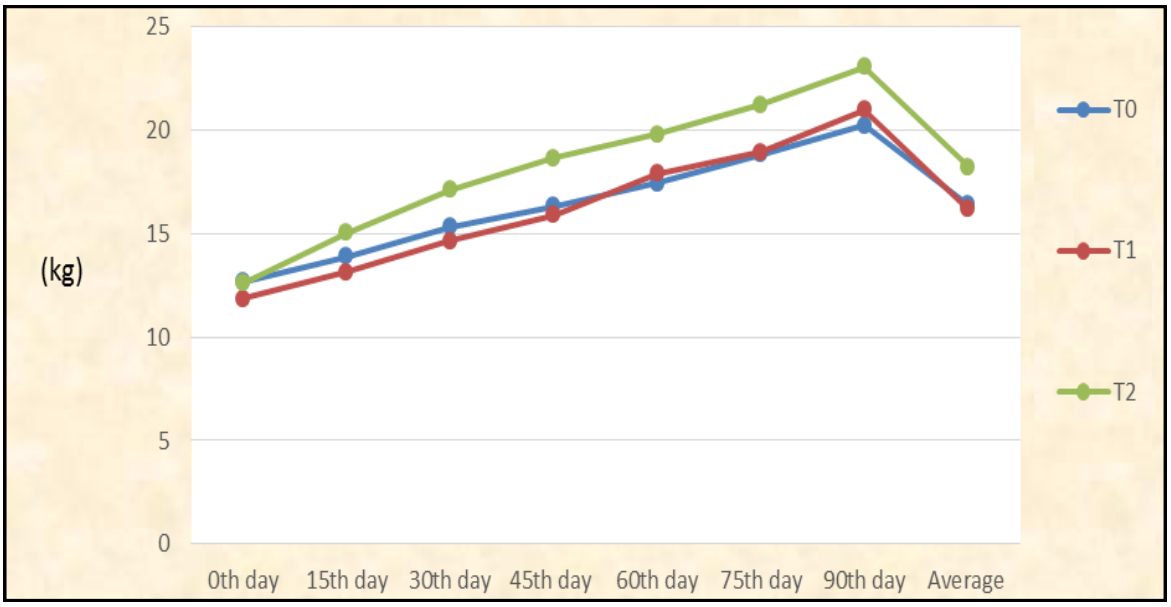

Fig. 1 showing Mean fortnightly body weights of goats in different groups (kg)

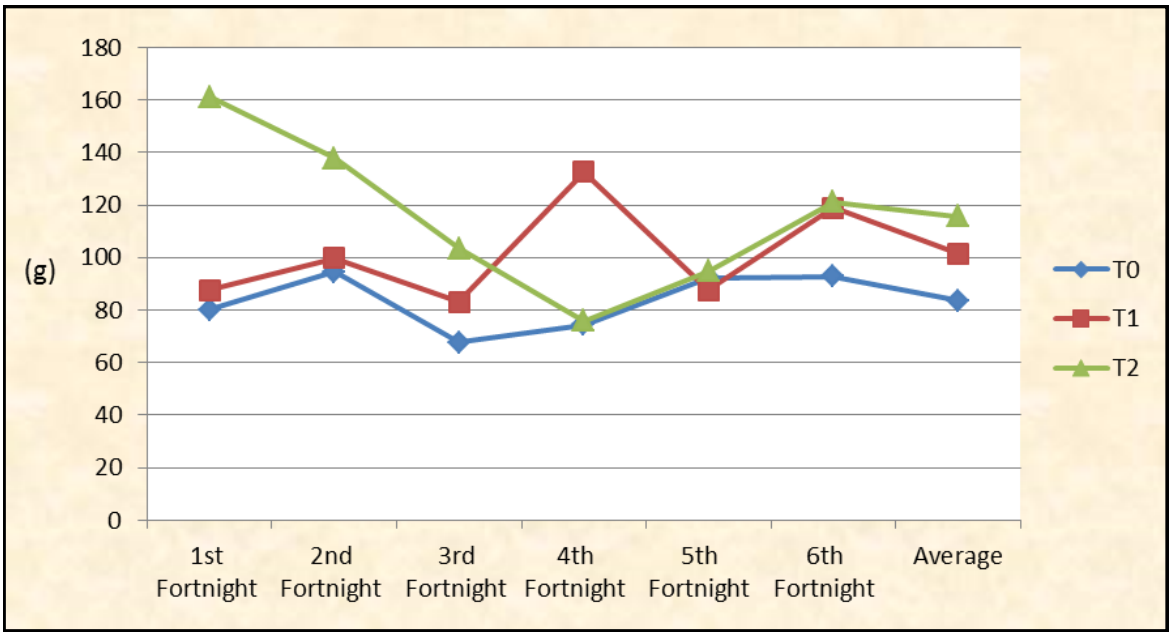

Fig. 2 showing Mean average daily gain expressed fortnightly of goats in different groups (g)

significantly higher for group fed with gram straw based pelleted complete feed supplemented with fibre degrading enzymes and yeast than that of control. Further body weight gain on gram straw based pelleted complete feed without enzyme and yeast was also significantly higher than that of control fed with gram straw and concentrates complete mash feed at 60:40 ratio, indicated better effect of pelleting on body weight gain and fortification with enzymes and yeast further elevated the body weight gain. Supplementation of enzymes and yeast may have created favourable rumen fermentation, thereby utilization of nutrients and culminated into positive growth in goats. The body weight gain are in accordance with Rekhate *et al.* (2007[a]) reported comparable body weights on arhar pellets; Madavi *et al.* (2006) reported on arhar and gram straw based pelleted complete feed and Madavi *et al.* (2006) reported for goats on arhar straw and concentrate pellets. Rekhate *et al.* (2004) also reported similar body weight gain on gram straw based pelleted complete feed; however Rekhate *et al.* (2008) reported lower body weight gain on gram straw based complete feed mash.

Table 6 Average daily gain expressed fortnightly in different groups (g)

Fortnights	Groups			Pooled Mean
	T_0	T_1	T_2	
1st Fortnight	80.22^{A} ±12.81	87.55^{A} ±20.60	161.13^{B} ±16.75	109.62 ±13.25
2nd Fortnight	94.45^{A} ±12.81	99.66^{A} ±20.60	137.78^{B} ±16.75	110.62 ±13.25
3rd Fortnight	67.78^{A} ±12.43	83.11^{AB} ±28.71	103.56^{B} ±19.58	84.81 ±12.61
4th Fortnight	74.45^{A} ±12.43	132.67^{B} ±28.71	76.00^{A} ±19.58	94.37 ±12.61
5th Fortnight	92.22^{A} ±20.07	87.49^{A} ±25.05	94.89^{A} ±31.47	85.99 ±14.59
6th Fortnight	92.77^{A} ±20.07	118.89^{A} ±25.05	121.11^{A} ±31.47	110.92 ±14.59
Pooled Mean	83.65^{A} ±5.10	101.56^{AB} ±8.24	115.75^{B} ±6.74	

CD group – 30.93 (P<0.01), CD periods – Non significant
Common capital alphabets within the respective row indicates non significant differences

The average daily gains in goats for different groups are presented in Table 6 and depicted graphically in fig 2. The average daily gains were not consistent periodically in each group and no linear relationship was established for average daily gain. The ADG varied significantly ($P<0.01$) between the groups, however, periodic differences were non significant. The overall average daily gain was found to be 83.65±5.10, 101.56±8.24 and 115.75±6.74 g/day. The average daily gain was significantly higher for T_2 group fed with gram straw based pelleted complete feed supplemented with fibre degrading enzymes and yeast. It was comparable with the ADG of T_1 group fed with gram straw based pelleted complete feed without supplementation of fibre degrading enzymes and yeast, whereas ADG of T_1 was comparable with control fed with gram straw and concentrates complete mash feed at 60:40 ratio. Supplementation of enzymes and yeast added to the improvement in ADG in gram straw based pelleted complete feed. The ADG observed in the present study corroborates with Rekhate *et al.* (2005) who reported comparable ADG in local non-descript goats fed arhar straw and gram straw based pelleted complete feed. However, ADG was significantly higher when reported by Reddy and Reddy (2003) in sheep than goats, fed cotton stalk based complete diet. O Arce Cervantes *et al.* (2013) opined that the inclusion of extracts containing exogenous enzymes improved the daily weight gain by upto 15% without affecting the feed conversion. He also stated that the response is a function of the potentially digestible fraction of the forage and that a higher NDF fraction corresponds to a stronger response to the addition of diverse exogenous enzymes. Depending upon the magnitude of the effect on the NDF digestibility, enzyme additions can enhance the weight gain and in certain cases, as evident from the study, NDF digestibility was higher due to supplementation of enzymes and yeast.

Table 7 Mean daily DMI expressed weekly of goats in different groups (g)

Fortnights	Groups			Pooled Mean
	T_0	T_1	T_2	
1st week	506.58^{Aa} ±57.23	590.02^{Ba} ±41.27	558.31^{ABa} ±50.08	551.64^{a} ±28.36
2nd week	519.71^{Aab} ±57.43	601.46^{Ba} ±37.34	578.21^{Bab} ±51.08	566.46^{ab} ±28.08
3rd week	532.66^{Aab} ±57.86	614.09^{Bab} ±37.46	603.85^{Babc} ±51.86	583.53^{ab} ±28.41
4th week	556.53^{Aabc} ±60.07	612.60^{Bab} ±35.02	632.76^{Babcd} ±52.22	600.63^{abc} ±28.34
5th week	577.64^{Aabc} ±59.05	614.52^{ABab} ±34.15	663.49^{Bbcde} ±52.87	618.55^{abcd} ±28.37
6th week	602.98^{Aabcd} ±60.21	649.45^{ABabc} ±33.05	676.68^{Bbcdef} ±52.68	643.04^{abcde} ±28.10
7th week	624.71^{Abde} ±60.80	671.08A^{Babcd} ±33.40	700.93^{Bcdefg} ±52.30	665.57^{bcdef} ±28.26
8th week	648.75^{Acdef} ±63.21	698.48^{ABabcde} ±33.13	728.11^{Bdefgh} ±54.87	691.78^{cdefg} ±29.30
9th week	676.61^{Adef} ±65.86	718.95^{ABbcde} ±33.55	759.84^{Befgh} ±55.47	718.47^{defg} ±30.10
10th week	708.32^{Aef} ±67.32	739.98^{ABcde} ±34.15	783.94^{Bfgh} ±59.65	744.08^{efg} ±31.06
11th week	738.27^{Af} ±69.84	776.93^{ABde} ±41.68	804.86^{Bgh} ±68.22	773.35^{fg} ±33.91
12th week	749.77^{Af} ±71.09	781.95^{Ae} ±41.34	840.91^{Bh} ±71.04	790.88^{g} ±35.25
Pooled Mean	620.21^{A} ±19.22	673.85^{Ab} ±12.39	694.32^{B} ±18.22	

CD group – 54.84 (P<0.01), CD periods – 109.68 (P<0.01)
Common capital alphabets within the respective row and common small alphabets within the respective column indicates non significant differences

The daily dry matter expressed weekly in goats for different groups are presented in Table 7 and depicted graphically in fig 3. The dry matter intake varied significantly ($P<0.01$) between the groups as well as during the various weeks. The daily DMI from first week onwards increased linearly and significantly in each group. The average daily DMI for T_0, T_1 and T_2 group was found to be 620.12±19.22, 673.85±12.39 and 694.32±18.22 g per day. The daily DMI in each group has increased successively due to increased body weights at every week to get the requirement fulfilled. The DMI has increased significantly due to addition of enzymes and yeast as compared to other groups, indicated better palatability and acceptability due to supplementation enzymes and yeast

The results obtained for DMI are in agreement with Raut *et al.* (2002) reported on arhar straw based pelleted complete feed; Dhore *et al.* (2005) fed pelleted complete diet of different energy protein levels in weaned goats; Reddy *et al.* (2012) who reported average DMI 672.69 g/d) in goats fed on complete pelleted feed with Red Gram Straw and Rekhate *et al.* (2004) reported in goats fed on complete feed pellets containing arhar and gram straw. The DMI also corroborates with Kirubanath *et al.* (2003) who reported increased DMI in calves fed cotton straw based pelleted feed. They also reported better palatability on processing of cotton straw and blending it with concentrates. However Rekhate *et al.* (2007) reported higher DMI on arhar straw pellets

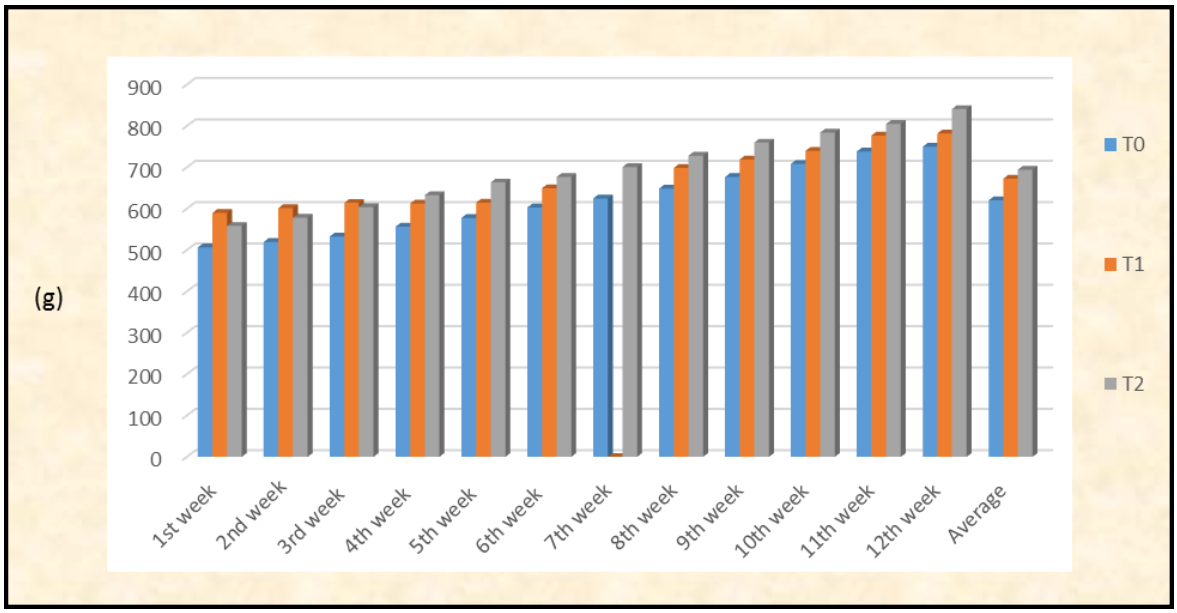

Fig. 3 showing Mean daily DMI expressed weekly of goats in different groups (g)

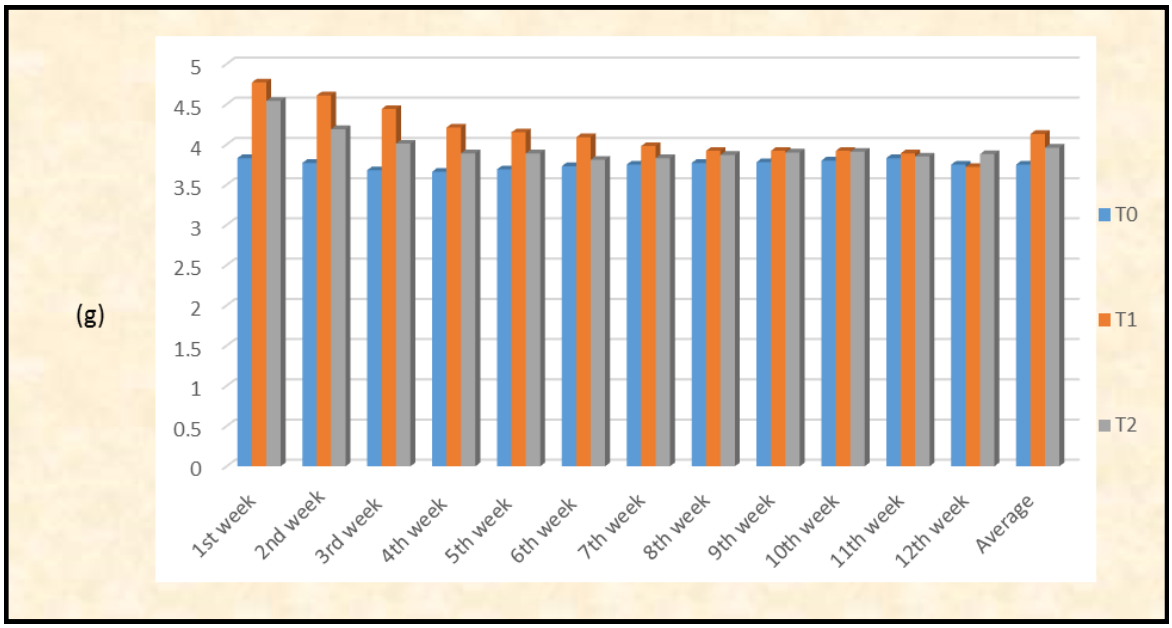

Fig. 4 showing Mean daily DMI % BW of goats in different groups (g)

Table 8 Mean daily dry matter intake % BW of goats in different groups (g)

Fortnights	Groups			Pooled Mean
	T_0	T_1	T_2	
1st week	3.83^{A}±0.09	4.77^{B}±0.15	4.54^{B}±0.86	4.38±0.29
2nd week	3.77^{A}±0.10	4.61^{C}±0.12	4.19^{B}±0.65	4.19±0.06
3rd week	3.68^{A}±0.11	4.44^{C}±0.09	4.01^{B}±0.53	4.04±0.28
4th week	3.66^{A}±0.13	4.21^{B}±0.09	3.89^{A}±0.43	3.92±0.13
5th week	3.69^{A}±0.13	4.15^{B}±0.07	3.89^{A}±0.43	3.91±0.29
6th week	3.73^{A}±0.14	4.09^{B}±0.09	3.81^{AB}±0.42	3.88±0.22
7th week	3.75^{A}±0.14	3.98^{A}±0.09	3.83^{A}±0.42	3.85±0.18
8th week	3.77^{A}±0.14	3.92^{A}±0.11	3.87^{A}±0.42	3.85±0.15
9th week	3.78^{A}±0.13	3.92^{A}±0.13	3.90^{A}±0.44	3.86±0.15
10th week	3.80^{A}±0.13	3.92^{A}±0.16	3.91^{A}±0.47	3.88±0.14
11th week	3.83^{A}±0.11	3.89^{A}±0.12	3.85^{A}±0.50	3.86±0.14
12th week	3.75^{A}±0.09	3.72^{A}±0.12	3.88^{A}±0.53	3.79±0.15
Pooled Mean	3.75^{A}±0.03	4.23^{B}±0.05	3.96^{AB}±0.15	

CD group – 0.28 (P<0.01), CD periods – Non significant
Common capital alphabets within the respective row indicates non significant differences

The dry matter intake percent body weight basis (DMI, % BW) are presented in Table 8 and depicted graphically in fig 4. The DMI percent body weight varied significantly (P<0.01) between the groups. The average DMI percent BW for T_0, T_1 and T_2 was found to be 3.75±0.03, 4.34±0.05 and 3.96±0.15 kg. The DMI percent BW was significantly lower for T_0 group than that of T_1 and comparable with T_2, further DMI percent BW was comparable for T_1 and T_2 group. The DMI percent BW was comparatively less when gram straw based complete mash feed was offered to the goats and pelleting has increase the percent DMI in goats, however when it is supplemented with enzymes and yeast, it is comparatively less. Moreover the DMI on percent BW basis is as per the

standard requirements of dry matter intake, hence goats have adjusted their dry matter requirements according to body weight and DMI percent body weights was optimum.

The findings corroborates with Raut *et al*. (2002) in goats, fed arhar straw based pelleted complete feed. The observations are also in accordance with Rekhate *et al.* (2004) who observed non significant difference in DMI percent body weight in goats fed on arhar and gram straw based complete pelleted feed. The DMI percent body weight was corroborating with Kirubanath *et al.* (2003) who reported that increased DMI percent body weight in calves fed cotton straw based pelleted feed. Dhore *et al.* (2005) and Madavi et al. (2006) also reported similar DMI in goats fed pelleted complete feed in goat; however Rekhate *et al.* (2007) reported slightly higher percent DMI in goat fed arhar straw pellets.

Table 9 Mean FCR in goats in different groups

Fortnights	Groups			Pooled Mean
	T_0	T_1	T_2	
1st week	7.47^{abcd}±1.30	6.80^{ab}±2.38	3.30^{a}±0.30	6.16^{a}±1.00
2nd week	6.99^{ab}±1.34	7.01^{ab}±2.28	3.42^{a}±0.31	6.29^{a}±0.98
3rd week	7.15^{abc}±0.64	5.53^{a}±2.35	4.59^{ab}±0.99	6.13^{a}±0.91
4th week	6.68^{a}±0.68	5.82^{a}±2.33	4.79^{ab}±1.00	6.29^{a}±0.89
5th week	11.13^{cd}±2.10	10.30^{b}±1.80	10.04^{c}±3.66	9.74^{ab}±1.44
6th week	10.80^{bcd}±2.22	10.80^{b}±1.87	10.29^{c}±3.78	10.10^{ab}±1.50
7th week	10.04^{abcd}±1.98	10.04^{b}±2.41	10.71^{c}±1.95	9.20^{ab}±1.22
8th week	10.41^{abcd}±2.04	10.41^{b}±1.90	11.16^{c}±2.10	9.34^{ab}±1.20
9th week	11.25^{d}±2.95	10.41^{b}±3.26	9.46^{c}±2.74	10.81^{b}±1.66
10th week	10.86^{bcd}±3.06	10.86^{b}±3.37	9.71^{c}±2.87	11.24^{b}±1.72
11th week	9.04^{abcd}±1.35	8.54^{ab}±3.28	7.25^{abc}±1.34	8.12^{ab}±1.20
12th week	9.29^{abcd}±1.30	8.62^{ab}±3.46	7.60^{bc}±1.43	8.32^{ab}±1.25
Pooled Mean	9.27±0.55	8.98±0.73	7.69±0.67	

CD group – Non significant, CD periods – 4.07 (P<0.01)
Common small alphabets within the respective column indicates non significant differences

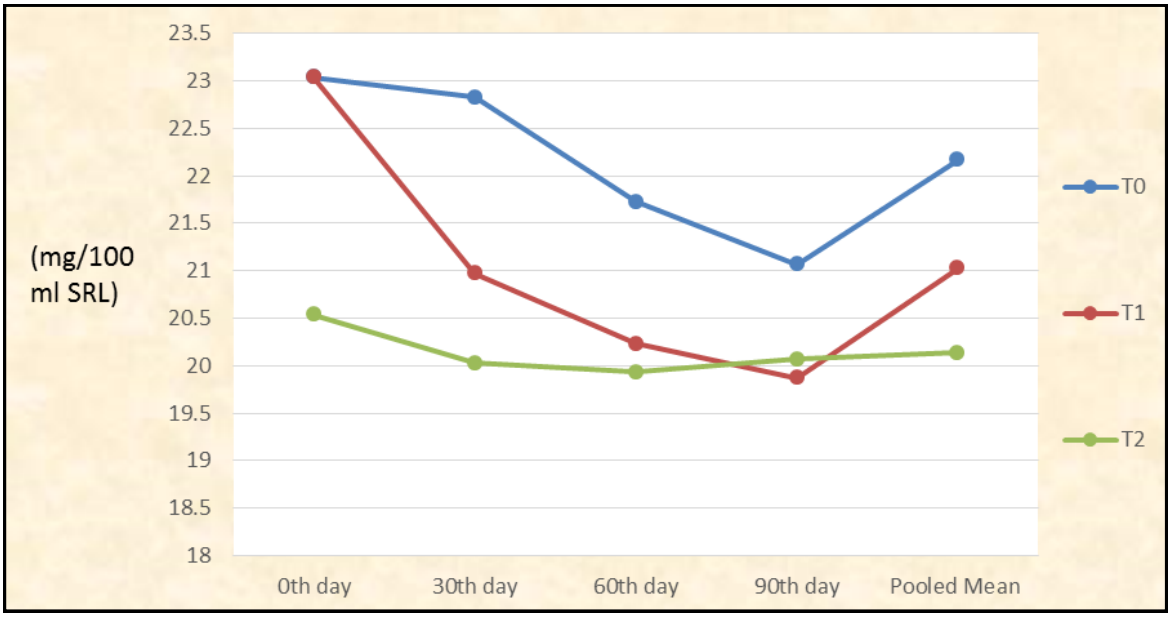

Fig. 7 showing Rumen liquor NH_3-N (mg/100 ml SRL) in goats in different groups

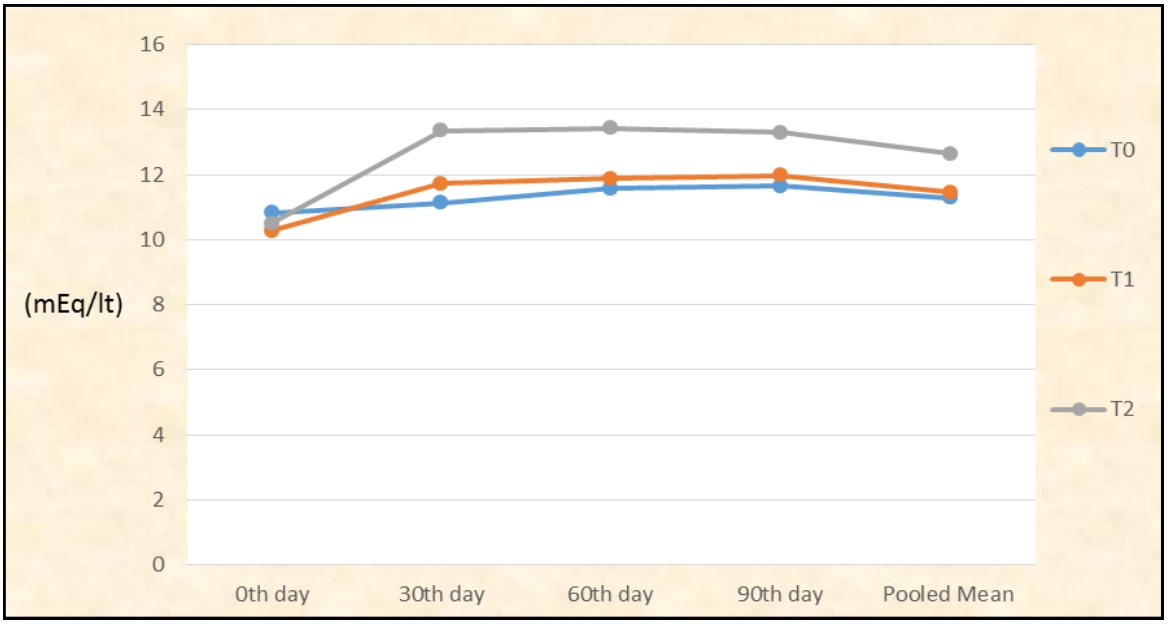

Fig. 8 showing Mean rumen liquor TVFA (mEq/lt) in goats in different groups

The feed conversion ratio (FCR) are presented in Table 9 and depicted graphically in fig 5. The FCR between the groups did not significantly, however the periodic differences were significant (P<0.01). The average FCR for T_0, T_1 and T_2 was found to be 9.27±0.55, 8.98±0.73 and 7.69±0.67. The FCR was better for T_2 group than that of T_1 and control, however statistically differences were non significant. it was comparable with T_1. The FCR was not consistent during the different fortnights; however it is apparently revealed that FCR was quite better in earlier days than that of latter stages of experiments, it seems that as the age advances feed conversion efficiency goes down. The results of the present study revealed that, supplementation of enzymes and yeast has improved the FCR comparatively in goats, indicated better utilization of crop residues due to fortification. The results are also consistent with Rekhate *et al.* (2007[a]) who reported better FCE in goats fed on complete pelleted feed with 60% arhar straw. The observations are also in accordance with Rekhate *et al.* (2004) reported in goats fed on arhar and gram straw based complete pelleted feed and Dhore *et al.* (2005) reported in weaned goats fed varying energy protein pelleted complete feed.

Table 10 Mean rumen liquor pH in goats in different groups

Periods	Groups			Pooled Mean
	T_0	T_1	T_2	
0[th] day	6.08[a]±0.06	5.85[a]±0.11	6.13[a]±0.07	6.02[a]±0.05
30[th] day	6.52[b]±0.05	6.55[b]±0.12	6.72[c]±0.19	6.59[b]±0.08
60[th] day	6.57[b]±0.11	6.58[b]±0.07	6.65[bc]±0.09	6.60[b]±0.05
90[th] day	6.63[b]±0.07	6.58[b]±0.07	6.50[c]±0.04	6.57[b]±0.04
Pooled Mean	6.45±0.06	6.39±0.08	6.50±0.07	

CD group – Non significant, CD periods – 0.17 (P<0.01)
Common small alphabets within the respective column indicates non significant differences

The rumen liquor was collected at monthly interval from each goat to study the rumen fermentation pattern and various parameters were recorded. The mean rumen liquor pH values are presented in Table 10 and depicted graphically in fig 6. The rumen liquor pH did not vary between the groups, however periodic differences were significant (P<0.01). The average values for T_0, T_1 and T_2 were

found to be 6.45±0.06, 6.39±0.08 and 6.50±0.07. It is revealed that the rumen liquor pH reached to the normal after feeding of experimental diet to the goats and has created positive ruminal environment for optimum fermentation. The pH values of strained rumen liquor observed in the experiment at monthly interval in all dietary groups were within the physiological range (Chakrabarti, 2006). The growth of cellulolytic bacteria is optimal at ruminal pH and fibre digestion is more active at 6.2 to 6.8. The observations indicated that, the dietary treatments have maintained an environment suitable for fibre digestion. In general the results revealed that, the ruminal pH was not found to be influenced due treatments. The results are also in agreement with Rekhate *et al.* (2007[a]) reported on complete pelleted feed with 60% arhar straw; Rekhate *et al.* (2004) reported in goats fed on arhar and gram straw based complete pelleted feed; Madavi *et al.* (2006) reported in arhar and gram straw based pelleted complete feed.; Dhore *et al.* (2005) reported in weaned goats fed varying energy protein pelleted complete feed; Rekhate *et al.* (2008) reported on complete gram straw based mash, gram straw based complete feed pellets and arhar stalk pellets. pelleted feed with 60% arhar straw

Table 11 Rumen liquor NH_3-N (mg/100 ml SRL) in goats in different groups

Periods	Groups			Pooled Mean
	T_0	T_1	T_2	
0th day	23.04^{B}±2.44	23.04^{B}±2.44	20.54^{A}±1.29	22.21±1.19
30th day	22.83^{B}±1.51	20.97^{A}±1.87	20.03^{A}±1.50	21.28±0.93
60th day	21.73^{B}±0.57	20.23^{AB}±1.12	19.93^{A}±0.75	20.63±0.50
90th day	21.07^{A}±0.64	19.87^{A}±0.99	20.07^{A}±0.70	20.33±0.45
Pooled Mean	22.17^{B}±0.72	21.03^{AB}±0.84	20.14^{A}±0.52	

CD group – 1.67 (P<0.05), CD periods – Non significant
Common capital alphabets within the respective row indicates non significant differences

The mean rumen liquor NH_3-N values are presented in Table 11 and depicted graphically in fig 7. The rumen liquor NH_3-N varied significantly (P<0.01) between the groups as well as during the various periodic interval. The average values for T_0, T_1 and T_2 were found to be 22.17±0.72, 21.03±0.84 and 20.14±0.52 mg/100 ml SRL. The average rumen liquor NH_3-N was significantly

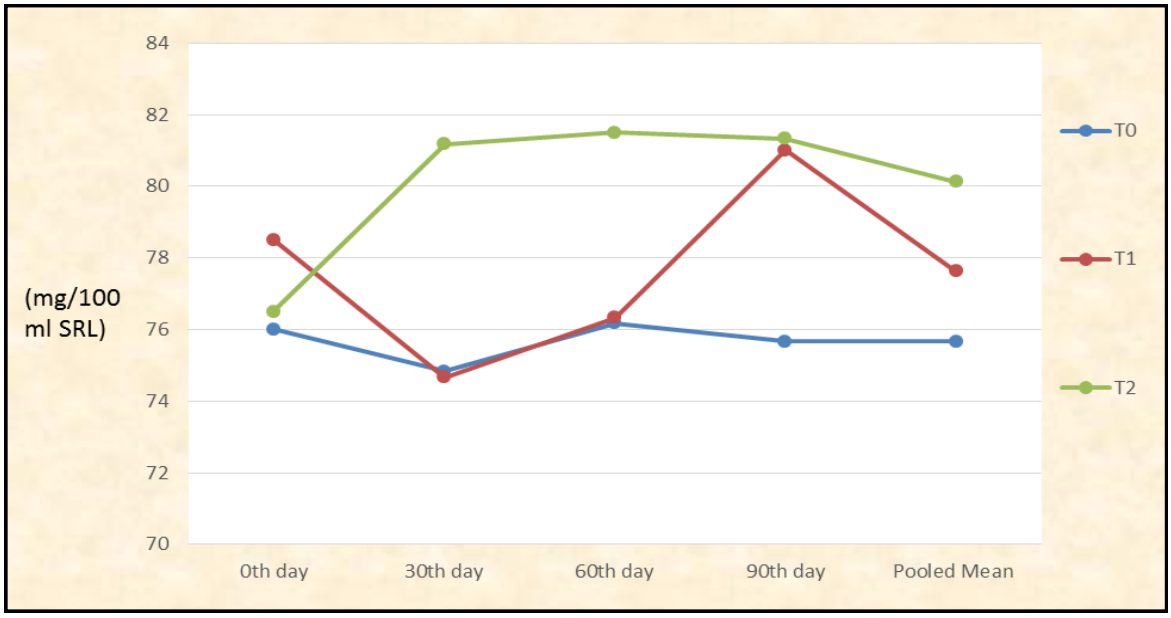

Fig. 9 showing Rumen liquor total nitrogen (mg/100 ml SRL) in different groups

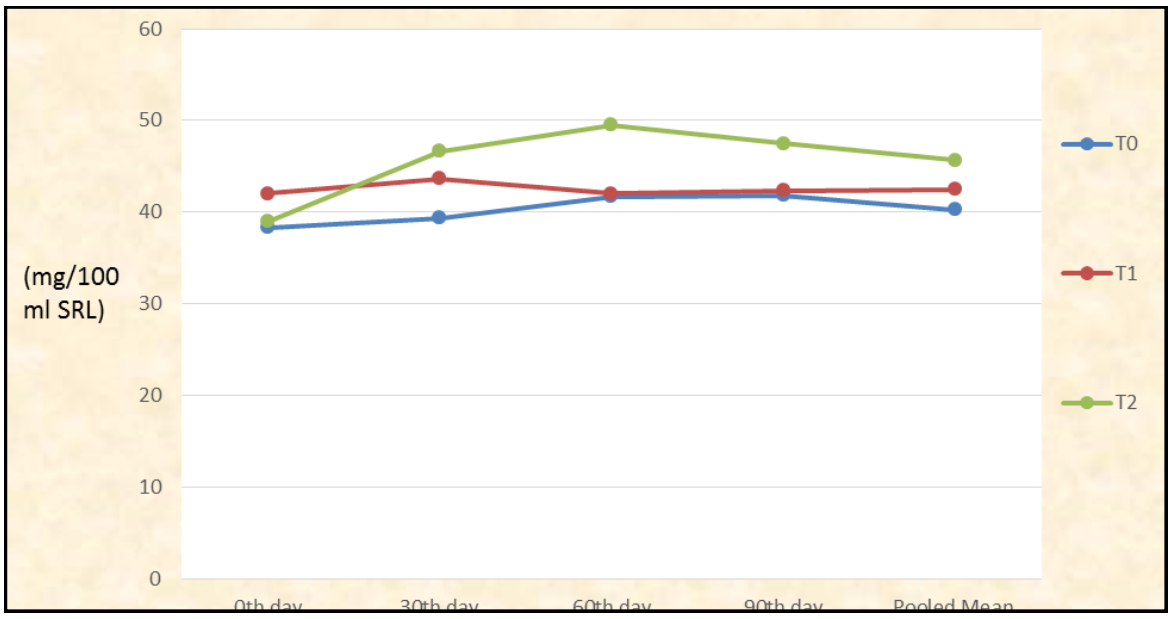

Fig. 10 showing Rumen liquor TCA- ppt- N (mg/100 ml SRL) in different groups

lower for T_2 group than that of control. The rumen liquor NH_3-N was comparatively more on 0^{th} day for T_0, T_1 and T_2 and it was decreased at successive month in each group. It is revealed that the rumen liquor NH_3-N production seems to be less after feeding of experimental diet to the goats and favours the positive ruminal environment for optimum fermentation. The results are in agreement with Rekhate *et al.* (2007^b) reported on complete pelleted feed with 60% arhar straw; Rekhate *et al.* (2004) reported in goats fed on arhar and gram straw based complete pelleted feed. The results of the present study revealed that, more feed nitrogen was efficiently utilized by the rumen micro-organisms for the synthesis of microbial protein in T_1 group than that in T_0 (control). This showed that, the inclusion of fibre degrading enzymes and yeast enhanced the protein degradation for microbial protein synthesis with less ammonia production by maintaining rumen eco-friendly environment.

Table 12 Rumen liquor TVFA (mEq/lt) in goats in different groups

Periods	Groups			Pooled Mean
	T_0	T_1	T_2	
0^{th} day	$10.82^{Aa}\pm0.39$	$10.27^{Aa}\pm0.44$	$10.50^{Aa}\pm0.34$	$10.53^{a}\pm0.22$
30^{th} day	$11.13^{Aab}\pm0.47$	$11.73^{Bb}\pm0.43$	$13.35^{Cb}\pm0.34$	$12.07^{b}\pm0.32$
60^{th} day	$11.57^{Ab}\pm0.42$	$11.87^{Ab}\pm0.19$	$13.43^{Bb}\pm0.32$	$12.29^{b}\pm0.27$
90^{th} day	$11.65^{Ab}\pm0.22$	$11.98^{Ab}\pm0.12$	$13.30^{Bb}\pm0.37$	$12.31^{b}\pm0.22$
Pooled Mean	$11.29^{A}\pm0.19$	$11.46^{A}\pm0.21$	$12.65^{B}\pm0.30$	

CD group – 0.55 (P<0.01), CD periods – 0.64 (P<0.01)
Common capital alphabets within the respective row and common small alphabets within the respective column indicates non significant differences

The mean rumen liquor TVFA values are presented in Table 12 and depicted graphically in fig 8. The rumen liquor TVFA varied significantly (P<0.01) between the groups as well as during the various periodic interval. The average values for T_0, T_1 and T_2 were found to be 11.29±0.19, 11.46±0.21 and 12.65±0.30 mEq/lt. The average rumen liquor TVFA production was significantly lower on 0^{th} day for each group and it was significantly increased for successive months in each group, however it was more in T_1 and T_2 group than that of control. The average rumen liquor TVFA indicated better ruminal environment for

optimum fermentation. The results are also consistent with Rekhate *et al.* (2007[a]) and Rekhate *et al.* (2004) reported in goats fed on arhar and gram straw based complete pelleted feed. The inclusion of fibre degrading enzymes and yeast may have enhanced the total volatile fatty acids production in the rumen as compared to control group due to reduction in lignin content and corresponding increase in cell contents for fermentation, which might increase solubility of nitrogen and increased availability of substrates for rumen microbes for VFA's production. The observations are in accordance with Rekhate *et al.* (2007[b]) in non-descript local goats fed sole arhar straw pellets supplemented with concentrate pellets and 60% arhar straw based pelleted complete ration. The present findings are also supported by Rekhate *et al.* (2004) and Bhadane *et al.* (2009) who reported higher TVFA production in goats fed on arhar straw based complete feed pellets and Dhore *et al.* (2005) who also summarized that higher TVFA production couldbe attributed to higher fibre digestibility as evident from the present study, while Rekhate *et al.* (2005) reported less TVFA production in goats fed pelleted complete feed.

Table 13 Rumen liquor total nitrogen (mg/100 ml SRL) in different groups

Periods	Groups			Pooled Mean
	T_0	T_1	T_2	
0^{th} day	76.00^{A}±1.44	78.50^{A}±2.16	76.50^{A}±1.38	77.00±0.96
30^{th} day	74.83^{A}±2.93	74.67^{A}±4.67	81.17^{B}±2.23	76.89±2.00
60^{th} day	76.17^{A}±1.94	76.33^{A}±2.39	81.50^{B}±1.34	78.00±1.21
90^{th} day	75.67^{A}±3.39	81.00^{B}±4.16	81.33^{B}±4.02	79.33±2.19
Pooled Mean	75.67^{A}±1.19	77.63^{AB}±1.71	80.13^{B}±1.24	

CD group – 4.71 (P<0.05), CD periods – Non significant
Common capital alphabets within the respective row indicates non significant differences

The mean rumen liquor total nitrogen values are presented in Table 13 and depicted graphically in fig 9. The rumen liquor total nitrogen production varied significantly ($p<0.05$) between the groups, however periodic intervals did not show any significant variation. The average total nitrogen values were found to be 75.67±1.19, 77.63±1.71 and 80.13±1.36 mg/100 ml SRL. The total nitrogen was significantly better in T_2 group than that of control. The results are also supported

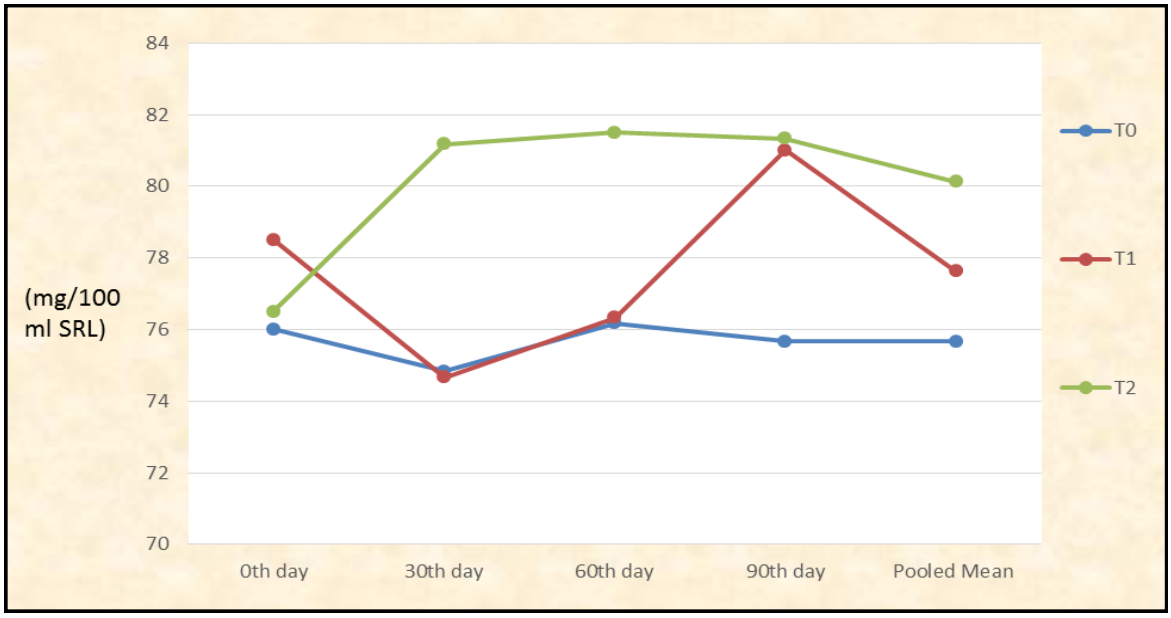

Fig. 9 showing Rumen liquor total nitrogen (mg/100 ml SRL) in different groups

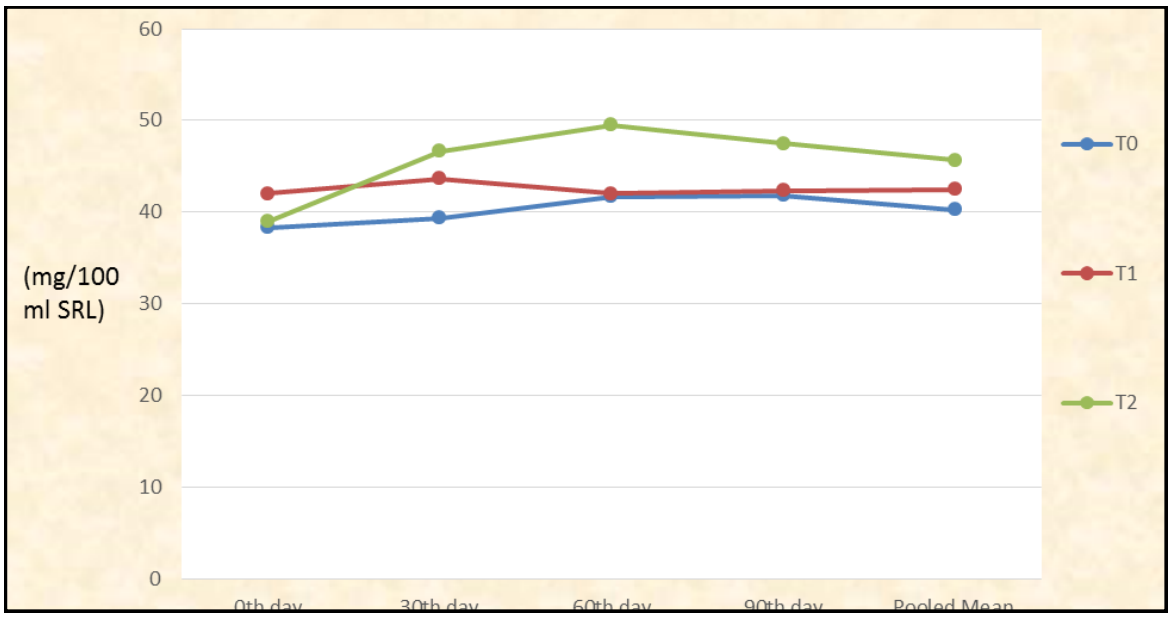

Fig. 10 showing Rumen liquor TCA- ppt- N (mg/100 ml SRL) in different groups

by Rekhate *et al.* (2007[b]) and Rekhate *et al.* (2004) reported in goats fed on arhar and gram straw based complete pelleted feed.

Table 14 Rumen liquor TCA-ppt-N (mg/100 ml SRL) in different groups

Periods	Groups			Pooled Mean
	T_0	T_1	T_2	
0^{th} day	38.33^{A}±2.17	42.00^{A}±3.62	39.00^{A}±2.52	39.78±1.59
30^{th} day	39.33^{A}±1.02	43.67^{AB}±2.50	46.67^{B}±3.29	43.22±1.52
60^{th} day	41.67^{A}±4.18	42.00^{A}±5.11	49.50^{B}±2.83	44.39±2.41
90^{th} day	41.83^{A}±2.17	42.33^{AB}±3.08	47.50^{B}±0.96	43.89±1.37
Pooled Mean	40.29^{A}±1.27	42.50^{AB}±1.73	45.67^{B}±1.45	

CD group – 5.64 (P<0.05), CD periods – Non significant
Common capital alphabets within the respective row indicates non significant differences

The mean rumen liquor TCA-ppt-N values are presented in Table 14 and depicted graphically in fig 10. The rumen liquor TCA-ppt-N production varied significantly ($p<0.05$) between the groups, however periodic intervals did not show any significant variation. The average TCA-ppt-N values were found to be 40.29±1.27, 42.50±1.73 and 45.67±1.45 mg/100 ml SRL. The TCA-ppt-N was significantly better in T_2 group than that of control. The results are supported by Rekhate *et al.* (2007[b]) and Rekhate *et al.* (2004) reported in goats fed on arhar and gram straw based complete pelleted feed.

Table 15 Rumen liquor NPN (mg/100 ml SRL) in goats in different groups

Periods	Groups			Pooled Mean
	T_0	T_1	T_2	
0^{th} day	37.67±2.67	36.50±3.48	37.50±2.91	37.22±1.65
30^{th} day	35.50±3.51	31.00±4.67	34.50±3.24	33.67±2.14
60^{th} day	34.50±5.02	34.33±5.48	32.00±3.30	33.61±2.56
90^{th} day	33.83±2.59	38.67±3.77	33.83±4.62	35.44±2.11
Pooled Mean	35.37±1.70	35.13±2.14	34.46±1.72	

Non significant

The mean rumen liquor NPN values are presented in Table 15 and depicted graphically in fig 11. The NPN production did not show any significant variation in various groups as well as during various periods. The average NPN values were found to be 35.37±2.14, 35.13±2.14 and 34.46±1.72 mg/100 ml SRL. The results are supported by Rekhate *et al.* (2007[b]) and Rekhate *et al.* (2004) reported in goats fed on arhar and gram straw based complete pelleted feed.

Table 16 Nutrient digestibility coefficients (%) in experimental goats

Nutrients	Groups			CD
	T_0	T_1	T_2	
Dry matter	54.79^{A}±2.90	64.80^{B}±1.49	71.26^{B}±1.59	8.47**
Crude protein	60.46^{A}±1.62	71.34^{B}±0.78	73.01^{B}±1.01	4.64**
Ether extract	72.09^{A}±0.97	77.71^{AB}±1.93	79.33^{B}±1.01	5.72**
Crude fibre	53.51±4.04	62.80±4.72	66.07±3.12	NS
Nitrogen free extract	61.08±3.43	68.33±2.72	69.51±2.42	NS
Neutral detergent fibre	37.70^{A}±0.45	39.78^{AB}±2.36	45.08^{B}±1.95	5.38*
Acid detergent fibre	30.53^{A}±0.60	33.09^{A}±1.06	35.47^{B}±1.38	3.20*
Hemicellulose	60.80^{A}±1.58	64.91^{AB}±1.57	69.13^{B}±1.97	5.15*
Cellulose	63.71^{A}±1.87	73.07^{B}±1.24	74.43^{B}±0.44	5.49**

** (P<0.05), ** (P<0.01), NS- Non significant, Common alphabets within the respective row indicates non significant differences*

The digestibility trial was conducted at the end of experiment with 5 days collection period and digestibility of various nutrients was determined. The data obtained on different nutrients are presented in Table 16 and depicted graphically in fig 12.

The dry matter digestibility in T_0 (control), T_1 and T_2 group was found to be 54.79±2.90, 64.80±1.49 and 71.26±1.59 per cent, respectively and the differences amongst the group were significant. The crude protein digestibility in T_0 (control), T_1 and T_2 group was 60.46±1.62, 71.34±0.78 and 73.01±1.01 per cent respectively. The DM and CP digestibility of T_2 group was significantly ($p<0.01$) higher than the control group, however it was comparable with T_1 group where goats were fed with gram straw based pelleted complete feed, further DM

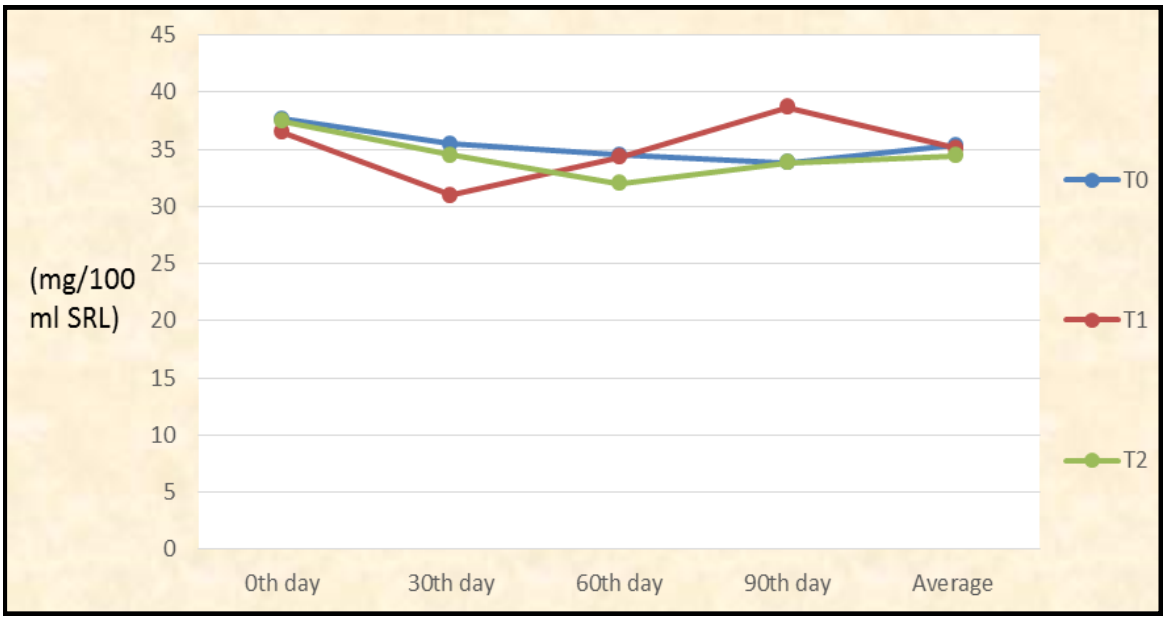

Fig. 11 showing Rumen liquor NPN (mg/100 ml SRL) in different groups

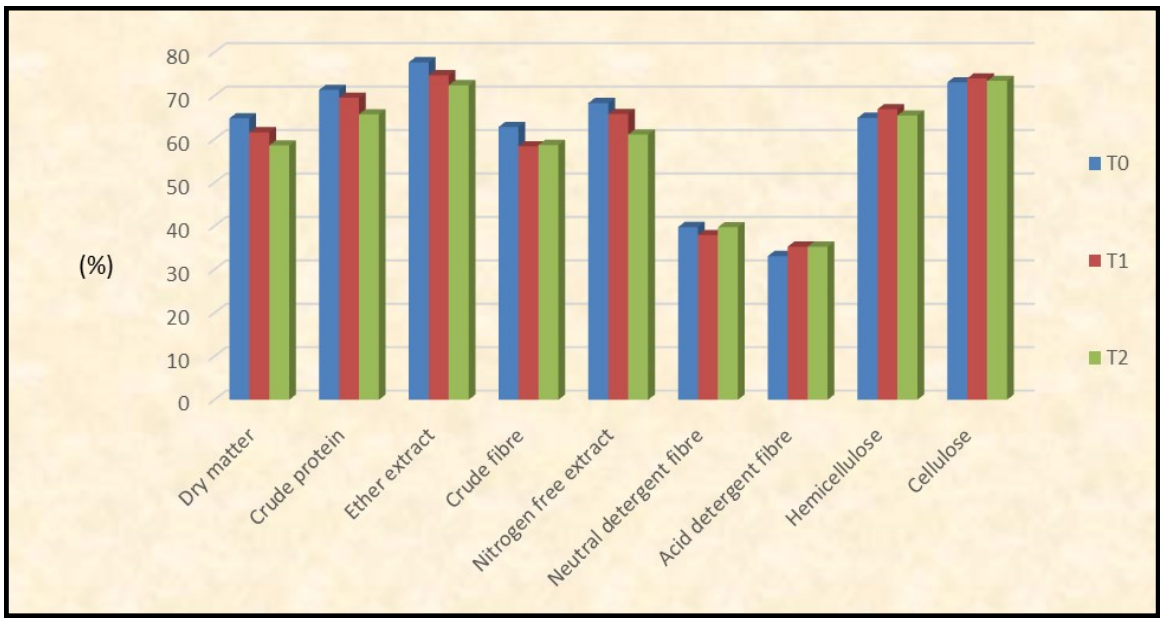

Fig. 12 showing Nutrient digestibility (%) in experimental goats

and CP digestibility of this group was also significantly better than control group where gram straw based mash feed was offered to the goats. This has revealed that Pelleting has increased DM and CP digestibility significantly and also addition of fibre degrading enzymes supplemented with *Saccharomyces cerevisiea* added to the larger extent in enhancement of DM and CP digestibility on pelleted complete feed in goats. Significant increase in DMD indicated catalytic effect of enzyme on substrate and the fermentation efficiency of forages may be improved as enzyme used as additives in ruminant feedstuffs. The cellulose and xylanase usually have a synergistic effect on cell wall hydrolysis and addition of cellulose and xylanase could improve rumen fermentation, increase DM digestibility and also enhance the rumen bacterial numbers. Further enzymes increase the digestion of DM, as more energy substrates are released, improving microbial protein synthesis by reducing the concentrations of NH_3-N, as evident in the present study (Gado *et al.* 2011)

The ether extract digestibility in T_0 (control), T_1 and T_2 group was found to be 72.09±0.97, 77.71±1.93 and 79.33±1.01 per cent, respectively and the differences amongst the group were significant. The EE digestibility of T_2 group was significantly ($p<0.01$) higher than the control group, however it was comparable with T_1 group. The EE digestibility of T_1 group was also comparable with control group. The Pelleting of complete feed mash supplemented with fibre degrading enzymes coupled with *Saccharomyces cerevisiea* increased the EE digestibility significantly, however pelleting over mash could not elevate digestibility significantly, although numerically EE digestibility was better on pelleting of complete mash feed.

The crude fibre digestibility in T_0 (control), T_1 and T_2 group was found to be 53.51±4.04, 62.80±4.72 and 66.07±3.12 per cent, respectively and the differences amongst the group were non significant. The NFE digestibility in T_0 (control), T_1 and T_2 group was found to be 61.08±3.43, 68.33±2.72 and 69.51±2.42 per cent, respectively and the differences amongst the group were non significant. The Pelleting of complete feed mash supplemented with fibre degrading enzymes coupled with *Saccharomyces cerevisiea* increased the CF and

NFE digestibility far better than the complete mash feed, however statistically differences could not be significant.

The NDF digestibility in T_0 (control), T_1 and T_2 group was found to be 37.70±0.45, 39.78±2.36 and 45.08±1.95 per cent, respectively and the differences amongst the group were significant. The ADF digestibility in T_0 (control), T_1 and T_2 group was found to be 30.53±0.60, 33.09±1.06 and 35.47±1.38 per cent, respectively and the differences amongst the group were significant. The NDF and ADF digestibility of T_2 group was significantly ($p<0.05$) higher than the control group, however it was comparable with T_1 group where goats were fed with gram straw based pelleted complete feed, further NDF and ADF digestibility of this group was comparable with control group where gram straw based mash feed was offered to the goats, summarized that addition of fibre degrading enzymes supplemented with *Saccharomyces cerevisiea* enhanced NDF and ADF digestibility on pelleted complete feed in goats. Chandrasekhariah *et al.* (2002) reported that the increase in NDF digestibility of finger millet straw by supplementation of various ingredients could be attributed to the rate of rumen NH_3-N production providing desired rumen environment to microbes to stimulate straw digestion. Significant increase in NDF digestibility indicated catalytic effect of enzyme on substrate and the fermentation efficiency of forages may be improved as enzyme used as additives in ruminant feedstuffs. The cellulose and xylanase usually have a synergistic effect on cell wall hydrolysis and addition of cellulose and xylanase could improve rumen fermentation, increase NDF digestibility and also enhance the rumen bacterial numbers. Further enzymes increase the digestion of NDF, as more energy substrates are released, improving microbial protein synthesis by reducing the concentrations of NH_3-N, as evident in the present study (Gado *et al.* 2011)

The hemicellulose digestibility in T_0 (control), T_1 and T_2 group was found to be 60.80±1.58, 64.91±1.57 and 69.13±1.97 per cent, respectively and the differences amongst the group were significant. The hemicellulose digestibility of T_2 group was significantly ($p<0.05$) higher than the control group, however it was comparable with T_1 group where goats were fed with gram straw based

pelleted complete feed, further hemicellulose digestibility of this group was comparable with control group where gram straw based mash feed was offered to the goats, summarized that pelleting as well as addition of fibre degrading enzymes supplemented with *Saccharomyces cerevisiea* enhanced hemicellulose digestibility of complete feed in goats.

The cellulose digestibility in T_0 (control), T_1 and T_2 group was found to be 63.71±1.87, 73.07±1.24 and 74.43±0.44 per cent, respectively and the differences amongst the group were significant. The cellulose digestibility of T_2 group was significantly ($p<0.01$) higher than the control group, however it was comparable with T_1 group, further cellulose digestibility of this group was also significantly better than control group where gram straw based mash feed was offered to the goats. This has revealed that Pelleting has increased cellulose digestibility significantly and also addition of fibre degrading enzymes supplemented with *Saccharomyces cerevisiea* enhanced cellulose digestibility on pelleted complete feed in goats.

It is revealed that the digestibility of most of the nutrients was enhanced due to pelleting of complete mash feed and also addition of fibre degrading enzymes supplemented with *Saccharomyces cerevisiea* has intensified the effect on digestibility of nutrients culminated into better average daily gain in goats. Overall pelleting and addition of enzymes and yeast indicated beneficial effect on growth and health status of growing goats. The cell walls are not fully degraded by endogenous enzymes in the rumen due to acidic conditions created by feed concentrates and to obtain the most nutrients from forages, exogenous fibrolytic enzymes have been used, since there is evidence that their addition to the diets for ruminants have positive effects on carbohydrate degradation of cell walls, cooperating in the feed hydrolysis, they also interact synergistically with rumen micro-organisms to enhance the digestion of feed ingredients (Beauchemin *et al.* 2004).

Table 17 Carcass characteristics in experimental goats

Nutrients	Groups			CD
	T_0	T_1	T_2	
Dressing %, slaughter wt basis	50.89^{a} ±0.10	51.27^{a} ±0.10	52.55^{b} ±0.05	0.47**
Loin eye area, cm^2	10.06^{a} ±0.10	11.07^{b} ±0.08	11.75^{c} ±0.08	0.47**
Meat percentage	71.93^{a} ±0.08	72.42^{a} ±0.24	73.49^{b} ±0.13	0.88**
Bone percentage	24.54^{c} ±0.05	24.23^{b} ±0.03	24.01^{a} ±0.01	0.16**
Meat : Bone ratio	2.93^{a} ±0.05	2.99^{b} ±0.02	3.06^{c} ±0.05	0.05**
Weight of visceral organ, %	3.49^{a} ±0.04	3.50^{a} ±0.02	3.69^{b} ±0.02	0.14**

*** (P<0.01), Common alphabets within the respective row indicates non significant differences*

The carcass characteristics determined by sacrificing three animals in each groups is presented in Table 17. The dressing percentage in T_0 (control), T_1 and T_2 group was found to be 50.89±0.10, 51.27±0.10 and 52.55±0.05 per cent, respectively.

The dressing percentage varied significantly ($p<0.01$) and it was significantly higher for T_2 group fed gram straw based pelleted complete feed supplemented with fibre degrading enzymes and yeast, however dressing percentage for T_0 and T_1 group was comparable.

The loin eye area, cm^2, which is indicative of better muscle mass gain found to be 10.06±0.10, 11.07±0.08 and 11.75±0.08 for T_0 (control), T_1 and T_2 group, respectively. The loin eye area found to be significantly better for T_2 group than that of T_1 and T_0 group, this has indicated that pelleting of gram straw based complete feed supplemented with fibre degrading enzymes and yeasts yields significantly better meat attributes and favours the stallfed goat rearing as commercial venture and also quality of meat.

The meat yield obtained during the study found to be 71.93±0.8, 72.42±0.24 and 73.49±0.13 percent for T_0 (control), T_1 and T_2 group, respectively. The meat percentage revealed significant ($p<0.01$) variations for the groups and it was higher in group fed gram straw based pelleted complete feed

supplemented with fibre degrading enzymes and yeast, however it was comparable for other two groups. The bone yield obtained during the study found to be 24.54±0.05, 24.23±0.03 and 24.01±0.01 percent for T_0 (control), T_1 and T_2 group, respectively. The bone percentage varied significantly for the groups and it was higher in group fed gram straw based complete mash feed.

The meat to bone ratio was 2.93±0.05, 2.99±0.02 and 3.06±0.05 for T_0 (control), T_1 and T_2 group, respectively. The meat and bone ratio varied significantly ($p<0.01$) amongst the group and it was significantly higher for T_2 group. The weight of visceral organs was 3.49±0.04, 3.50±0.02 and 3.69±0.02 for T_0 (control), T_1 and T_2 group, respectively. The organ weight varied significantly ($p<0.01$) amongst the group and it was significantly higher for T_2 group. The findings on carcass characteristics obtained in the present study are in agreement with Bhadane *et al.* (2007) reported in goats fed arhar straw based pelleted complete feed. Wadhwani *et al.* (2010) reported lower carcass yield on conventional and non conventional TMR in lambs, however in the present study even gram straw based complete mash feed also yields better carcass characteristics, indicates balancing of feed in terms of energy and protein for optimum meat yield in goats. Gad *et al.* (2011) also reported lower dressing percentage in lambs fed cotton stalk and wheat straw based complete feed., who also stated that exogenous enzymes has no significant effect on dressing percentage in lambs, however in the present study supplementation of exogenous enzymes coupled with yeast have yielded significantly higher dressing percentage in goats under stall fed conditions, attributed to better ADG in goats and thereby gain of muscle mass culminated into higher dressing percentage. The overall it is revealed that the under stall fed conditions carcass characteristics are much higher than reported by other workers, may be due to the superior roughage source as gram straw in pelleted complete feed and also supplementation of fibre degrading enzymes and yeast.

Economics of feedings

In present study economics of feeding of goats was compared between all the three dietary groups using the data generated during the experiment. The costs

of ingredients were considered as per actual purchase of ingredients at farm. The cost of cotton stalk was also considered including transportation. The feed preparation cost of experimental feed was also considered and unit cost of feed per kg was calculated. Based on total body weight gain during the entire experimental period and feed consumed the cost per kg unit weight gain was calculated and presented in table 18.

Table 18 Economics of feeding of goats at different dietary treatments

Sr. No.	Particulars	Groups		
		T_0	T_1	T_2
1	Cost of feed per kg (Rs)	14.30	14.55	14.76
2	Total feed consumed per goat (kg)	61.29	66.60	68.22
3	Total cost of feeding per goat (Rs)	876.44	969.03	1006.92
4	Average body wt gain per goat (kg)	7.53	9.14	10.42
5	Feed cost per kg body weight gain (Rs)	116.39	106.02	96.63

It is observed that, per kg cost of feed was lower in T_0 group followed by T_1 group and T_2 group, since gram straw based complete mash feed was pelleted in T_1 group and it was supplemented with fibre degrading enzymes and *Saccharomyces cerevisiea* in T_2 group.

Hence total cost of feed incurred in T_2 groups is more as compared to T_1 and it was lowest in T_0 group. The total body weight gain was 7.53, 9.14 and 10.42 kg for T_0, T_1 and T_2 group, respectively. Thus cost of feed per kg body weight gain was lowest in T_2 group (Rs. 96.63) where gram straw based complete mash feed was pelleted and supplemented with fibre degrading enzymes and *Saccharomyces cerevisiea*, followed by T_1 group (Rs. 106.02) where gram straw based complete mash feed was pelleted, however feeding cost was highest in control group fed gram straw based complete mash feed.

Thus, it is indicated that pelleting of complete mash for intensive rearing of goats supplemented with fibre degrading enzymes and *Saccharomyces cerevisiea* reduces the cost of feeding without any adverse effect. The

observations on economics of feeding are supported by Shembekar (2019) and Jadhav (2019) reported when gram straw replaced with cotton stalk in pelleted complete feed of goats.

Lower feed cost per kg body weight gain of growing experimental goats was also reported by Rashid *et al.* (2016) who concluded that compound pelleted feed is best for economic goat production in stall feeding.

Plate 10 Showing full carcass in T1 group

Plate 11 Showing liver and heart in T2 group

SUMMARY AND CONCLUSIONS

The present experiment was conducted on growing goats reared under intensive system at Goat Unit of Nagpur Veterinary College, Nagpur. The experiment was conducted with an objective to study the effect on growth performance, rumen fermentation, digestibility of nutrients, carcass characteristics and economics of goat production of growing goats.

Eighteen healthy growing goats between 4 to 6 months of age with similar body weights were selected for experiment and randomly allotted to three dietary treatments groups i. e. group T_0 (Control), group T_1 and group T_2 with six goats in each. The experiment was carried out for a period of 90 days for recording the observations.

The experimental goats were housed in shed with proper ventilation, flooring, with facility of stall feeding and loose paddock. A standard practice of hygiene, management, vaccination, de-worming and feeding schedule was followed during the experiment.

The 60:40 roughage to concentrate ratio was maintained in all the diets, which were iso-nitrogenous and iso-caloric. The group T_0 was offered complete mash feed prepared from 60% gram straw (GS) as roughage and 40% concentrates. While, T_1 group was offered pelleted complete feed prepared from 60% gram straw (GS) as roughage and 40% concentrates. The group T_2 was fed pelleted complete feed comprised of 60% gram straw (GS) as roughage and 40% concentrates supplemented with fibre degrading multi enzymes @ 500 g/ton of feed and *Saccharomyces cerevisiae* @ 250 g/ton of feed.

The body weights of goats in treatment groups were recorded at fortnightly interval and average daily gain was calculated. The dry matter intake (DMI) per animal was recorded from the daily observations of feed offered, feed intake and the feed leftover of individual animal in the experimental groups. The feed conversion ratio was determined from dry matter intake and body weight gain during the respective fortnight. The rumen liquor samples were collected

from each goat at monthly interval and analysed for pH, NH_3-N, TVFA, total nitrogen, TCA-ppt-N and NPN concentrations. The digestibility trial was conducted for 5 days at the end of experiment and digestibility coefficients for DM, CP, EE, CF, NFE, NDF, ADF, hemicellulose and cellulose were determined. The carcass characteristics was determined at the end of experiment and dressing percentage, loin eye area, meat and bone percentage and weight of visceral organs was determined. The economics of feeding of goats was also studied at the end of the experiment after getting the price of feed and total body weight gain of goats.

The body weights in goats at the beginning of experiments i.e. on 0^{th} day in each group were statistically non significant body weights were 12.68±1.41, 11.83±1.12 and 12.60±2.27 kg for T_0, T_1 and T_2, respectively. The non significant differences amongst the body weights for different groups indicated homogenous distribution of animals for the experiment. The corresponding body weights at the end of experiment i.e. on 90^{th} day were 20.21±2.13, 20.97±0.69 and 23.02±1.55 kg. The body weights in each group were increased linearly in positive direction with significant ($p<0.01$) variations. The overall average daily gain was found to be 83.65±5.10, 101.56±8.24 and 115.75±6.74 g/day. The average daily gain was significantly higher for T_2 group fed with gram straw based pelleted complete feed supplemented with fibre degrading enzymes and yeast. The average daily DMI for T_0, T_1 and T_2 group was found to be 620.12±19.22, 673.85±12.39 and 694.32±18.22 g per day and DMI percent BW was found to be 3.75±0.03, 4.34±0.05 and 3.96±0.15 for respective group. The average FCR for T_0, T_1 and T_2 was found to be 9.27±0.55, 8.98±0.73 and 7.69±0.67. The FCR between the groups did not differ significantly, however the periodic differences were significant ($p<0.01$).The FCR was better for T_2 group than that of T_1 and control.

The rumen liquor pH did not vary between the groups, however periodic differences were significant ($p<0.01$). The average values for T_0, T_1 and T_2 were found to be 6.45±0.06, 6.39±0.08 and 6.50±0.07.The rumen liquor NH_3-N varied significantly ($p<0.01$) between the groups as well as during the various periodic interval. The average values for T_0, T_1 and T_2 were found to be 22.17±0.72, 21.03±0.84 and 20.14±0.52 mg/100 ml SRL. The rumen liquor TVFA varied

significantly ($p<0.01$) between the groups as well as during the various periodic interval. The average values for T_0, T_1 and T_2 were found to be 11.29±0.19, 11.46±0.21 and 12.65±0.30 mEq/lt. The average total nitrogen values were found to be 75.67±1.19, 77.63±1.71 and 80.13±1.36 mg/100 ml SRL. The rumen liquor total nitrogen production varied significantly ($p<0.05$) between the groups, however periodic intervals did not show any significant variation. The average TCA-ppt-N values were found to be 40.29±1.27, 42.50±1.73 and 45.67±1.45 mg/100 ml SRL. The rumen liquor TCA-ppt-N production varied significantly ($p<0.05$) between the groups, however periodic intervals did not show any significant variation. The average NPN values were found to be 35.37±2.14, 35.13±2.14 and 34.46±1.72mg/100 ml SRL. The NPN production did not show any significant variation in various groups as well as during various periods.

The nutrient digestibility determined at the end of experiment for DM, CP, EE, CF NFE, NDF, ADF, hemicellulose and cellulose in T_0 (control) group was 54.79±2.90, 60.46±1.62, 72.09±0.97, 53.51±4.04, 61.08±3.43, 37.70±0.45, 30.53±0.60, 60.80±1.58, 63.71±1.87 and in T_1 groups it was 64.80±1.49, 71.34±0.78, 77.71±1.93, 62.80±4.72, 68.33±2.72, 39.78±2.36, 33.09±1.06, 64.91±1.57, 73.07±1.24 whereas in T_2 group it was 71.26±1.59, 73.01±1.01, 79.33±1.01, 66.07±3.12, 69.51±2.42, 45.08±1.95, 35.47±1.38, 69.13±1.97 and 74.43±0.44 percent, respectively. The DM and CP digestibility of T_2 group was significantly ($p<0.01$) higher than the control group, however it was comparable with T_1 group. EE, NDF, ADF, hemicellulose, cellulose vary significantly within dietary treatment groups and CF digestibility did not vary significantly within dietary treatment groups.

The carcass characteristics determined in each groups revealed dressing percentage in T_0 (control), T_1 and T_2 group as 50.89±0.10, 51.27±0.10 and 52.55±0.05 per cent, respectively. The dressing percentage varied significantly ($p<0.01$) and it was significantly higher for T_2 group fed gram straw based pelleted complete feed supplemented with fibre degrading enzymes and yeast, however dressing percentage for T_0 and T_1 group was comparable. The loin eye area, cm^2 was found to be 10.06±0.10, 11.07±0.08 and 11.75±0.08 for T_0

(control), T_1 and T_2 group, respectively. The loin eye area found to be significantly better for T_2 group than that of T_1 and T_0 group, this has indicated that pelleting of gram straw based complete feed supplemented with fibre degrading enzymes and yeasts yields significantly better meat attributes and favours the stallfed goat rearing as commercial venture and also quality of meat. The meat yield obtained during the study found to be 71.93±0.8, 72.42±0.24 and 73.49±0.13 percent for T_0 (control), T_1 and T_2 group, respectively. The meat percentage revealed significant ($p<0.01$) variations for the groups and it was higher in group fed gram straw based pelleted complete feed supplemented with fibre degrading enzymes and yeast, however it was comparable for other two groups. The bone yield obtained during the study found to be 24.54±0.05, 24.23±0.03 and 24.01±0.01 percent for T_0 (control), T_1 and T_2 group, respectively. The bone percentage varied significantly for the groups and it was higher in group fed gram straw based complete mash feed.

The meat to bone ratio was 2.93±0.05, 2.99±0.02 and 3.06±0.05 for T_0 (control), T_1 and T_2 group, respectively. The meat and bone ratio varied significantly ($p<0.01$) amongst the group and it was significantly higher for T_2 group. The weight of visceral organs was 3.49±0.04, 3.50±0.02 and 3.69±0.02 for T_0 (control), T_1 and T_2 group, respectively. The organ weight varied significantly ($p<0.01$) amongst the group and it was significantly higher for T_2 group.

The cost of feed per kg body weight gain was lowest in T_2 group (Rs. 96.63) where gram straw based complete mash feed was pelleted and supplemented with fibre degrading enzymes and *Saccharomyces cerevisiea*, followed by T_1 group (Rs. 106.02) where gram straw based complete mash feed was pelleted, however feeding cost was highest in control group fed gram straw based complete mash feed.

It is indicated that pelleting of complete mash for intensive rearing of goats supplemented with fibre degrading enzymes and *Saccharomyces cerevisiea* reduces the cost of feeding without any adverse effect.

CONCLUSIONS

From the results obtained in present study it appears that, the digestibility of most of the nutrients was enhanced due to pelleting of complete mash feed and also addition of fibre degrading enzymes supplemented with *Saccharomyces cerevisiae* has intensified the effect on digestibility of nutrients culminated into better average daily gain in goats.

Overall pelleting of complete mash feed with addition of fibre degrading enzymes and yeast indicated beneficial effect on growth and health status and carcass characteristics of growing goats.

It is concluded that supplementation of fibre degrading enzymes and *Saccharomyces cerevisiea* in gram straw based pelleted complete feed of growing goats proved to be economical yielding better carcass under stall fed conditions.

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APPENDIX

ANOVA for fortnightly body weights of goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	161.982	32.396	1.786
Treatments	20	1209.842	60.492	3.334
Factor A	2	103.215	51.607	2.844
Factor B	6	1085.233	180.872	9.969
A X B	12	21.394	1.783	0.098
Error	100	1814.366	18.144	-
Total	125	-	-	-

ANOVA for fortnightly body weight gain of goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	11.637	2.327	4.287
Treatments	17	16.288	0.958	1.765
Factor A	2	4.190	2.095	3.859
Factor B	5	3.784	0.757	1.394
A X B	10	8.315	0.831	1.532
Error	85	46.141	0.543	-
Total	107	-	-	-

ANOVA for average daily gain of goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	53897.742	10779.548	4.329
Treatments	17	66920.140	3936.479	1.581
Factor A	2	18558.850	9279.425	3.726
Factor B	5	14058.673	2811.735	1.129
A X B	10	34302.617	3430.262	1.378
Error	85	211667.335	2490.204	-
Total	107	-	-	-

ANOVA for daily dry matter intake of goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	177485.309	35497.062	2.175
Treatments	35	1557571.932	44502.055	2.727
Factor A	2	208828.143	104414.071	6.399
Factor B	11	1319584.378	119962.216	7.352
A X B	22	29159.411	1325.428	0.081
Error	175	2855442.142	16316.812	-
Total	215	-	-	-

ANOVA for daily dry matter intake % BW of goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	29.971	5.994	13.302
Treatments	35	15.106	0.432	0.958
Factor A	2	5.285	2.642	5.864
Factor B	11	5.853	0.532	1.181
A X B	22	3.968	0.180	0.400
Error	175	78.861	0.451	-
Total	215	-	-	-

ANOVA for FCR in goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	1480.545	296.109	13.348
Treatments	35	1139.089	32.545	1.467
Factor A	2	102.544	51.272	2.311
Factor B	11	653.915	59.447	2.680
A X B	22	382.630	17.392	0.784
Error	175	3882.130	22.184	-
Total	215	-	-	-

ANOVA for rumen liquor pH in goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	1.146	0.229	5.782
Treatments	11	4.833	0.439	11.082
Factor A	2	0.141	0.071	1.780
Factor B	3	4.343	1.448	36.513
A X B	6	0.349	0.058	1.467
Error	55	2.181	0.040	-
Total	71	-	-	-

ANOVA for rumen liquor NH_3-N in goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	510.470	102.094	21.679
Treatments	11	102.744	9.340	1.983
Factor A	2	49.474	24.737	5.253
Factor B	3	37.233	12.411	2.635
A X B	6	16.037	2.673	0.568
Error	55	259.019	4.709	-
Total	71	-	-	-

ANOVA for rumen liquor TVFA in goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	16.322	3.264	6.237
Treatments	11	77.353	7.032	13.436
Factor A	2	26.106	13.053	24.940
Factor B	3	39.472	13.157	25.140
A X B	6	11.775	1.963	3.750
Error	55	28.785	0.523	-
Total	71	-	-	-

ANOVA for rumen liquor total nitrogen in goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	946.611	189.322	5.060
Treatments	11	486.944	44.268	1.183
Factor A	2	239.694	119.847	3.203
Factor B	3	69.500	23.167	0.619
A X B	6	177.750	29.625	0.792
Error	55	2057.722	37.413	-
Total	71	-	-	-

ANOVA for rumen liquor TCA-ppt-N in goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	312.903	62.581	1.165
Treatments	11	796.819	72.438	1.348
Factor A	2	350.361	175.181	3.261
Factor B	3	234.375	78.125	1.454
A X B	6	212.083	35.347	0.658
Error	55	2954.931	53.726	-
Total	71	-	-	-

Table 24 ANOVA for rumen liquor NPN in goats in different groups

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Replications	5	559.403	111.881	1.266
Treatments	11	347.819	31.620	0.358
Factor A	2	10.778	5.389	0.061
Factor B	3	159.153	53.051	0.600
A X B	6	177.889	29.648	0.336
Error	55	4859.764	88.359	-
Total	71	-	-	-

ANOVA for nutrient digestibility in experimental goats

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Dry Matter				
Treatments	2	767.336	383.668	15.466
Error	15	372.098	24.807	-
Total	17	-	-	-
Crude Protein				
Treatments	2	557.053	278.526	37.339
Error	15	111.892	7.459	-
Total	17	-	-	-
Ether Extract				
Treatments	2	84.747	42.374	1.102
Error	15	577.022	38.468	-
Total	17	-	-	-
Crude Fibre				
Treatments	2	509.235	254.618	2.794
Error	15	1367.193	91.146	-
Total	17	-	-	-
Nitrogen free extract				
Treatments	2	250.144	125.072	2.519
Error	15	744.811	49.654	-
Total	17	-	-	-
Neutral Detergent Fibre				
Treatments	2	174.387	87.193	4.552
Error	15	287.300	19.153	-
Total	17	-	-	-
Acid Detergent Fibre				
Treatments	2	73.291	36.645	5.418
Error	15	101.460	6.764	-
Total	17	-	-	-
Hemicellulose				
Treatments	2	208.180	104.090	5.936
Error	15	263.036	17.536	-
Total	17	-	-	-
Cellulose				
Treatments	2	409.049	204.525	19.581
Error	15	156.678	10.445	-
Total	17	-	-	-

ANOVA for carcass characteristics in experimental goats

Source of variation	Degrees of freedom	Sum of squares	Mean sum of squares	F cal
Dressing %, slaughter wt basis				
Treatments	2	4.326	2.163	88.761
Error	6	0.146	0.024	-
Total	8	-	-	-
Loin eye area				
Treatments	2	4.387	2.194	88.336
Error	6	0.149	0.025	-
Total	8	-	-	-
Meat percentage				
Treatments	2	4.191	2.096	24.683
Error	6	0.509	0.085	-
Total	8	-	-	-
Bone percentage				
Treatments	2	0.643	0.322	110.065
Error	6	0.018	0.003	-
Total	8	-	-	-
Meat to bone ratio				
Treatments	2	0.030	0.015	54.040
Error	6	0.002	0.000	-
Total	8	-	-	-
Visceral organ weight				
Treatments	2	0.062	0.031	13.270
Error	6	0.014	0.002	-
Total	8	-	-	-

VITA

The author Dr. Omsatya Prakash Ingle was born on 28th October, 1996 at Buldana, Dist. - Buldana. He passed his SSC examination with distinction, in the year 2012 from Prabodhan Vidyalaya, Buldana Dist.-Buldana. He passed his HSSC examination in the year 2014 from Bharat junior college, Buldana, Dist-Buldana.

Due to awareness and personal interest in veterinary field, Author joined Nagpur Veterinary College, Nagpur, in the year 2014 & successfully completed B.V.Sc. & A.H. degree in the year 2019 with first class. He has actively participated and attended conferences, workshops and animal health camps during his academic days. He has represented "Maharashtra NCC Directorate at the National Integration Camp, Patna, Bihar" held at Patna, Bihar From 15th Nov -26th Nov 2016. Author have played Chess at state level championship held at Aurangabad. He has passed "MS-CIT" course of computer education successfully. He also completed National Service Scheme successfully and also attended various animal treatment camps under NSS. During his degree course he participated in various extra-curricular activities such as Tiger census, Livestock census, Vidarbha Pakshimitra Sammelan.

Author developed huge interest in veterinary field during his under graduation and decided to take higher education. Author pursued admission for M.V.Sc. degree in Department of Animal Nutrition, at Nagpur Veterinary College, Nagpur in the year 2019 for completing his postgraduate studies. During the studies he worked as student fellow in sponsored project entitled "Scale-Up and techno economic feasibility studies on complete feed for animals using ozonated cotton stalk as roughage" at department of animal nutrition, NVC, Nagpur, also worked as research assistant in the agency project entitled "studies on supplementation of 'PROTEIN-C' powder on nutrient utilization, rumen fermentation, milk production and milk composition in buffalo" at Department of Animal Nutrition, NVC Nagpur. He has been bestowed with many professional awards and recognitions.

Author got selected as 'Livestock Development Officer, Maharastra Animal Husbandry Services, Class-1(Gazetted)' through MPSC while completing his post-graduation. Author considers himself fortunate enough to serve the voiceless animals and this noble profession.

The dedication and sincere efforts performed during two years resulted in the submission of the present thesis successfully.

THESIS ABSTRACT

a)	Title of the thesis	:	**"SUPPLEMENTATION OF FIBRE DEGRADING ENZYMES AND *Saccharomyces cerevisiea* IN GRAM STRAW BASED PELLETED COMPLETE FEED OF GROWING GOATS"**
b)	Full name of student	:	**Ingle Omsatya Prakash**
c)	Name and Address of Major Advisor	:	**Dr. A. P. Dhok** Assistant Professor Department of Animal Nutrition, Nagpur Veterinary College, Nagpur.
d)	Degree to be awarded	:	**Master of Veterinary Science**
e)	Year of award of degree	:	**2021**
f)	Major Subject	:	**Animal Nutrition**
g)	Total number of pages in the thesis	:	**95**
h)	Number of words in the abstract	:	**300**
i)	Signature of Student	:	
j)	Signature, Name and address of forwarding authority	:	

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ABSTRACT

An experiment was conducted to study the effect of supplementation of fibre degrading enzymes and *Saccharomyces cerevisiae* in gram straw based pelleted complete feed of 18 growing goats (4 to 6 months of age) for 90 days and

randomly allotted to three dietary treatments i.e. Group T_0 (Control), T_1 and T_2 with six goats in each. The basal complete ration was formulated with 60:40 roughage to concentrate ratio. The group T_0 was offered complete mash feed prepared from 60% gram straw as roughage and 40% concentrates. The group T_1 was offered pelleted complete feed containing 60% gram straw and 40% concentrates while, T_2 group was offered pelleted complete feed containing 60% gram straw and 40% concentrates with fibre degrading enzymes and *Saccharomyces cerevisiae.* The average daily DMI for T_0, T_1 and T_2 group was found to be 620.12±19.22, 673.85±12.39 and 694.32±18.22 g per day, The dry matter intake varied significantly ($p<0.01$) between the groups.The overall average daily gain was found to be 83.65±5.10, 101.56±8.24 and 115.75±6.74 g/day. The average daily gain was significantly higher for T_2, it was comparable with the ADG of T_1 group, whereas ADG of T_1 was comparable with control group. The FCR between the groups did not differ significantly, however the periodic differences were significant ($p<0.01$).The average FCR for T_0, T_1 and T_2 was found to be 9.27±0.55, 8.98±0.73 and 7.69±0.67. The FCR was better for T_2 group than that of T_1 and control, however statistically differences were nonsignificant. It was comparable with T_1. The DM and CP digestibility of T_2 group was significantly ($p<0.01$) higher than the control group, however it was comparable with T_1 group. EE, NDF, ADF, hemicellulose, cellulose vary significantly within dietary treatment groups T_0, T_1 and T_2 and CF digestibility did not vary significantly. The rumen liquor profile study revealed significant variations in rumen TVFA, NH_3-N and total nitrogen while, rumen pH and NPN concentration did not vary significantly. The carcass characteristics determined in each groups revealed dressing percentage in T_0 (control), T_1 and T_2 group as 50.89±0.10, 51.27±0.10 and 52.55±0.05 per cent, respectively with significant variations. The loin eye area found to be significantly better for T_2 group than that of T_1 and T_0 group. The meat yield obtained during the study found to be 71.93±0.8, 72.42±0.24 and 73.49±0.13 percent for T_0 (control), T_1 and T_2 group, respectively. The meat percentage revealed significant ($p<0.01$) variations for the groups and it was higher in group fed gram straw based pelleted complete feed supplemented with fibre degrading enzymes and yeast. The cost of feed per kg

body weight gain was lowest in T_2 group (Rs. 96.63) where gram straw based complete mash feed was pelleted and supplemented with fibre degrading enzymes and *Saccharomyces cerevisiea*. It is concluded that supplementation of fibre degrading enzymes and *Saccharomyces cerevisiea* in gram straw based pelleted complete feed of growing goats proved to be economical under stall fed conditions.

प्रबंध सारांश

अ.	प्रबंधाचे शिर्षक	:	"तंतुमय पदार्थांचे विघटन करणारे बहुविकरे व सॅक्रोमायसेस सर्वीसेसह वाढीव शेळ्यांसाठी चणा कुटरयुक्त संपूर्ण कांडीखाद्याचा वापर"
ब.	विद्यार्थ्याचे पुर्ण नाव	:	इंगळे ओमसत्य प्रकाश
क.	मार्गदर्शकाचे नाव आणि पत्ता	:	डॉ. ए. पी. ढोक सहाय्यक प्राध्यापक पशुपोषण आहारशास्त्र विभाग, नागपूर पशुववैद्यक महाविद्यालय, नागपूर
ड.	प्रदान करण्यात येणारी पदवी	:	स्नातकोत्तर (एम. व्ही. एस. सी.)
इ.	पदवी प्रदान करण्याचे वर्ष	:	२०२१
फ.	मुख्य विषय	:	पशुपोषणआहारशास्त्र
ग.	प्रबंधातील एकुण पृष्ठे	:	९५
ह.	सारांषातील एकुण शब्द	:	३००
ई.	विद्यार्थ्याची स्वाक्षरी	:	
ज.	अग्रेषित करणाऱ्याची स्वाक्षरी नाव आणि पत्ता	:	(डॉ. ए. पी. सोमकुंवर) सहयोगी अधिष्ठाता नागपूर पशुववैद्यक महाविद्यालय, नागपूर

सारांश

चार ते सहा महिने वयोगटाच्या अठरा शेळ्यांना प्रत्येकी सहा अश्या तीन वेगवेगळ्या खाद्यगटांमध्ये (जसे; गट टी-०, टी-१ व टी-२ विभाजून वाढीव शेळ्यांच्या संपुर्ण कांडीखाद्यामध्ये चण्याचे कुटार, तंतुमय पदार्थांचे विघटन करणारे

विकर व सॅक्रोमायसेस सर्वीसेच्या वापराचा प्रयोग नव्वद दिवसांसाठी करण्यात आला. साठ टक्के वाळला चारा व चाळीस टक्के खुराक मिश्रण असलेले संपुर्ण आहार बनवून त्याचे कांडीखाद्यात रूपांतर करून शेळ्यांना खाण्यास देण्यात आले. त्यापैकी टी-० शेळीगटाला साठ टक्के चणा कुटार व चाळीस टक्के खुराक मिश्रण असलेले खाद्य तसेच टी-१ शेळीगटाला साठ टक्के चणा कुटार व चाळीस टक्के खुराक मिश्रण असलेले कांडीखाद्य त्याचप्रमाणे टी-२ शेळीगटाला साठ टक्के चणा कुटार, चाळीस टक्के खुराक मिश्रण, तंतुमय पदार्थांचे विघटन करणारे बहुविकरे व सॅक्रोमायसेस सर्वीसे इत्यादींपासून बनवलेले कांडीखाद्य प्रयोगात खाण्यास देण्यात आले. सांख्यिकीदृष्टया शेळ्यांनी वाढत्या वयोमानानुसार जास्त (पी <०.०१) शुष्क पदार्थ ग्रहण केले असुन लक्षणीय फरक आढळून आला. शेळ्यांचे सरासरी दैनंदिन शुष्क पदार्थांचे ग्रहण गट टी-०, टी-१ व टी-२ अनुक्रमे ६२०.१२±१९.२२, ६७३.८५±१२.३९ व ६९४.३२±१८.२२ ग्राम होते. शेळ्यांची सरासरी दैनंदिन वजनातील वाढ हि ८९.६७±५.१०, १०८.८६ ± ८.२४, १२३.९४ ± ६.७४ ग्राम प्रतिदिन इतकी असुन गट टी-० व गट टी-१ मधील शेळ्यांच्या सरासरी दैनंदिन वाढीपेक्षा गट टी-२ मधील शेळ्यांमधील सरासरी दैनंदिन वजनात लक्षणीय वाढ दिसुन आली. शेळीगटांमधील अन्नाचे वजनात रूपांतराचे (एफ. सी. आर) सरासरी प्रमाण हे ८ ९.२७ ± ०.५५ ८.९८± ०.७३ व ७.६९ ±०.६७ इतके असुन इतर गटांपेक्षा गट टी-२ मध्ये कमी अन्नाचे जास्त वजनामध्ये रूपांतरण करण्याची सरस क्षमता दिसुन आली. शुष्क पदार्थ व प्रथिनांची पाचकता गट टी-२ मध्ये जास्त आढळून अली तसेच इतरही पोषणमूल्यांच्या पाचकतेत लक्षणीय बदल आढळून आला परंतु तंतुमय पदार्थांच्या पाचकतेत कुठलाही बदल आढळून आला नाही. दरमाही रोमंथिकाच्या आंबवण्याच्या अभ्यासादरम्यान असे आढळून आले की- टी. व्ही. एफ. ए., एकुण नैट्रोजन, टी. सी. ए.-पीपीटी-नैट्रोजन व अमोनिया नैट्रोजन ह्या रवंथीकेतील द्रव्यांच्या तत्वांवर लक्षणीय फरक आढळून आला तसेच सामु व प्रथिने-विरहित-नैट्रोजन ह्या रवंथीकेतील द्रव्यांच्या तत्वांवर वेगवेगळ्या गटातील शेळ्यांमध्ये सांख्यिकीदृष्ट्या कुठलाही लक्षणीय बदल दिसून आला नाही. प्रयोगाअंती मटणाच्या उत्पादनाचा अभ्यास करण्यात आला , त्यात ड्रेसिंग टक्केवारी गट टी-०, टी-१ व टी-२ मध्ये अनुक्रमे ५०.८९±०.१०, ५१.२७ ± ०.१० व ५२.५५ ±०.०५ होती व या तत्वांमध्ये सांख्यिक दृष्ट्या फरक आढळून

आला. तसेच लॉयन आय एरिया गट टी-०, टी-१ व टी-२ मध्ये अनुक्रमे ७१.९३ ± ०.८, ७२.४२ ± ०.२४ व ७३.४९ ± ०.१३ सेमी^{२} आढळून आला व या तत्वात विविध गटांमध्ये सांख्यिकीदृष्ट्या बदल आढळून आला . तसेच मांसल टक्केवारी मध्ये सुद्धा लक्षणीय बदल घडून आला. शेळीगटांमधील गट टी-२ शेळ्यांच्या प्रति किलो वजनवाढीसाठीचा खर्च रुपये ९६.६३ इतका होता जिथे शेळीगटाला साठ टक्के चणा कुटार, चाळीस टक्के खुराक मिश्रण, तंतुमय पदार्थांचे विघटन करणारे विकर व सॅक्रोमायसेसेस सर्वीसे इत्यादींपासून बनवलेले कांडीखाद्य प्रयोगात खाण्यास देण्यात आले. ह्या सर्व सद्यःअभ्यासाच्या निरीक्षणावरून असा निष्कर्ष काढण्यात येतो की- तंतुमय पदार्थांचे विघटन करणारे बहुविकरे व सॅक्रोमायसेस सर्वीसे इत्यादींपासून बनवलेल्या संपूर्ण कांडीखाद्याचा बंदिस्त पद्धतीत वापर केल्यास शेळीपालन किफायतशीर ठरते.