NUTRITIVE EVALUATION OF PALMYRA (*Borassus flabellifer*) SEEDHUSK AND SUGAR CANE (*Saccharum officinarum*) BAGASSE IN CROSSBRED CALVES

SANOODH MOHAMMED AV

(16-MVM-035)

DEPARTMENT OF ANIMAL NUTRITION

COLLEGE OF VETERINARY AND ANIMAL SCIENCES

MANNUTHY, THRISSUR 680651

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THESIS

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DEPARTMENT OF ANIMAL NUTRITION
COLLEGE OF VETERINARY AND ANIMAL SCIENCES
MANNUTHY, THRISSUR – 680651
KERALA, INDIA

DECLARATION

I hereby declare that this thesis, entitled ***"Nutritive evaluation of palmyra (Borassus flabellifer) seed husk and sugar cane (Saccharum officinarum) bagasse in crossbred calves"*** is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Mannuthy **Sanoodh Mohammed AV**

Date **(16 MVM 035)**

Dr. Deepa Ananth
Assistant Professor
Department of Animal Nutrition
College of Veterinary and Animal Sciences
Mannuthy, Thrissur- 680651

Date:

CERTIFICATE

Certified that this thesis, entitled ***"Nutritive evaluation of palmyra (Borassus flabellifer) seed husk and sugar cane (Saccharum officinarum) bagasse in crossbred calves"*** is a record of research work done independently by **Sanoodh Mohammed AV (16 MVM 035)** under my guidance and supervision and it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

Mannuthy

Dr. Deepa Ananth
Chairperson
Advisory Committee

CERTIFICATE

We, the undersigned members of the Advisory Committee of **Dr. Sanoodh Mohammed AV (16 MVM 035)** a candidate for the degree of **Master of Veterinary Science in Animal Nutrition**, agree that this thesis entitled **"** ***Nutritive evaluation of palmyra (Borassus flabellifer) seed husk and sugar cane (Saccharum officinarum) bagasse in crossbred calves*****"** may be submitted by **Dr. Sanoodh Mohammed AV (16 MVM 035)** in partial fulfillment of the requirement for the degree.

Dr. Deepa Ananth
Assistant Professor
Department of Animal Nutrition
College of Veterinary and Animal Sciences
Mannuthy, Thrissur- 680651
(Chairperson)

Dr. K. Ally
Professor and Head
Department of Animal Nutrition
College of Veterinary and Animal Sciences
Mannuthy, Thrissur- 680651
(Member)

Dr. K.S Anil
Professor and Head
Dept. of Livestock Production Management
College of Veterinary and Animal Sciences
Mannuthy, Thrissur- 680651
(Member)

Dr. Surej Joseph Bunglavan
Assistant Professor
Department of Animal Nutrition
College of Veterinary and Animal Sciences
Mannuthy, Thrissur- 680651
(Member)

EXTERNAL EXAMINER

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Sanoodh

DEDICATED TO MY FAMILY

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INTRODUCTION

INTRODUCTION

Ever expanding human population in Kerala had reduced the cultivable land area which results in severe shortage of roughages. The land utilised for fodder cultivation in Kerala is very negligible. It is estimated that out of the requirement of 23.20 million tonnes of green fodder, only 5.10 million tonnes is produced per year, indicating that there is an annual deficit of 78 per cent, in the State (Government of Kerala, 2013). Out of 194.40 M Ha of total gross cropped area, only 5 per cent land is allocated for cultivation of green fodder crops. Reduced roughage feeding due to shortage of affordable and easily available fodder resources, is the prime factor which influence the feeding of roughage by the farmers in the State.

Green grass and straw are the important source of energy and bulk in ruminants especially in developing countries like India. Nowadays, even the straw has become an expensive commodity. Due to droughts in recent years, the green grass availability has become unusually low. Shortage of green grass and rising cost of the paddy straw are resulting in reduced profitability from the dairy sector. Reduced roughage feeding, results not only in poor milk production and growth rate but also increased incidence of diseases like lactic acidosis.

The Palmyra palm (*Borassus flabellifer*), is a multipurpose tree of great utility grows extensively in Southern States. India is a leader in the world in its wealth of sugar palm with an approximate of 122 million palms. Due to lack of the value addition, commercialization and marketing is poor in the Palmyra palm products like traditional Palm Sugar, Chocolate products from Palm, Nongu, Palmyra palm fruit, tuber etc. Kerala has immense potential for growth, development and marketing of palm products so as to attract foreign exchange by way of export of various palm products. Palmyra is the "State Tree" of Tamil Nadu. Palmyra palm tree (*Borassus flabellifer*) is having an important role in farm systems in India. Sugar palm has excellent qualities, but the utilization of palmyra palm is restricted to the toddy production, traditional sugar block production from palm sap and neera syrup. A lot of farmers in Kerala and Tamilnadu earn an income by tapping. Palmyra endosperm can be eaten raw, and fibrous sugar palm peels obtained as by-product by processing of this fruit (Rungrodnimitchai, 2011).

India is one of the highest producer of sugar cane with total production estimated above 26.1 million tonnes. (Venkatesh, 2017). Sugar cane bagasse is a major by-product from the sugar cane industry as well as is locally available from the local sugar cane juice vendors. Economic utilization of this, which is otherwise getting wasted, will be a firm step towards sustainable livestock production. It can serve as an unconventional feed resource in cattle feed due to its abundant availability in the season.

Main hurdles affecting cattle livestock production are availability of feed and its cost. Hence, it is necessary to make efforts to utilize alternate resources such as agriculture waste which are seasonally available. Efficient Palmyra seed production and sale is an important source of seasonal income for the farmers. But at the same time the other parts of Palmyra fruit are getting wasted and poses problem for its proper disposal. Sugar cane bagasse is also a by-product which can be utilized and is available during the summer period where there is acute shortage of grass. Present work is planned to assess the effect of complete feeds using sugar cane bagasse and Palmyra seed husk on growth performance of crossbred calves.

REVIEW OF LITERATURE

2. REVIEW OF LITERATURE

2.1. AVAILABILITY OF GREEN FODDER

Country is facing a net fodder deficit of 35.5 per cent. Cereal straws and agriculture by-products forms potential source of energy in livestock feed in India. The health and productivity of livestock are dependent on the quantity and quality of forage available. Lower livestock productivity in India is mainly due to the scarcity of feeds and fodders (Pachauri and Mahanta, 1997).

Waje *et al.*, 2010 reported that the shortage of green fodder and rising demand for cereal food ingredients for human consumption and its price hike has forced farmers to change to the un-conventional and agro-industrial by-products and non-competitive crop residues in livestock feeding.

Babu *et al.* (2013) observed that the green fodder scarcity will be met only through the efficient use of crop residues that do not compete with human food.

Kerala has 85 percent cross bred cattle. The bulk of dry matter requirement is mainly met from crop residues. Demand is increasing for alternate fiber resources as there is scarcity for cultivated fodder and limited land for grazing. The scarcity is aggravated during lean season due to poor availability and early maturation of fodder. Seasonal produces during summer such as sugar cane and Palmyra could be alternate resources of fodder.

2.2 CALF GROWTH

Consumption of forage improves the rumen muscular development (Hamada *et al.*, 1976) and helps in rumination and proper flow of salivary enzymes into the rumen (Hodgson, 1971).

Concentrations of rumen volatile fatty acid, especially butyrate needed for optimal rumen papillae development won't be obtained from microbial forage digestion. Butyrate required to stimulate papillae development is usually obtained from fermentation of concentrates, but these feeds may cause rumen papillae keratinization in cattle and sheep (Nocek *et al.*, 1980).

Feed particle size will affect the rumen environment and papillae development and normal functions. (Beharka *et al.*, 1998).

2.3. ALTERNATE UNCONVENTIONAL RESOURCES

Unconventional feed resources are those feeds that are not been used traditionally in cattle feed production and or are not normally used in commercial rations (Devendra, 1992).

2.3.1 TREE AS FODDER FOR RUMINANTS:

Fodder source from trees and shrub, in India are generally used during summer and other extreme situations except in certain hilly areas where it forms a part of daily ration for ruminant animals. Pipal (*Ficus religiosa*) leaves have been found to contain 7.91% DCP and 40.36% TDN (Mia *et al.*, 1960).

Similarly Guar leaves (*Ficus glomerata*) contain 53.82% TDN and 6.69% DCP and Bamboo (*Bamboosa arundinaceae*) leaves have been shown to contain 13.50% DCP and 46.52% TDN and Kachnar (*Bauhenia variegata*) leaves contain 4.98% DCP and 47. 92%TDN. Shisham (*Debergia sissoo*) leaves contain 9.07 % DCP and 52.44% TDN (Jayal, 1962). With a work on the partial replacement of protein by Subabul *(Leucaena leucocephala)* leaves in the ration of growing crossbred calves, it was reported that 50% of DCP requirement of the calves can be met by feeding *Leucaena leucocephala* leaves.

2.3.2 UNCONVENTIONAL AGRICULTURAL BY·PRODUCTS

In India, 0.464 million acres of land is under banana *(Musa paradiosica)* cultivation producing 5 M tonnes of banana fruit every year. In practice, after the collection of cluster of banana fruits, the entire plant is cut and thrown away as waste. Ffoulkes, D. and Preston, T.R., (1979) fed banana leaves to adult cattle and found that it contained 8.04% DCP and 60.82% TDN. And also fed whole banana plant to adult cattle along with mustard cake and paddy straw and found that the total ration contained 3.86% DCP 'and 54. 91% TDN on dry matter basis. It was also observed that Oiltorius leaf hay could form the part of the ration of growing cattle at 50% level without affecting their growth.

Alagiapillai (1996) reported that Jack fruit waste from ripe fruits is more palatable than waste from raw fruits. It contains 7.9 per cent crude protein, 14.1per cent crude fibre, and 0.80 per cent calcium and 0.1per cent phosphorus. This is rich source of energy, having 65.3 per cent NFE.

Investigation carried out by (Muralidharan *et al*., 1997) on converting jack fruit waste into a useful livestock feed showed that the nonedible portion of the fruit was 59·2 per cent with a dry meal recovery of 11·6 per cent. Jack fruit waste utilization is highly useful in Indian climate due to its low cost and availability in off seasons when the food is short.

Ajey (2013) reported that on microbial processing of jackfruit waste with two per cent ammonium sulphate and fermented by combined yeast and LAB recorded highest crude protein (22.34per cent), crude fibre (23.37per cent). The developed enriched animal feed from jackfruit waste in the form of dried powder contained with moisture (5.42per cent), protein (23.81per cent), crude fibre (22.63per cent), crude fat (6.37per cent), carbohydrates (71.40per cent), ash (6.5per cent) and had yeast and lactic acid bacterial population of 1.1x106 cfu and 1.8x106 cfu/g respectively.

2.4.1 Palmyra (*Borassus fabeliffer*)

Palmyra is cultivated in the eastern midlands of Kerala. Palmyra sap, which is having sucrose as the main sugar, is the main product from Palmyra palm (Naknean *et al.*, 2010).

Davis *et al*., (1987) reported that, Palmyra palm leaves can be used for matting, cigarette papers production, roofing, producing brooms, baskets.

The other products that are obtained from Palmyra palm include neera syrup, juices, traditional sap sugar blocks, toddy, sugar crystal (Mogea et al., 1991).

Other value added food products from Palmyra palm include bio-ethanol, sea water resistant fibre, vinegar starch from trunk (Mogea *et al*., 1991).

Sugar palm is one of the non-conventional feed source which can be successfully converted to cattle feeds (Sath *et al*., 2008).

Palmyra fruit is coconut-like and seed can be eaten raw, and fibrous sugar palm peels obtained as by-product by processing of this fruit (Rungrodnimitchai, 2011).

The articles on feeding value of Palmyra palm could not be found. However, studies on potential of oil palm fronds and industrial waste as cattle feed has been done. It is presumed that Asian Palmyra palm has close relationship with oil palm also is a cattle livestock feed.

2.4.2. Sugar cane (*Sachaarum officinarum*)

Sugar cane (*Saccharum officinarum*) is belonging to the family Poaceae, is an important cash crop reared mainly for sugar production. The plant is two to six metres tall. Bagasse is the fibrous residue after juice extraction for commercial sugar industry. Sugar cane has stout and other fibrous parts that are rich in sucrose, which are usually seen in the internodes. Sugar cane bagasse contain cellulose, hemicellulose, pentosans, lignin (Horton *et al*. 1991).

Horton *et al.* (1991) reported that cottonseed hulls was successfully substituted by sugar cane bagasse in finishing rations containing approximately 15 per cent roughage had improved ($P<0.10$) animal performance.

2.3.1 SUGAR CANE BAGASSE IN NON-RUMINANTS DIET

Castañón-Rodriguez *et al.*, (2015) reported that sugar cane bagasse when treated with pressure increases the cellulose fiber pore formation, which in turn promotes better digestibility of amorphous region in the fiber and resulted in improving the FCR of non-ruminants.

Ferreira *et al.* (2017) evaluated the use of sugar cane waste added with vinasse, in feed for rabbits showing large amounts of NDF (742–900 g/kg DM), ADF (493–616 g/kg DM) and lignins (88.1–136 g/kg DM).

Ferreira et al (2017) reported a low crude protein content (22.6–31.3 g/kg DM), which shows a remarkable difference between the enriched and non-enriched Sugar cane bagasse chemical composition.

Ferreira *et al*.,(2017) reported that sugar cane waste added with vinasse in feed of growing New Zealand White rabbits showed that it is safe up to a level of 150 g/kg, and an average inclusion of 51.9 g/kg is good for good average daily gain.

2.2. COMPLETE RATION FEEDING

Crop residues and agro industrial by-products that are locally available could be utilized better when combined scientifically and judiciously with concentrate feed in production of complete feed for cattle. Concept of complete feeding system encompasses feeding of a variety of ingredients which are locally available to provide completely balanced ration and is a good method to reduce the cost of feeding. The term complete ration is currently used synonymously with complete feed, total mixed ration and total blended ration. Complete feed is defined as a quantitative mixture of all feed ingredients, mixed thoroughly to prevent separation and sorting, formulated to balanced nutrient content and usually offered *ad libitum* (Senani *et al*., 2013).

Complete ration increases the nutrient value of a low quality roughage sources but also makes feeding easier, minimizes labour and maximizes automation (Raut *et al*., 2002).

It also helps to have a control on the concentrate roughage ratio, and provides balanced feed consumption, reduces the selective feeding, and milk fat production and also is economical feeding (Lailer *et al*., 2010).

2.2.1. MERITS OF COMPLETE FEEDS

Blended complete rations are convenient to feed and permit precise control of the ratio of ingredients and nutrients consumed, Marshall *et al.* (1975). Economic and balanced feeding of livestock are extremely important for optimum production.

Kishore *et al*. (2016) reported complete rations based on agricultural residue in the feed of cattle had increased availability of nutrients and without any harmful effect on feed consumption.

Marshall *et al.* (1975) reported that there was a trend towards higher milk fat per cent on the bagasse ration since Sugar cane bagasse pellets will absorb six times their weight of water accompanied by an increase in volume which might have slowed passage rate through the digestive tract and influenced ration digestion favourably for maintaining milk fat test. Bargo *et al*. (2002) conducted a study in Holstein cows and reported that milk production was highest for cows fed on total mixed ration, lowest for those on pasture and concentrate and intermediate for the pasture and fed group, when these three rations were compared.

Marshall *et al.* (1975) reported that there was high ($P< 0.05$) solids-not-fat on the 30% bagasse ration fed group versus 20% bagasse ration fed group and is not having any explanation. The cows gained weight on all rations. No evidence of injury to the digestive tract by roughages was observed in cows fed rations containing 25% sugar cane bagasse pellets, corn silage, or oat and rye pasture.

Devries and Gill (2012) reported that incorporating a molasses-based liquid feed to TMR could be used to decrease selective feeding, increases dry matter intake and improve milk yield.

Kishore *et al.* (2016) reported a similar dry matter intake in kg/100 kg BW or as g/kg $W^{0.75}$ in all the animals fed with locally available agricultural residue based complete feed along with concentrate mixture in 60:40 ratios, and conventional ration (C) in 28 days. The diets were palatable and improved the intake was noticed due to the mixing of concentrates and roughages in the complete feed.

Khan *et al.* (2010) also made similar observations when lactating cross bred cows fed complete rations based on wheat straw.

The crude fiber digestibility increased in buffalo when feed was given in form of complete feed rather than conventional feeding regime. Similar observations on increasing in crude fiber digestibility fractions among cattle and buffaloes fed complete ration (Reddy *et al*., 2002).

2.3 INCORPORATING PALMYRA AND SUGAR CANE BAGASSE IN FEED

Dahlan and Khotimah, (2017) have reported that non-fermented husk of Asian Palmyra palm could be used as feed for seven month old beef cattle weighing 100-150 kg during fattening phase. Dahlan and Khotimah, (2017) have reported that Palmyra palm seed husk when incubated with 0, 0.1, 1, 5 and 10 percent EM-4, a mix of fermentation bacteria from *Lactobacillus*, *Actinomycetes*, photosynthetic bacteria and yeast had improved the crude protein content from 5.95 per cent (control) to 8.28, 10.25, 13.04, and 16.9 percent respectively.

Horton *et al.* (1991) reported that bagasse is a good alternative for cottonseed hulls in feed with 15 per cent roughage and improved animal performance ($P<0.10$) as the degree of steam pressure treatment increased. High gains by cattle fed up to 30 per cent sugar cane bagasse treated with steam pressure was also reported by Pate (1982). Horton et al. (1990) reported that dried and ground raw sugar cane bagasse, incorporated in proportions up to 25 per cent, serves adequately as a fiber source in complete rations.

Randell *et al.* (1972) reported that in a trial in which alkali-treated and raw-bagasse rations were fed to dairy cows during one full lactation, very large amounts of urea in the bagasse complete rations were fed without any symptoms of toxicity or inappetance.

2.4 NUTRIENT VALUE

Nutrient value of the feed is amount of nutrients present in feed and the availability to the animal or the digestibility.

2.4.1 CRUDE PROTEIN

Dahlan and Khotimah, (2017) have reported that Palmyra palm seed husk when incubated with 0, 0.1, 1,5and 10 percent EM-4 a mix of fermentation bacteria from Lactobacillus, Actinomycetes, photosynthetic bacteria and yeast has improved the crude protein content from 5.95percent (control)to 8.28, 10.25, 13.04, and 16.9percent respectively. Crude protein content increased presumably due to other nutrients decreasing, particularly carbohydrates which were used by the microbes to grow and develop such as Lactobacillus in EM-4 which played important role fermenting organic matters (OM) to produce lactate acid.

Saenphoom (2015) reported that Palmyra seed husk peel contained 82 per cent moisture, 1.4per cent crude protein, 46 per cent hemicellulose and 31per cent cellulose.

Hozabri *et al.* (2006) reported that crude protein content of Sugar cane bagasse and wheat straw (2.98 vs3.41per cent) indicated that both roughages were low in protein content confirming the earlier observations (Reddy et al., 2002 and Pandya et al., 2005).

Gado *et al*. (2007) reported that out of the groups with (1) control, (2) chemical mixture solution, (3) with enzyme 15per cent, (4) cellulase enzyme 25 per cent, (5) rumen liquor and (6) *Cellulomonas cellulasea* the highest values of crude protein (CP) were obtained for treated rumen liquor (R) and *Cellulomonas cellulasea* and the lowest value was recorded for untreated bagasse. These effects were due mainly to the nitrogen content of added urea (about 3per cent w/w), or microbial protein from rumen liquor or bacteria treatments and nitrogen content of growing Cellulomonas in silage of bagasse.

Ferreira *et al.* (2017) analyzed nutrient content (g/kg DM basis) of different Sugar cane bagasse and reported that the crude protein content was 23.8 g/kg DM basis.

Sallam *et al.* (2007) evaluated the nutrient value of various roughages by in vitro rumen gas production technique reported that Sugar cane bagasse contain less ($P<0.05$) ash (21.0 g/kg) and crude protein (12.9 g/kg) compared to other roughage sources like straw of linseed and rice, date stone and berseem hay.

Crude protein content reported were 3.5 per cent in raw shredded form against 3.7% in shredded steam pressure treated Sugar cane bagasse. The increase in crude protein content after ammonization is similar with observations made in Sugar cane bagasse and cereal straws (Horton 1991).

Reddy *et al.* (1993) subjected bagasse to various processing like grinding and pelleting was fed ad libitum in a digestion trial and studied the effect in sheep and goat. Pelleted as well as ground Sugar cane bagasse were having same crude protein content of 3.4 per cent.

2.4.2 CRUDE FIBER (CF)

Dahlan and Khotimah, (2017) have reported that Palmyra palm seed husk when incubated with 0, 0.1, 1, 5 and 10 per cent EM-4 a mix of fermentation bacteria from Lactobacillus, Actinomycetes, photosynthetic bacteria and yeast had improved the Crude Fiber content from 23.53 per cent (control) to 29.68, 30.14, 28.94, and

31.47 percent respectively. According to this study, significant influence was noticed by EM-4 treatment ($p<0.05$) on Crude Fiber content of the husk through 0.1per cent to 10per cent over the control.

Gado et al. (2007) reported that out of the groups with (1) control, (2) chemical mixture solution, (3) with enzyme 15 per cent, (4) cellulase enzyme 25per cent, (5) rumen liquor, and (6) *Cellulomonas cellulasea* Crude fiber content decreased from 41.9 per cent in untreated to 30.21 per cent in treated bagasse by *Cellulomonas cellulasea*. The decline of crude fiber values in the experimental treatments could be as result of the cellulase enzymes secreted by the bacteria or microorganisms in rumen liquor or commercial cellulase enzyme.

Randel (1972) reported that Crude fiber digestibility of raw Sugar cane bagasse is only one-third digestible compared to the two-third digestibility of 2 per cent Sodium hydroxide treated Sugar cane bagasse when determined by Chromic oxide- indicator method.

Sallam *et al.* (2007) done the chemical analysis of various roughages using an in vitro gas production technique to find out the chemical composition of ruminant feedstuffs and showed that Sugar cane bagasse (411g/kg) and linseed straw had more crude fibre content in comparison to other feedstuffs.

Reddy *et al.* (1993) subjected Sugar cane bagasse to various processing like grinding and pelleting and was fed ad libitum in a digestion trial and studied the effect in sheep and goat. Crude fiber content was higher in ground Sugar cane bagasse compared to pelleted.

2.4.3 ETHER EXTRACT

The highest crude fat content of 1.04 per cent was found in Palmyra palm seed husk (control), followed by 0.1 per cent,1 per cent, 5 per cent respectively when

Palmyra palm seed husk when incubated with 0, 0.1, 1, 5 and 10 per cent EM-4 a mix of fermentation bacteria from Lactobacillus, Actinomycetes, photosynthetic bacteria and yeast (Dahlan and Khotimah, 2017).

Saenphoom (2016) showed that crude fat content of pineapple peel mixed with fermented sugar palm peel in 1:2 ratio at day-14 (0.58±0.03), was more than other treatment combinations (P<0.05).

Hozabri *et al* (2006) reported that ether extract content of Sugar cane bagasse was higher than that of wheat straw which indicated its potential for ruminants feeding.

Sallam et al. (2007) done the chemical analysis of various roughages using an in vitro gas production technique to find out the chemical composition of ruminant feedstuffs showed that Sugar cane bagasse is having Ether extract of 5.2 g/Kg.

2.4.4 NDF

Hozabri *et al* (2006) reported NDF content of Sugar cane bagasse (84.61) was higher (P<0.05) than that of Wheat Straw (81.75).

NDF in Sugar cane Bagasse has been reported to be in the range of 69.77 (Reddy *et al*., 2002) to 90.16 per cent (Tinh *et al.*, 2001) indicating that NDF content in SB varied in a wide range influenced largely by the variety of Sugar cane and type of its processing for sugar extraction.

Gado *et al*. (2007) reported that different treatments with cellulase enzymes had significant effects on bagasse cell wall constituents. Neutral detergent fiber (NDF) content was not affected significantly (P>0.05) by any solution treatment including treatments with (1) control, (2) chemical mixture solution, (3) with enzyme 15per cent, (4) cellulase enzyme 25per cent, (5) rumen liquor, and (6) *Cellulomonas cellulasea.*

Ferreira *et al.* (2017) analyzed nutrient composition (g/kg DM basis) of Sugar cane bagasse waste and reported that the Neutral detergent fibre content was ranging from (742–900) g/kg DM basis.

Sallam *et al.* (2007) done the chemical analysis of various roughages showed that the linseed straw (845 g/Kg), rice straw (775 g/Kg) and Sugar cane bagasse (770 g/Kg) showed the higher levels of NDF.

2.4.5 ADF

Hozabri *et al.* (2006) reported ADF of Sugar cane Bagasse (53.41per cent) and Wheat Straw (51.63per cent) showed similar trend as recorded for NDF content. Wheat straw and Sugar cane Bagasse both were having similar hemicellulose and cellulose contents and values were 30 and 40per cent, respectively.

Gado *et al*. (2007) reported that all treatments with (1) control, (2) chemical mixture solution, (3) with enzyme 15per cent, (4) cellulase enzyme 25%, (5) rumen liquor, and (6) *Cellulomonas cellulasea* had improved the crude protein content when compared with the 90 per cent sundried untreated Sugar cane bagasse and increasing degrading crude fiber and ADF content of bagasse.

Ferreira *et al.* (2017) analyzed nutrient content (g/kg DM basis) of Sugar cane bagasse and reported that the Acid detergent fiber content was 493 g/kg DM basis.

Sallam *et al.* (2007) reported ADF content of Sugar cane bagasse to be 476 g/Kg.

2.5 EFFECT OF FEEDING PALMYRA AND SUGAR CANE BAGASSE ON:

2.5.1 DRYMATTER INTAKE

Pandya *et al.* (2009) reported that there is no difference in drymatter consumption in the rumen fistulated male cattle when fed with conventional and complete rations. This indicated that roughages and concentrates when mixed properly in complete feed will not affect the consumption.

Ahrens *et al*., (1986) reported a 13.1 per cent increase ($P<0.05$) in the digestibility of organic matter in bagasse following steam-pressure treatment.

Pate (1982) reported that dry matter intake by steers fed with a ration containing 32 per cent steam pressure treated bagasse was higher than that of the animals fed with 57 per cent steam pressure treated diet.

The voluntary feed consumption of diet with 60 per cent Sugar cane bagasse was increased ($P<0.01$) following steam pressure treated and pelleted, by 80 per cent and 36 per cent, respectively (Horton *et al.*1990).

Gado *et al.* (2007) showed that the low quality bagasse can be used to increase growth rate of small ruminants by biological treatments (1) control, (2) chemical mixture solution, (3) with enzyme 15per cent, (4) cellulase enzyme 25 per cent, (5) rumen liquor and (6) *Cellulomonas cellulasea* improved the digestibility, ADG, feed intake and feed efficiency.

Seshaiah *et al.* (2013) reported that buffalo calves when fed with *Sorghum bicolour* moench crushed residue, maximum dry matter intake (95.37g/ kg $w^{0.75}$), decreased sorting behavior was shown by calves fed with sweet sorghum crushed residue based complete ration expander extruder pelleted.

Molina *et al.* (1983) reported that Sugar cane bagasse sun dried to less than 25 per cent moisture was sprayed with alkali solutions to supply 0, 20, 40 or 60 g alkali per kilogram of dried Sugar cane bagasse and ensiled for a 90 day period showing average daily dry matter consumption of 29.8, 35.7, 44.7and 40.6 g/kgW $^{0.75}$ for diets respectively.

Pelleting of low quality roughages will improve intake and average daily gain and the voluntary consumption of bagasse pellets was lower than that of Bermuda grass 3.93 vs 6.12 kg, Horton *et al.*(1991).

2.5.2 BODYWEIGHT GAIN

Chapman and Palmer (1912) showed satisfactory growth with feedlot cattle when fed with 7 .5-10 per cent pelleted raw Sugar cane bagasse, but bodyweight gain was lesser when increased to 15per cent. Pate (1982) reported good gain by steers fed with 30 per cent steam pressure treated Sugar cane bagasse.

Raja *et al.* (2010) fed calf starter as per BIS specification to female crossbred calves and reported total bodyweight gain of 45.82 kg in a period of 150 days.

Pate *et al.* (2002) reported cattle feed containing a medium Sugar cane (30-39%) had feed efficiency and bodyweight gain in range to animals fed 45% corn silage. cattle feed containing high bagasse diets (77%) had lower growth efficiency when compared to animals fed 75% corn silage diets.

Seshaiah *et al*. (2013) reported that when buffalo fed with *Sorghum bicolour* moench crushed residue, attained better total body weight gain (87.80) in 150 days period compared to animals fed with sorghum straw (72.70).

Kishore *et al.* (2016) observed an total body weight gain in 90 days in eighteen weaned crossbred calves of three to four months of age maintained on dietary treatments T1, T2 and T3 contained 24, 20 and 17 per cent of crude protein, respectively and the T2 and T3 treatments were made iso-nitrogenous with T1 by supplementing hydroponics maize fodder had30.39, 33.36 and 40.58 kg respectively.

2.5.3 AVERAGE DAILY GAIN

Feed efficiency and daily gain increased by 26 and 9 per cent, respectively, when steam-pressure treated, 3 per cent anhydrous ammonia and pelleted Sugar cane was given compared to cottonseed hulls (Horton *et al*. 1991).

Horton *et al.*, (1991) has reported that pelleting and other processing has improved the growth rate of finishing cattle fed with a 40 per cent wheat straw based diet.

Pate (1982) showed excellent bodyweight gains and increased animal growth rate following the replacement of 30 per cent treated bagasse for cottonseed hulls by steers.

Improved animal body weight gain and performance were reported by Chapman and Palmer (1972) following the substitution of Sugar cane for cottonseed hulls.

Seshaiah *et al*., (2013) reported that when buffalo fed with *Sorghum bicolour* moench crushed residue, sweet sorghum crushed residue expander extruder pelleted (SSCRP) ration had the increased intake compared to sorghum straw in buffalo calves which is due to easier consumption of pelleted feed and proper digestibility of nutrients compared to chopped form of the ration.

Raja *et al.*, (2010) fed calf starter as per BIS specification to female crossbred calves and reported average daily gain of 305 grams in a period of 150 days.

Kishore *et al.*, (2016) observed an average daily gain (ADG) in eighteen weaned crossbred calves of three to four months of age maintained on dietary treatments T1, T2 and T3 contained 24, 20 and 17 per cent of crude protein, respectively and the T2 and T3 treatments were made iso-nitrogenous with T1 by supplementing hydroponics maize fodder having 0.34, 0.37 and 0.45 kg, respectively.

2.6 EFFECT OF FEEDING PALMYRA AND SUGAR CANE BAGASSE ON NUTRIENT DIGESTIBLITY

Gado *et al.,* (2007) reported that sugar cane bagasse had a positive effect on dry matter digestibility of which cellulose enzyme increased the percentage of dry matter digestibility coefficient. Moreover, crude protein digestibility of treated bagasse with enzyme was the highest (85.89 per cent), while crude protein digestibility of untreated bagasse was the lowest (71.02 per cent). Crude fiber (CF) digestibility of treated bagasse with rumen liquor was the highest (72.58per cent), meanwhile crude fiber digestibility of treated bagasse by *Cellulomonas* was the lowest (60.62 per cent). The enzyme treatment positively affected digestibility of organic matter, ether extract and nitrogen free extract.

Randel (1972) reported significantly ($P<0.05$) higher DM digestibility of 51.1per cent with two per cent Sodium Hydroxide treated sugar cane bagasse as against 31.9 per cent with raw sugar cane bagasse when determined by Chromic oxide- indicator method. The digestibility of crude protein was lower with two per cent Sodium Hydroxide treated sugar cane bagasse compared with raw sugar cane bagasse.

Zadrazil (1995) showed in his studies that sugar cane bagasse when differentiated into different fractions of sizes (< 1 mm, 1-3 mm, 3-5mm, 5-10 mm) with a view to enhance its chemical value as animal feed showed a varying pattern of in vitro rumen digestions when acted by white-rot . The per cent dry matter digestibility of 40.9 ± 1.8, 37.3 ± 0.7, 34.0 ± 2.8, 32.8 ± 1.9 respectively when acted upon by water, acid (0.5N, 0.1N Sulphuric acid) and alkali (0.5N,0.1N Sodium Hydroxide.

MATERIALS AND METHODS

MATERIALS AND METHODS

3.1 EXPERIMENTAL ANIMALS

Eighteen healthy female crossbred calves of six to seven months old were selected from University Livestock Farm and Fodder Research Development ULF&FRDS. The calves were divided into three groups of six each as uniformly as possible with regard to age and body weight and each group were allotted randomly to one of the three dietary treatments, T1 T2 and T3. All the calves were dewormed before the feeding trial. All calves were maintained under identical conditions of feeding and management throughout the experimental period.

3.2 HOUSING AND MANAGEMENT

The experimental calves were housed in the same shed with facilities for individual feeding and watering. Stall-feeding was practiced throughout the experimental period. The animals were washed every day in the morning before 9 A.M. Stalls were cleaned twice daily with frequent removal of dung.

3.3 EXPERIMENTAL RATION

All the experimental complete rations consisted of a concentrate mixture and roughage in 70: 30 ratio with 16 per cent crude protein and 65 percent total digestible nutrient. Concentrate mixture T1, T2 and T3 were formulated as follows

T1-- Complete feed with grass (Hybrid Napier) as roughage source

T2-- Complete feed with 50 per cent of grass (Hybrid Napier) replaced Palmyra seed husk on dry matter basis

T3-- Complete feed with 50 per cent of grass (Hybrid Napier) replaced by sugar cane bagasse on dry matter basis

Fresh Sugar cane bagasse (SB) having a moisture content of about 65% was procured from local vendors at Thrissur and sun dried to about 90% DM. Palmyra seed husk was procured locally. The seed husks were peeled and chopped and dried for subsequent experiment. The ingredient composition of the concentrate mixture is presented in Table 1.

3. 4 EXPERIMENTAL METHODS

The selected eighteen calves were given respective experimental diets for 10 days for adaptation. A feeding trial was followed for a period of ninety days. Weighed quantity of complete feed as per NRC (2001) requirement was offered to all the experimental animals during the forenoon and afternoon periods. Fifty per cent of green grass (Hybrid Napier) in the complete feed was replaced by Palmyra and Sugar cane bagasse on drymatter basis in T2 and T3 respectively. Individual data on quantities of complete feed offered to each animals daily were recorded. The left over portion were weighed daily and their moisture content was analyzed to calculate the dry matter intake. The record of daily feed intake was maintained throughout the experimental period. The bodyweight of all the experimental animals were recorded fortnightly. The daily allowance of complete feed was periodically revised taking into consideration the increased nutrient requirement with the growth increment.

3.5 HAEMATOLOGICAL PARAMETERS

Blood samples were collected from all animals at the beginning and at end of the feeding experiment. The plasma was separated after centrifugation at 3000 rpm for 10 minutes. Plasma samples were used to determine glucose (GOP-PAP method), total protein (Jong and Vegeter, 1950), albumin (Bromocresol green method), and blood urea nitrogen (modified Berthlot method) using Semi automated biochemical analyser (Master T). The standard biochemical kits used for these assays were purchased from M/s. Agappe Diagnostics Limited, Emakulam, and Kerala.

3.6 DIGESTIBILITY TRIAL

A digestion trial involving five days of collection was carried out at the end of feeding trial. Representative samples of feed offered were taken daily during the digestion trial. The balance of feed samples if any were also collected from individual animals and their moisture content was determined. The dung was collected manually as and when voided. All the precautions were taken to collect the dung quantitatively, uncontaminated by urine, feed residue or dirt. The dung voided during each day was weighed accurately, mixed thoroughly and representative samples (10 per cent of the total quantity voided) were collected in air-tight, double lined plastic bags and stored in deep freezer. At the end of the collection period, individual samples were pooled and representative samples were subjected to chemical analysis. From the data obtained on the intake and outgo of different nutrients during the digestion trial, digestibility coefficient of nutrients were calculated.

3.7 ANALYSIS OF FEED AND DUNG

Proximate analysis of Palmyra, Sugar cane bagasse, grass, complete feeds and dung was done as per the standard procedures (AOAC, 1990). Dung samples collected from each animal for the five consecutive days was pooled, mixed thoroughly and representative samples were taken for analysis. Crude protein in faecal samples was estimated using fresh samples. The apparent digestibility coefficient of dry matter, crude protein, ether extract and crude fibre were calculated using appropriate formulae. Minerals like calcium and phosphorus in the feed and faecal samples were analysed by conventional precipitation and titration method as per AOAC (2012).

3.8 STATISTICAL ANALYSIS

Data obtained on different parameters during the course of the experiment were subjected to statistical analysis using Analysis of Variance (ANOVA) and Analysis of Covariance (ANACOVA) (Snedecor and Cochran, 1994).

Table 1. Ingredient composition of the experimental concentrate mixtures, % DM

Ingredients, %	Treatments		
	T1	T2	T3
Maize	39	32	39
Soybean meal	13	16	16
Wheat bran	10	10	9
DORB	6	10	4
Green Grass	30	15	15
Palmyra seed husk	-	15	-

basis

Sugar cane bagasse	-	-	15
Minerals	1.5	1.5	1.5
Salt	0.5	0.5	0.5

RESULTS

4. RESULTS

The results obtained from the present study are given under the following headings.

4.1 PROXIMATE COMPOSITION

The proximate composition of Palmyra, green grass and Sugar cane bagasse are given in Table 4. The crude protein content of Palmyra, Sugar cane bagasse and green grass were 5.83, 2.36 and 8.35 per cent respectively on DM basis.

The proximate composition of complete rations T1, T2 and T3 containing grass, Palmyra or Sugar cane bagasse are given in Table 3. The crude protein content of the three experimental concentrate mixtures T1, T2 and T3 were 15.24, 15.13 and 15.40 respectively.

The chemical composition of the dung of the experimental animals collected during the digestibility trial is given in Table 10.

4.2 BODY WEIGHT

The average body weight of experimental calves on the three treatments T1, T2 and T3 recorded at fortnight intervals is presented in Table 7 and is graphically represented in Fig. 1. The mean initial body weight of experimental calves on three treatments T1, T2 and T3 were 65.40±2.98, 66.47±2.90 and 65.90±2.28 kilograms respectively and the mean final body weight of experimental calves on three treatments T1, T2 and T3 after 90 days of feeding trial were 108.80±4.99, 103.25±3.65 and 108.28±4.47 kilograms respectively. The average weight of experimental calves were not significantly ($P>0.05$) different between treatments.

4.3 AVERAGE DAILY GAIN

Total body weight gains of the calves observed during the experimental period were 43.40±2.44, 36.78±1.64 and 42.38±2.39 kilograms on the three treatments T1, T2 and T3 respectively and are given in Table 8.

Average daily gain of experimental calves on three treatments T1, T2 and T3 were 516.66±2.89, 437.89±1.95 and 504.56±2.84g, respectively. Fortnightly cumulative average body weight gain of experimental calves is given in Table 9 and is graphically represented in Fig 3. The Average daily gain of experimental calves was not significantly ($P>0.05$) different between treatments.

4.4 DRY MATTER INTAKE

The total dry matter intake during the feeding trial were similar among the experimental animals and were 209.97±9.96, 205.22±8.97 and 200.83±9.38 kilograms respectively for the treatments T1, T2 and T3. The weekly intakes significantly ($P<0.05$) lower in Sugar cane bagasse fed calves during 4th, 9th and 10th weeks (Table 5).

4.5 FEED CONVERSION EFFICIENCY

Feed conversion efficiency (kg feed per kg gain) in calves, on the three treatments T1, T2 and T3 were 4.87 ±0.18, 5.61±0.28 and 4.76±0.12 respectively and are given in Table 8. The Feed conversion efficiency (kg feed per kg gain) in calves were significantly ($P<0.05$) lower in Palmyra seed husk fed calves during 4th, 9th and 10th weeks.

4.6 DIGESTIBILITY

Per cent digestibility of nutrients among experimental rations is given in Table 11 and is graphically represented in Fig. 5. Digestibility percentage of dry matter were similar (P>0.05) for T1, T2 and T3 rations were 75.95±1.50, 75.66±2.34 and 75.82±1.37 respectively. Digestibilities of crude protein were 82.10±1.27, 80.60±1.82 and 82.50±1.71 per cent respectively and also were similar for T1, T2 and T3 rations. Digestibility of NDF were 74.20±1.89, 71.03±2.75 and 72.45±1.78 per cent for T1, T2 and T3 rations respectively and was not significantly (P>0.05) different. ADF digestibility percentages were 59.93±1.62, 55.55±2.92 and 60.68±2.59 respectively for T1, T2 and T3 rations and also was not significantly (P>0.05) different among treatments. Per cent digestibility of ether extract among experimental rations were 86.19±0.91, 78.53±1.58 and 75.55±2.87 respectively for T1, T2 and T3 rations and differed significantly (P<0.01) among treatments. Per cent digestibility of crude fiber among experimental rations were 53.19±3.09, 61.07±3.94 and 66.88±2.25 respectively for T1, T2 and T3 rations and also there was significant (P<0.05) difference among treatments.

4.7 HAEMATOLOGICAL PARAMETERS

Hematological parameters of the experimental calves such as hemoglobin, plasma protein, plasma glucose, and serum calcium and serum phosphorus were recorded at first, sixth and 20th week of the experiment are listed in Table 12 and Table 13. The hematological parameters of experimental calves did not differ significantly (P>0.05) between treatments.

4.8 ECONOMICS OF PRODUCTION

Cost of experimental concentrate mixture per kilogram of feed were Rs.17.16, 16.01 and 16.23 for the three treatments T1, T2 and T3 respectively. The feed cost per kg body weight gain of experimental calves for the three treatments T1, T2, and T3 were Rs. 238.78±8.92, 256.84 ±12.65 and 192.97±5.46 respectively and differed significantly(P<0.05). The data on economics of production is depicted in Table 14.

Table 3. Chemical composition* of three dietary treatments of complete feed fed to experimental calves, %

Parameters	**T1**	**T2**	**T3**
Dry matter	70.03	70.53	79.09
Crude protein	15.24	15.13	15.40
Crude fiber	10.41	11.53	14.28
Ether extract	3.76	3.36	3.38
Total ash	11.64	11.29	12.40
Total insoluble ash	2.35	2.81	2.32
Nitrogen free extract	58.95	58.69	54.55
NDF	33.90	25.81	27.97
ADF	14.71	13.18	14.75
Calcium	0.73	0.83	0.84
Phosphorus	0.73	0.51	0.60

* on dry matter basis except DM

*Average of three values

Table 4. Chemical composition* of Palmyra and sugar cane bagasse in the dietary treatments, % on DM basis

Nutrient	Treatments		
	Palmyra	Sugar cane Bagasse	Green grass
Dry matter	22.01	78.38	20.37
Crude protein	5.83	2.36	8.35
Crude fiber	32.37	42.45	28.83
Ether extract	0.92	0.76	1.74
Total ash	4.82	2.68	8.93
Nitrogen free extract	56.06	51.75	52.15
Neutral detergent fibre	57.8	71.59	60.2
Acid detergent fibre	38.7	48.95	36.8
Calcium	0.85	0.67	0.5
Phosphorous	1.3	0.4	0.4

* on dry matter basis except DM

*Average of four values

Table 5. Daily average dry matter intake (on % DM basis) by the experimental calves, kg

weeks	Treatments			F value	P value
	T1	T2	T3		
1	1.87±0.08	1.92±0.08	1.70±0.06	1.94[ns]	0.177
2	1.91±0.09	1.98±0.10	1.70±0.06	2.55[ns]	0.111
3	2.18 ±0.04	2.21 ±0.11	1.95 ±0.08	3.01[ns]	0.079
4	2.30[a] ±.10	2.23[a] ±.10	1.95[b] ±.08	3.95*	0.042
5	2.34 ±0.08	2.29 ±0.10	2.28±0.13	0.08[ns]	0.919
6	2.36 ±0.10	2.29 ±0.10	2.28±0.13	0.18[ns]	0.836
7	2.58±0.14	2.53±0.12	2.17±0.10	3.15[ns]	0.072
8	2.57±0.13	2.53±0.12	2.18±0.11	3.22[ns]	0.068
9	2.82[a] ±0.13	2.71[a] ±0.12	2.33[b] ±0.12	4.42*	0.031
10	2.82[a] ±0.13	2.72[a] ±0.12	2.33[b] ±0.12	4.38*	0.032
11	3.01±0.17	2.93±0.13	2.66±0.13	1.63[ns]	0.229
12	3.03±0.17	2.95±0.12	2.66±0.13	1.85[ns]	0.191

*Average of six values

ns : Non Significant (P> 0.05)

Table 6. Dry matter intake per Kg metabolic body weight* of experimental calves maintained on three dietary treatments, kg

Fortnights	Treatments			F value	P value
	T1	T2	T3		
1	82.69[a] ±.89	83.16[a] ±.91	73.75[b] ±1.03	31.53*	0.001
2	93.15[a] ±1.35	91.01[a] ±1.29	78.91[b] ±1.32	33.80*	0.001
3	89.06[a] ±0.98	88.29[a] ±0.85	88.12±1.95	0.13[ns]	0.875
4	90.97[a] ±1.22	90.60[a] ±1.09	77.82[b] ±1.45	35.16*	0.001
5	92.95[a] ±1.00	91.84[a] ±0.88	77.74[b] ±1.75	44.45*	0.001
6	94.62[a] ±1.29	94.12[a] ±0.99	83.42[b] ±1.41	25.98*	0.001

*Average of six values with SE

ns : Non Significant (P> 0.05)

Table 7. Fortnightly body weight* of experimental calves maintained on three dietary treatments, kg

Fortnights	Treatments			F value	P Value
	T1	T2	T3		
0	65.40± 2.98	66.47± 2.90	65.90± 2.28	0.038 ns	0.963
1	72.08± 3.55	71.42± 3.26	71.90± 2.42	0.012 ns	0.988
2	79.03± 3.42	76.77± 3.46	76.30± 2.79	0.204 ns	0.817
3	86.50± 4.47	84.68± 4.01	84.80± 3.74	0.062 ns	0.940
4	94.40± 4.48	91.35± 4.15	93.05± 3.76	0.136 ns	0.874
5	101.40± 5.57	98.53± 4.17	100.87± 4.37	0.103 ns	0.903
6	108.80± 4.99	103.25±3.65	108.28± 4.47	0.485 ns	0.625

*Average of six values with SE

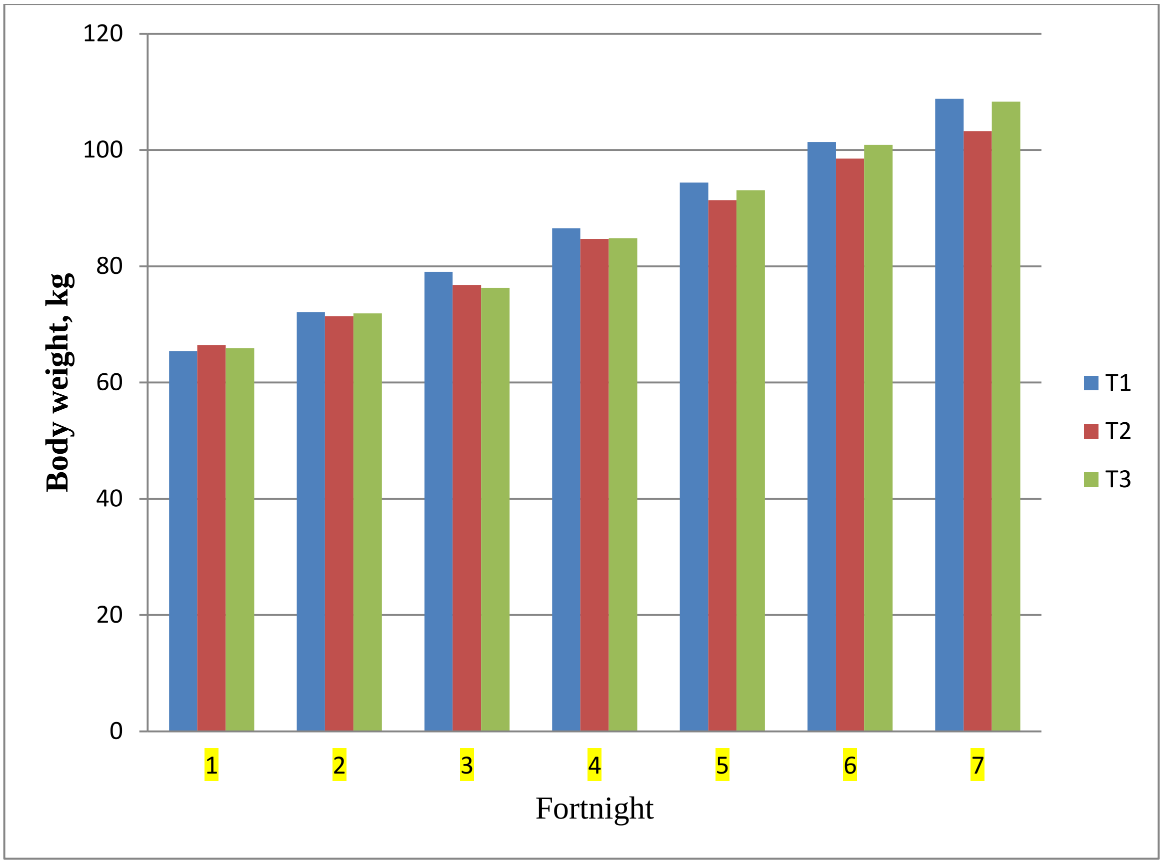


Fig 1. Average fortnightly body weight of experimental calves maintained on three dietary treatment

Table 8. Cumulative feed efficiency*and average daily gain of experimental calves

Items	T1	T2	T3	F value	P value
Initial body weight, kg	65.40± 2.98	66.47± 2.90	65.90± 2.28	0.038[ns]	0 .96
Final body weight, kg	108.80± 4.99	103.25±3.65	108.28±4.47	0.485[ns]	0 .62
Total body weight gain, kg	43.40± 2.44	36.78± 1.64	42.38± 2.39	4.24[ns]	0.10
Average daily gain, g	516.66± 2.89	437.89±1.95	504.56±2.84	2.66[ns]	0.10
Total dry matter intake from complete feed, kg	209.97 ±9.96	205.22±8.97	200.83±9.38	2.66[ns]	0.79
Feed conversion efficiency (kg feed/kg gain)	4.87[b] ±0.18	5.61[a] ±0.28	4.76[b] ±0.12	5.11*	0.02

*Average of six values with SE

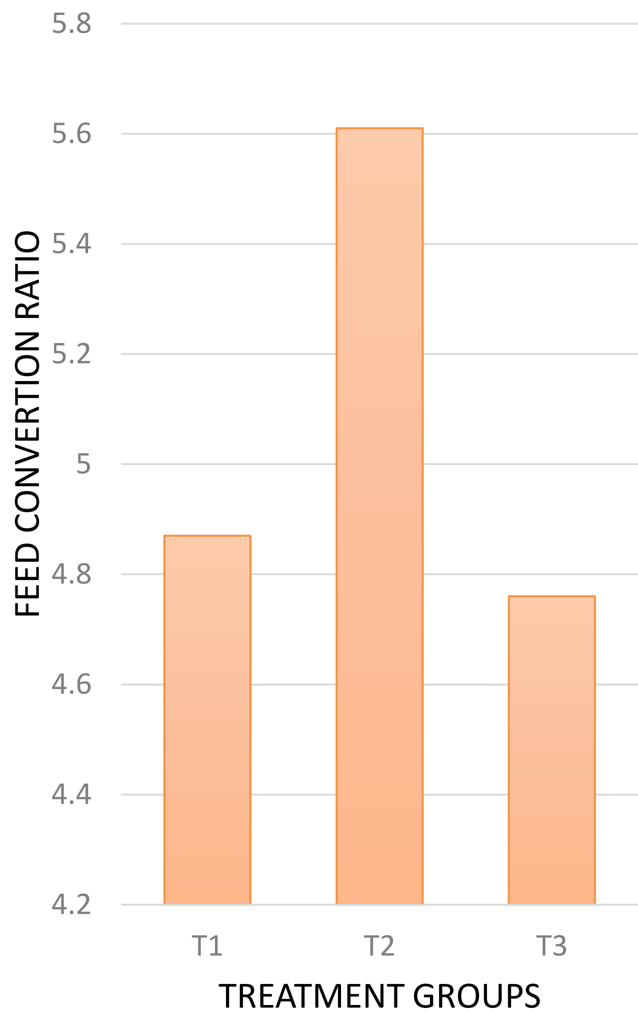


Fig 2. Cumulative feed efficiency of experimental calves maintained on three dietary treatments

Table 9. Fortnightly average daily gain* of experimental calves, grams

Fortnight	Treatments			P value	
	T1	T2	T3		
1	477.38± 5.28	353.57± 4.30	428.57± 3.13	2.07 ns	0.160
2	496.42±8.15	382.14± 6.30	314.28± 4.18	2.05 ns	0.163
3	533.33± 8.31	565.47± 5.58	607.14± 6.88	0.27 ns	0.761
4	564.28± 3.75	476.19± 2.21	589.28± 6.06	1.89 ns	0.184
5	500.00± 8.40	513.09± 5.79	558.33± 6.13	0.19 ns	0.822
6	528.57±10.1	336.90± 7.33	529.76±11.44	1.28 ns	0.305

*Average of six values with SE

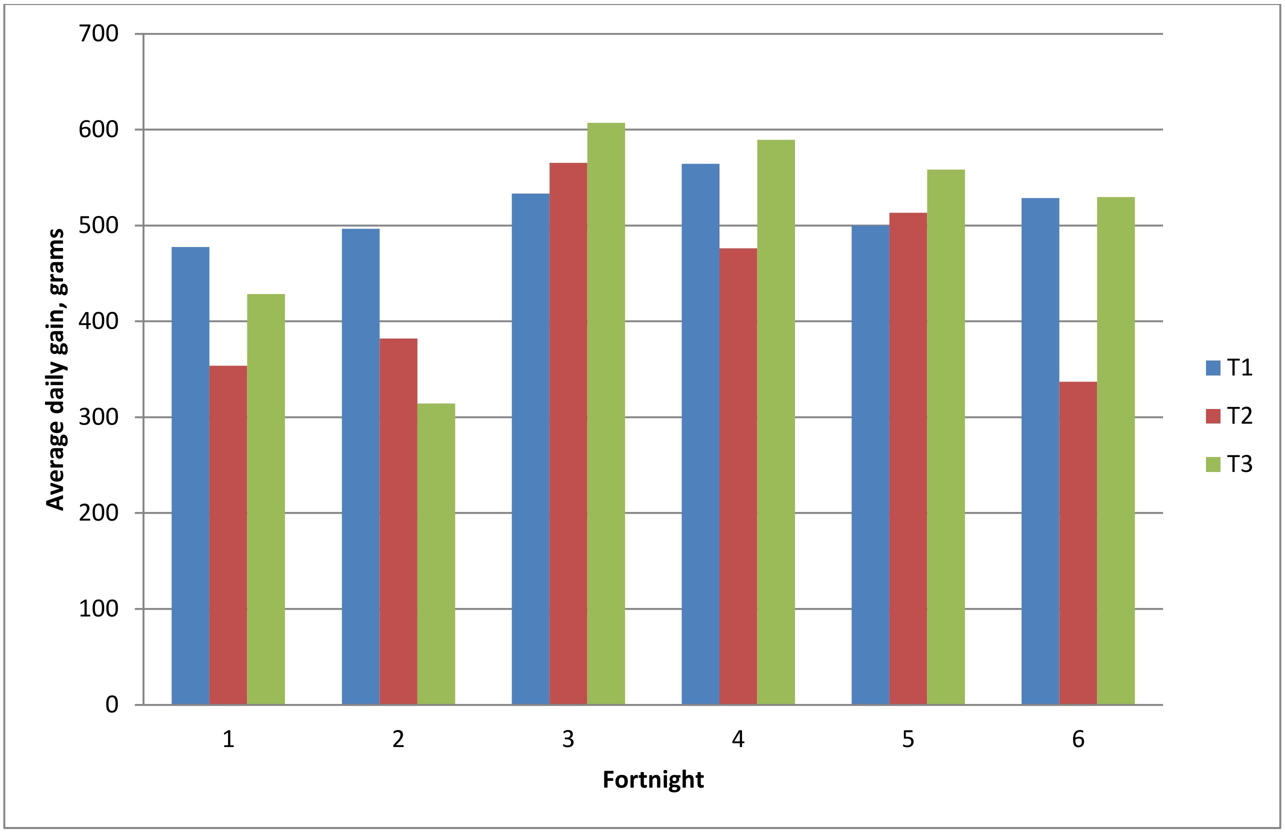


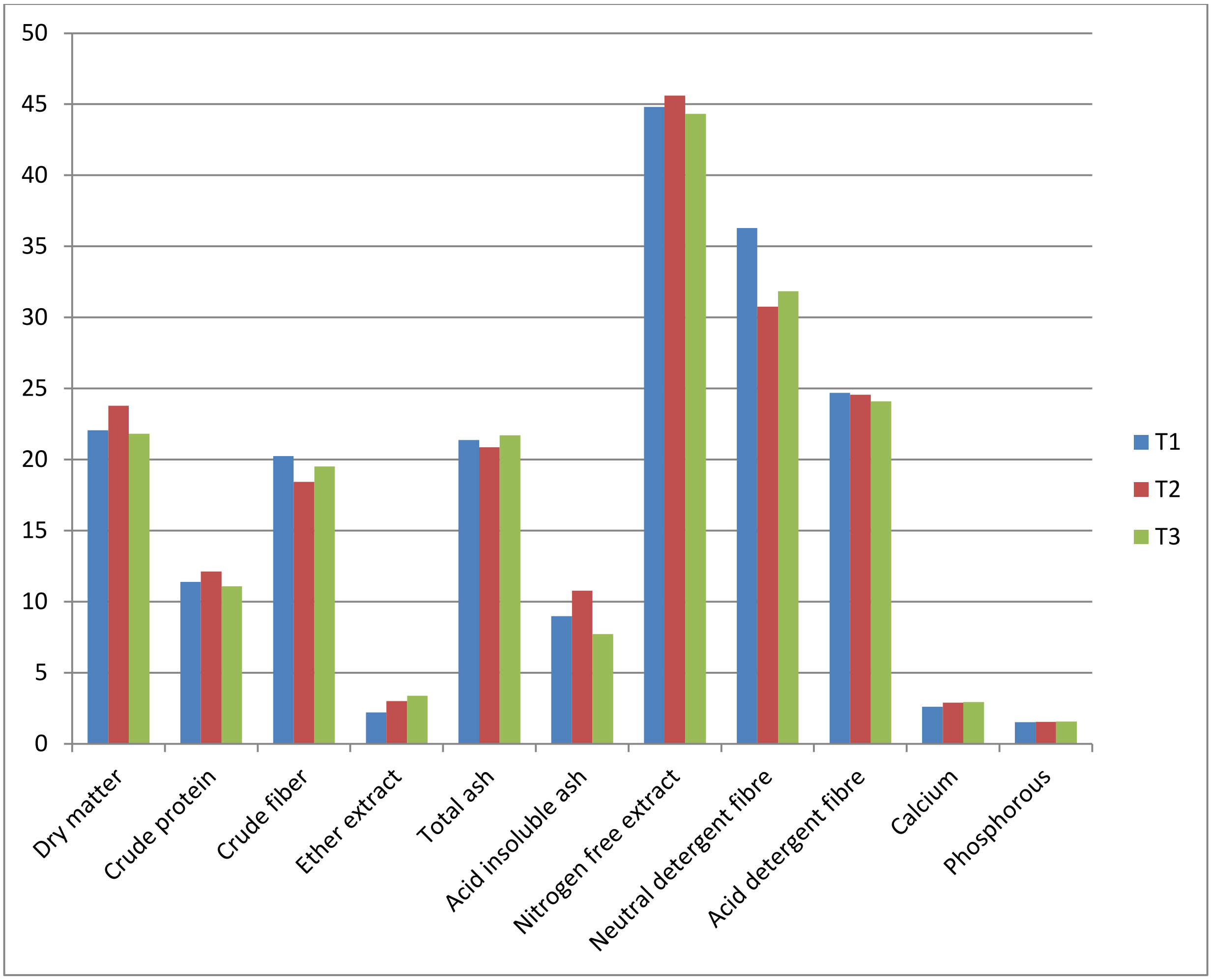
Fig. 3. Fortnightly average daily gain of experimental calves maintained on three dietary treatments

Table 10. Chemical composition* of the dung from experimental calves maintained on three dietary treatments, %

Nutrient	Treatments		
	T1	T2	T3
Dry matter	22.05± 0.90	23.78± 1.75	21.81± 1.08
Crude protein	11.38± 0.60	12.11± 0.33	11.08± 0.62
Crude fiber	20.24± 0.24	18.42± 0.32	19.52± 0.53
Ether extract	2.20±0.19	3.01±0.15	3.38±0.25
Total ash	21.38± 0.36	20.86± 0.65	21.70± 0.34
Acid insoluble ash	8.97±0.46	10.76± 0.18	7.71±0.55
Nitrogen free extract	44.80± 0.73	45.61± 0.36	44.32± 0.87
Neutral detergent fibre	36.29± 0.98	30.75± 0.70	31.84± 0.82
Acid detergent fibre	24.70± 0.69	24.56± 1.21	24.09± 1.21
Calcium	2.61± 0.12	2.90±0.17	2.94±0.15
Phosphorous	1.51± 0.04	1.55± 0.08	1.56± 0.09

*Average of six values with SE

* on dry matter basis except DM



50
45
40
35
30
25
20
15
10
5
0
Dry matter
Crude protein
Crude fiber
Ether extract
Total ash
Acid insoluble ash
Nitrogen free extract
Neutral detergent fibre
Acid detergent fibre
Calcium
Phosphorous
T1
T2
T3

Fig. 4 Chemical composition of the dung from experimental calves maintained on three dietary treatments.

Table 11. Apparent digestibility co-efficient of nutrients* of experimental rations

Item (Percent)	Treatments			F value	P value
	T1	T2	T3		
Dry matter	75.95±1.50	75.66±2.34	75.82±1.37	0.01[ns]	0.99
Crude protein	82.10±1.27	80.60±1.82	82.50±1.71	0.38[ns]	0.69
Ether extract	86.19[a]±0.91	78.53[b]±1.58	75.55[b]±2.87	7.80**	0.001
Crude fibre	53.19[b]±3.09	61.07[ab]±3.94	66.88[a]±2.25	4.70*	0.03
Nitrogen free extract	81.91±1.16	81.07±1.80	81.71±0.98	0.10[ns]	0.90
Neutral detergent fibre	74.20±1.89	71.03±2.75	72.45±1.78	0.53[ns]	0.60
Acid detergent fibre	59.93±1.62	55.55±2.92	60.68±2.59	1.28[ns]	0.31

*Average of six values with SE

a, b – Means with different superscripts in the same row differ significantly (P<0.01)

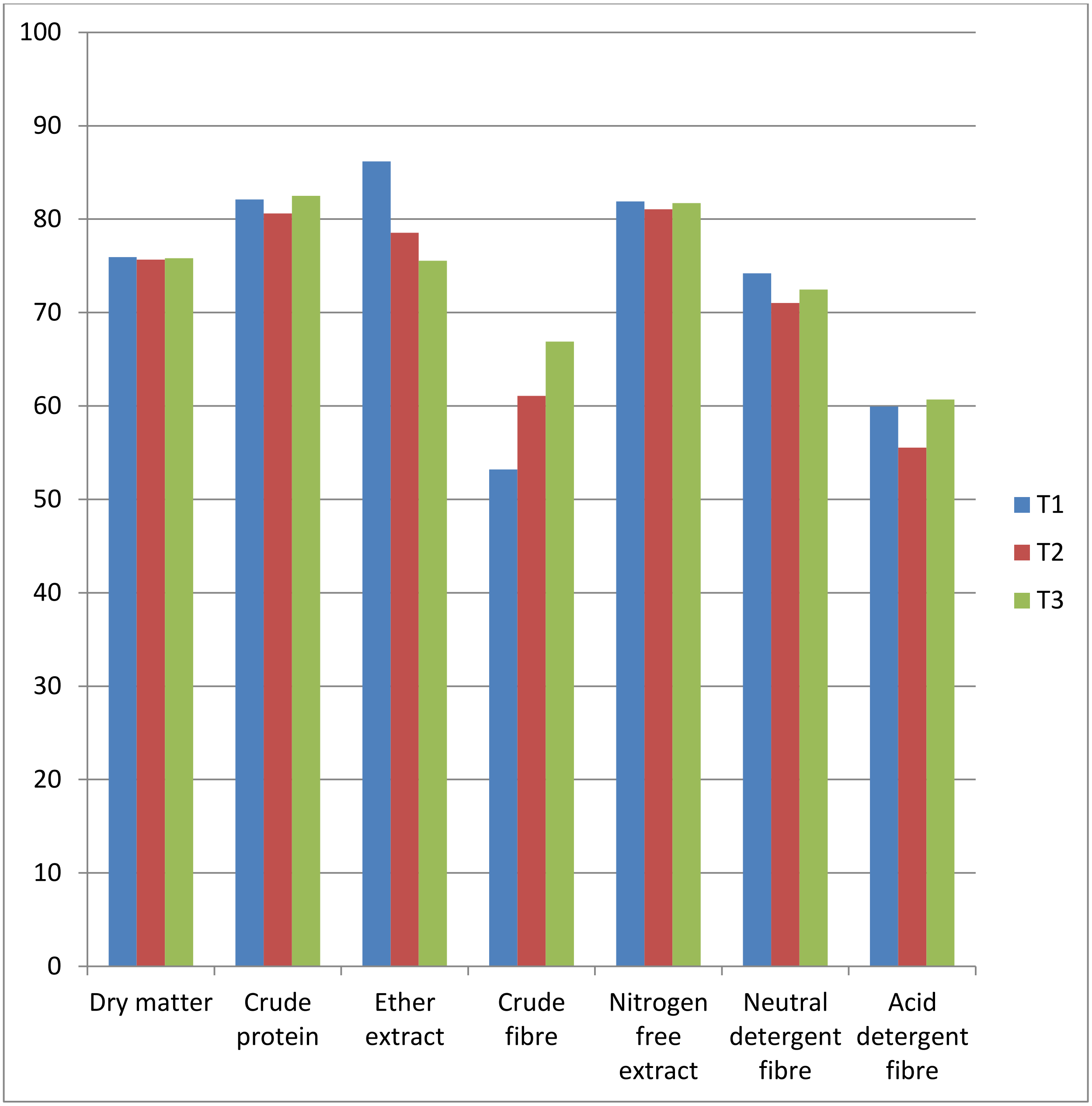


Fig. 5. Digestibility of nutrients of experimental rations

Table 12. Total protein, albumin and blood urea nitrogen* of experimental calves maintained on three dietary treatments, mg/dl

Parameters		Treatments			F value	P value
		T1	T2	T3		
Total protein	Initial	6.98±0.12	7.34±0.16	7.26±0.20	1.371^{ns}	0.284
	Final	7.36±0.09	7.25±0.16	7.21±0.11	0.396^{ns}	0.680
Albumin	Initial	3.30±0.23	3.33±0.20	3.50±0.23	0.233^{ns}	0.795
	Final	3.57±0.16	3.48±0.20	3.45±0.17	0.135^{ns}	0.875
BUN	Initial	8.86±0.52	10.08±0.24	9.27±0.45	2.146^{ns}	0.151
	Final	10.69±0.56	9.02±0.61	9.36±0.66	2.094^{ns}	0.158

* Average of six values with SE

a, b – Means with different superscripts in the same row differ significantly (P<0.05)

Table 13. Calcium and Phosphorous* of experimental calves maintained on three dietary treatments, mg/dl

Parameters		Treatments			F value	P value
		T1	T2	T3		
Blood Glucose	Initial	69.12±0.40	70.55±0.62	70.40±0.69	1.809^{ns}	0.198
	Final	69.50±0.26	70.58±0.41	70.21±0.44	2.072^{ns}	0.160
Serum phosphorous	Initial	7.42± 0.14	7.46± 0.14	7.85± 0.14	2.899^{ns}	0.086
	Final	7.54±0.08	7.96±0.24	7.19±0.18	2.306^{ns}	0.180
Serum calcium	Initial	10.17±0.38	10.98±0.40	11.30±0.16	3.121^{ns}	0.074
	Final	10.38±0.25	11.21±0.38	11.10±0.44	1.510^{ns}	0.253

* Average of six values with SE

a, b – Means with different superscripts in the same row differ significantly (P<0.05)

Table 14. Cost of feed per kg body weight gain of experimental animals maintained on the three dietary treatments

Parameter	Treatments				
	T1	T2	T3	F-value	P-value
Total cost of experimental ration consumed, Rs.	10295.88[a] ±488.37	9390.18[ab] ±410.32	8139.68[b] ±381.09	6.369*	0.010
Total feed consumed**, Kg	599.92± 28.45[a]	586.35± 25.62[a]	501.36± 23.47[b]	4.22*	0.035
Cost of feed per Kg**, Rs.	17.16	16.01	16.23	--	--
Total weight gain, kg	43.40 ±2.43	36.78 ±1.63	42.38 ±2.38	2.662[ns]	0.102
Cost/kg body weight gain, Rs.	238.78[a] ±8.92	256.84[a] ±12.65	192.97[b] ±5.46	12.060**	0.001

* Average of six values with SE.

** Calculated using the rate contract values fixed for feed ingredients by Department of Animal Nutrition, College of Veterinary and Animal Science, Mannuthy for the year 2017-18. Miscellaneous cost of preparation of Palmyra seed husk and Sugar cane bagasse was not taken into consideration.

DISCUSSION

DISCUSSION

5.1 GROWTH RESPONSE

The mean fortnightly body weight of the experimental calves maintained on the control ration (T1) with grass as roughage source, ration with fifty per cent grass replaced by Palmyra seed husk as roughage (T2) and ration with fifty per cent grass replaced by Sugar cane bagasse (T3) are given in Table 7. The average initial body weight of calves was 65.40 ± 2.98, 66.47 ± 2.90 and 65.90 ± 2.28 kg for the treatments T1, T2 and T3 respectively. The average body weight on completion of feeding trial of 90 days was 108.80 ± 4.99, 103.25 ± 3.65 and 108.28 ± 4.47 kg respectively for treatments T1, T2 and T3. On examination of the data on body weight recorded at fortnightly intervals, the animals gained in body weight as per recommendations of ICAR (2013) during the period of 90 days. Total body weight gain of calves in the three treatment groups during the period of 90 days were 43.40 ± 2.44, 36.78 ± 1.64 and 42.38 ± 2.39 Kg respectively and the average daily gain were 516.66 ± 2.89, 437.89 ± 1.95 and 504.56 ± 2.84 grams respectively for the three treatments T1, T2 and T3 (Table 8). The fortnightly cumulative body weight gain of the experimental animals maintained on three experimental rations T1, T2 and T3 are given in Table 9 and is depicted graphically in Fig. 3.

Present results on the growth performance of experimental calves were higher than the pre weaning growth rate of calves reported by Raja (2005), Rani (2006) and Vinu (2012) for cross bred calves below six months of age and the values ranged from 247g to 348g.

Statistical analysis of the data on fortnightly body weight and fortnightly cumulative body weight gain of experimental calves showed no significant difference (P>0.05) between the three treatments during the period studied. It is evident from the data that the partial replacement of green grass with Palmyra and Sugar cane bagasse did not limit the growth of calves. This is in line with the findings of Marshall *et al.* (1975) who reported increased average daily gain in lactating cattle when fed with 25 per cent Sugar cane bagasse and even higher average daily gain in animals fed with 12.5 per cent of Sugar cane bagasse and cotton seed hulls when compared with animals fed with 25 per cent cotton seed hulls. Horton *et al*. (1991) observed a lower daily weight gain (420 vs 1120 g) for growing steers fed ration containing steam pressure pelleted Sugar cane bagasse than those fed rations with bermuda grass pellets. Zade *et al.* (2009) also observed a decreased average daily gain for cross bred calves fed with ration of which 0, 11, 22, 33% replaced by Sugar cane bagasse. With increasing level of inclusion of Sugar cane bagasse the average daily gain (1.07 ± 0.06, 0.98 ± 0.06, 0.86 ± 0.07 and 0.77 ± 0.07 kg day) tend to decrease.

5.2 DRY MATTER INTAKE

Total dry matter intake were 209.97±9.96, 205.22±8.97 and 200.83±9.38 for the calves maintained on three treatments T1, T2 and T3 (Table 8). On statistical analysis of the data, no significant difference (P < 0.05) total dry matter intake of calves between the three groups. However the values differed in 4^{th}, 9^{th} and 10^{th} weeks with T3 having significantly lower (P>0.05) feed intake. Zade et al. (2009) observed no effect on total dry matter intake in cross bred calves fed with ration of which 0, 11, 22, 33 per cent replaced by Sugar cane bagasse. With increasing level of inclusion of Sugar cane bagasse drymatter intake difference between the groups were insignificant. However, Horton *et al.* (1991) observed a higher dry matter intake in *Santa gertrudis* cattle when fed on ration with Sugar cane bagasse compared to ration containing cotton seed hulls. Reddy *et al* (1993) reported that the dry matter intake was better (11.6%) in sheep compared to goat. Voluntary dry matter intake was comparable for ground (fineness of particles increased by 34%) and pelleted rations and it had 10.2% higher dry matter intake than the ground rations.

5.3 FEED CONVERSION EFFICIENCY

Feed conversion efficiency (kg feed per kg weight gain) of calves maintained on treatment T1, T2 and T3 was 4.87 ±0.18, 5.61 ±0.28 and 4.76 ±0.12 respectively (Table 8). Statistical analysis of the data showed significantly lower ($P<0.05$) efficiency in animals fed with Palmyra seed husk between the treatments. The calves fed with Sugar cane bagasse was showing feed conversion efficiency (kg feed per kg weight gain) similar to the control group fed with green grass as roughage. This result is in line with the results of Huston *et al.* (1974) reported no difference in sheep, when they were fed cotton seed hulls, urea or slow release urea in the ration. Data on the feed efficiency of crossbred calves recorded in the experimental period were comparable to that reported by several authors (Asitha, 2002; Raja, 2005; Jini 2014 and Vinu, 2012) and the values ranged from 3.33 to 4.94.

In contrary to this result, Zade *et al.* (2009) reported poorer feed conversion efficiency 6.25 ± 0.5, 6.67 ± 0.5, 7.59 ± 0.6 and 8.4 ± 0.6 when cross bred calves of 4-5 months age were fed with Sugar cane bagasse at the rate of 0, 11, 22, 33 per cent of the ration.

5.4 DIGESTIBILITY OF NUTRIENTS

The data on digestibility of nutrients of the three experimental rations T1, T2 and T3 fed to experimental animals are provided in Table 11 and is illustrated in Fig.3.

5.4.1 Dry Matter

Average dry matter digestibility observed in the present study was 75.95 ± 1.50, 75.66 ± 2.34, 75.82 ± 1.37 per cent for the three experimental rations T1, T2 and T3 respectively. There was no significant difference (P>0.05) in dry matter digestibility among the treatments. Randel (1972) found that using a chromic oxide-indicator method in eight lactating cows a complete ration containing 15-percent raw bagasse and 85-percent concentrates (71.9 ± 2.9) was significantly superior (P>0.05) to the 40-percent raw bagasse and 60-percent concentrates (55.7 ± 1.8) ration in digestibility of dry matter. Similar values of dry matter digestibility as observed in the present study were also reported by Babu (2013), Asitha (2002), Jini (2014) and Vinu (2012) ranging from 66 to 77.

However, Randel *et al.* (1972) also observed a dry matter digestibility of 55.7 ± 1.8 in cross bred steers for ration with raw Sugar cane bagasse which is significantly lower (P < 0.01) than cross bred steers for ration with 2 per cent NaOH solution for 24 hours treated bagasse. Similarly, Molina *et al.* (1983) observed lower dry matter digestibility when 12 month old Segurena wethers were fed untreated bagasse was 47.4 and rose to 66.5 with the feeding of dried Sugar cane bagsse and ensiled for 90 days and added with 60 g alkali/kg with Sodium hydroxide. The dry matter digestibilities of feed containing Sugar cane bagasse were slightly higher than those observed by Randel (1972) in feed with lower quantity of bagasse. Reddy et al. (1993) reported that digestibility of dry matter, and other nutrients were significantly (P < 0.01) higher in goats with processed bagasse: grinding and pelleting.

Saenphoom (2016) reported dry matter digestibility of fermented Palmyra palm peel with pineapple peel 2:1,1:1,1:2 on day 14 of ensiling and 2:1,1:1,1:2 on day 21 was 28.63, 27.80, 36.88, 24.28, 26.21, 28.45 respectively

5.4.2 Crude Protein

The average percentage digestibility of crude protein observed in the present study was 82.10 ±1.27, 80.60 ±1.82 and 82.50 ± 1.71 for the three rations T1, T2 and

T3 respectively and the values were statistically similar (P>0.05). In agreement with the present study, Randel (1972) obtained a crude protein digestibility of 71.3 ± 1.1 and 71.0 ± 1.3 in complete rations containing 15-percent and 40-percent raw bagasse incorporated rations respectively. The crude protein digestibility values obtained in the present study were higher than digestibility values reported by Jini (2014) and Vinu (2012) in crossbred calves of similar age groups and it ranged from 77 to 81.

Contrary to this, Reddy *et al.* (1993) reported a lower crude protein digestibility in sheep and goat fed with ground Sugar cane bagasse (63.6± 0.9), than those fed with pelleted Sugar cane bagasse (66.4±1.1) based ration. Similarly, Randel *et al.* (1972) also observed a significantly lower (P < 0.05) crude protein digestibility (71.0 ± 1.3) in cross bred steers for ration with raw Sugar cane bagasse compared to 2 per cent NaOH solution for 24 hours treated bagasse ration (79.6 ± 1.5).

5.4.3 Crude Fiber

The average percentage digestibility of crude fiber observed in the present study were 53.19 ±3.09, 61.07 ±3.94, 66.88 ±2.25 for the three rations T1, T2 and T3 respectively. The crude fiber digestibility was higher (P<0.01) for T3 than that of T1 and T2 ration.

In agreement with the present study, Pate (1982) stated that Sugar cane bagasse (steam-pressure treated) have higher (P < 0.05) digestibility of fiber fractions without affecting (P>0.05) dry matter (DM) or organic matter (OM) digestibility.

Similarly, Reddy *et al.* (1993) observed an increased crude fibre digestibility in sheep and goat for ground Sugar cane bagasse (52.1 ± 1.6) supplemented ration compared to pelleted Sugar cane bagasse (51.7 ± 1.1) based ration.

This is in contrary to the findings of Randel *et al.* (1972) also observed a significantly lower ($P < 0.01$) crude fiber digestibility in cross bred steers for ration with raw Sugar cane bagasse compared to 2 per cent NaOH solution for 24 hours treated bagasse ration. CF digestibility values obtained in the present study were is in contrary to the findings Jini (2014) and Vinu (2012) which ranged from 63 to 70 in crossbred calves below six months of age.

The crude fiber content as well as in vitro digestibility of various Sugar cane varieties was observed and reported that the crude fiber is negatively related to in vitro digestibility (Pate ,1982).

Pate (2002) reported that nutritive content of bagasse varieties is highly variable and importance have to be given on fiber content when formulating feed for livestock.

5.4.4 Neutral Detergent Fibre

Digestibility of neutral detergent fibre observed in the present study was 74.20 ±1.89, 71.03 ±2.75 and 72.45 ±1.78 per cent respectively for the three experimental rations T1, T2 and T3. There were no significant difference ($P>0.05$) in neutral detergent fibre digestibility among the three treatments.

This is in contrary to the findings of Molina *et al.* (1983) who reported a lower neutral detergent fibre digestibility for ration containing Sugar cane bagasse and significantly higher effect due to alkali treatment by 20g/kg NaOH and was less pronounced as the amount of NaOH in the bagasse increased to 60g/kg.

But, Reddy *et al.* (1993) observed an increased neutral detergent fibre digestibility in sheep and goat for ground Sugar cane bagasse (44.8±0.8) supplemented ration compared to pelleted Sugar cane bagasse (42.3± 1.0) based ration.

5.4.5 Acid Detergent Fibre

Percentage digestibility of acid detergent fiber observed in the present study were 59.93±1.62, 55.55±2.92 and 60.68±2.59 respectively for the three treatments T1, T2 and T3. There were no significant difference (P>0.05) in acid detergent fiber digestibility among the three treatments. This is in contrary to the findings of Molina et al. (1982) who reported a ADF was higher than NDF at the highest level of NaOH (60g/kg) in the diet so the digestibility of hemicellulose was over 100%.

Reddy et al. (1993) observed an increased acid detergent fiber digestibility in sheep and goat for ground Sugar cane bagasse supplemented ration (42.8±1.6) compared to pelleted Sugar cane bagasse based ration (39.7±0.7).

5.5 HAEMATOLOGICAL PARAMETERS

The haematological parameters of the experimental calves such as haemoglobin, Total protein, Albumin, BUN, Blood glucose, serum calcium and serum phosphorus estimated at first, and 90th day of the experiment are listed in Table 12 and 13.

5.6.3 Blood Glucose

The average Blood glucose concentrations of experimental calves for T1, T2 and T3 were 69.12 ± 0.40, 70.55 ± 0.62 and 70.40 ± 0.69 mg/dl at the first week, 69.50 ± 0.26, 70.58 ± 0.41 and 70.21 ± 0.44 mg/dl at the end of trial respectively with no significant difference (P>0.05) between the groups. The values of glucose concentration recorded in the present work were within the normal range reported for the species. The values of blood glucose concentration in the present study were comparable to the values reported by Jini (2014) and Jith (2004) which ranged from 60 to 102 mg/dl.

5.6.4 Serum Calcium

The average serum calcium values obtained were 10.17±0.38, 10.98±0.40 and 11.30±0.16 mg/dl at the 0^{th} day and 10.38±0.25, 11.21 ±0.38 and 11.10±0.44mg/dl at the 90^{th} day of the trial for group T1, T2 and T3 respectively and the values did not differ significantly ($P > 0.05$) between the groups. The values of serum calcium concentration of crossbred calves in the study were within the normal range reported for the species and comparable with the values reported by Jith (2004) and Vinu (2012) ranging from 10 to 11 mg/dl.

5.6 ECONOMICS OF GAIN

Data on total feed intake for the experimental period is presented in Table 14. Cost per kg feed was Rs. 17.16 for T1, Rs. 16.01 for T2 and Rs. 16.23 for T3 ration. The total cost of feed during the experimental period of 90 days was Rs. 10295.88, 9390.18 and 8139.68 for the treatments T1, T2 and T3 respectively. Cost for green grass was calculated with Rs. 3.5 per kilogram. Cost of production when calculated in terms of feed cost per kg body weight gain was lower for Sugar cane bagasse containing feed (Rs. 192.97) than that of T1 (238.78) and T2 (256.84). The higher cost of production observed for 50 per cent Palmyra based feed is due to the comparatively lower (though not statistically significant) total body weight gain of calves.

Based on overall results, it could be seen that the calves could be raised on 50% replacement of green grass with Palmyra seed husk or Sugar cane bagasse for optimum weight gain. However, the feed efficiency on 50 per cent replacement of Palmyra was lower and cost of feed/kg bodyweight gain was higher due to lower bodyweight achieved in the experimental period. Cost of feed/kg body weight gain was lowest in calves fed on sugar cane bagasse.

SUMMARY

SUMMARY

An experiment was conducted to assess the effect of 50 percent replacement of green grass with Palmyra seed husk or sugar cane bagasse in complete feed on growth in crossbred calves. Three isocaloric, isonitrogenous complete rations having 70:30 roughage: concentrate ratio, with grass (T1), 50 per cent replacement of grass with Palmyra seed husk (T2) and 50 per cent replacement of grass with sugar cane bagasse (T3) on dry matter basis, as roughage source were prepared and evaluated for their nutritive value. Eighteen healthy female cross bred calves, six to seven months of age were selected from ULF, Mannuthy as uniformly as possible with regard to age and weight, and randomly allotted to three dietary treatments T1, T2 and T3 and fed with respective experimental rations as per NRC (2001) for a period of 90 days. The animals were fed twice daily, offered clean drinking water and the balance of feed was collected for obtaining daily dry matter intake. The record of daily feed intake and fortnightly bodyweight of all the experimental animals were maintained throughout the experimental period. At the end of the feeding trial, a digestibility trial for five days was conducted by total collection method. Feed, fodder and dung samples were analysed for proximate principles (AOAC, 2012). Blood samples were collected from the experimental animals at the beginning and end of the trial and was analysed for serum calcium, serum phosphorus, glucose, blood urea nitrogen, serum total protein, albumin (using standard kits) and hemoglobin (using blood analyzer).

Total body weight gain of calves of the three treatments during the experimental period were 43.40± 2.44, 36.78± 1.64 and 42.38± 2.39 Kg, and the average daily gain were 516.66±2.89, 437.89±1.95 and 504.56±2.84 g respectively for the three treatments T1, T2 and T3. There were no significant difference ($P>0.05$) in the fortnightly body weight and average daily gain. Dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), total ash (TA), nitrogen free

extract (NFE), Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) levels 22.01, 5.83, 32.37, 0.92, 4.82, 56.06, 57.8 and 38.7 per cent respectively in Palmyra seed husk. The Sugar cane bagasse has Dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE), total ash (TA), nitrogen free extract (NFE), Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) levels 78.38, 2.36,42.45, 0.76, 2.68, 51.75,71.59 and 48.95 per cent respectively. Dry matter intake per Kg metabolic body weight was significantly lower ($P<0.05$) in T3 animals in all the fortnights compared to the T1 and T2. The digestibility coefficient of nutrients were 75.95, 75.66 and 75.82 per cent for DM; 82.10, 80.60 and 82.50 per cent for crude protein, 53.19, 61.07 and 66.88 per cent for CF; 86.19, 78.53 and 75.55 per cent for EE; 81.91, 81.07 and 81.71 per cent for NFE; 74.20, 71.03 and 72.45 per cent for NDF and 59.93, 55.55 and 60.68 per cent for ADF for group TI, T2 and T3 respectively. The evaluation of digestibility trial revealed that all the three treatments had similar dry matter, crude protein, neutral detergent fiber, acid detergent fiber digestibility ($P>0.05$) while the ether extract digestibility was higher ($P<0.01$) for T3 than that of T1 and T2 ration. The feed conversion efficiency obtained were 4.87 ±0.18, 5.61 ±0.28 and 4.76 ±0.12 and was higher ($P<0.05$) for T1 and T3. Cost of production of one kilogram of complete feed were Rs.17.16, 16.01 and Rs.16.23 respectively. When calculated in terms of feed cost per kg body weight gain it was Rs.238.78±8.92, Rs.256.84±12.65 and Rs.192.97±5.46 respectively and was lower ($P<0.001$) for T3 compared to T2 and T1.

Hence the study indicated that the calves could be raised on 50% replacement of green grass with Palmyra seed husk or sugar cane bagasse for optimum weight gain. However, the feed efficiency on 50% replacement of Palmyra was lower and cost of feed/kg body weight gain was lowest in calves fed on sugar cane bagasse.

REFERENCES

REFERENCES

Ahrens, F., Hagemeister, H., Pfeuffer, M. and Barth, C.A. 1986. Effects of oral and intracecal pectin administration on blood lipids in minipigs. *J. of Nutr*. **116**:70-76.

Ajey, G. 2013. *Microbial Processing of Jackfruit Waste as Animal Feed* (Doctoral dissertation).

Alagiapillai, OA., Kuttalam, PS., Subramanian, V. and Jayasekhar, M. 1996. PPI-I jack: A new high yielding, regular bearing jack variety for Tamil Nadu. *Madras Agric. J.* **83**: 310-312

Asitha, T.V. 2002. Effect of supplementation of dried yeast (NEUTRAMIX-MDY) on growth performance in pre-ruminant calves. *M.V.Sc thesis*, Kerala Agricultural University, Thrissur, 64p.

Babu, A.S., Rao, D.S., Reddy, Y.R. and Nagalakshmi, D. 2013. Effect of feeding various roughage based processed complete diets on intake and nutrient utilization in ram lambs. *Indian J. Anim. Nutr*., **30**: 252-255.

Babu, L.K., Pandey, H.N. and Sahoo, A. 2003. Effect of individual versus group rearing and feeding of different levels of milk and skim milk on nutrient utilization in crossbred calves. *Asian-Aust. J. Anim. Sci.* **16**(10): 1455-1459.

Bargo, F., Muller, L.D., Delahoy, J.E and Cassidy, T.W. 2002. Performance of high producing dairy cows with three different feeding systems combining pasture and total mixed rations. *J. Dairy. Sci*. **85**: 2948 - 2963.

Beharka, A. A., T. G. Nagaraja, J. L. Morrill, G. A. Kennedy, and R. D. Klemm. 1998. Effect of form of the diet on anatomical, microbial, and fermentative development of the rumen of neonatal calves. *J. Dairy Sci*. **81**:1946–1955.

Castañón-Rodriguez, J.F., Welti-Chanes, J., Palacios, A.J., TorrestianaSanchez, B., Ramírez De León, J.A., Velazquez, G., Agular-Uscanga, M.G. 2015.

Influence of high-pressure processing and alkaline treatment on Sugar cane bagasse hydrolysis. *J. Food*. **13**: 613–620.

Chapman,H. L.,Jr. and Palmer, L. Z. 1972. Bagasse Pellets in beef cattle fattening rations. *FIa. Agric. Exp. Sta. Circ*. pp.5-126.

Dahlan, D.N.A. and Khotimah, K. 2017. Biosciences and Plant Biology. *Int. J. Curr. Res. Biosci. Plant Biol*, **4**:13-19.

Davis, T.A. and Johnson, D.V. 1987. Current utilization and further development of the palmyra palm (Borassus flabellifer L., Arecaceae) in Tamil Nadu State, India. *Econ. Bot.* **41**:247-266.

Devendra, C. 1992. Nutritional potential of fodder trees and shrubs as protein sources in ruminant nutrition. *Legume trees and other fodder trees as protein sources for livestock*, **100**:95-113.

Devries, T. J. and Gill, R. M. 2012. Adding liquid feed to a total mixed ration reduces feed sorting behaviour and improves productivity of lactating dairy cows. *J. Dairy Sci.***95**: 2648-2655.

Ffoulkes, D. and Preston, T.R., 1979. Effect on voluntary intake and digestibility of supplementing chopped sugar cane stalk with cane tops, banana leaves or cassava forage. *Trop. Anim. Prod*. **4**:37-41.

Ferreira, F.N.A., Ferreira, W.M., Neta, C.S.S., da Silva Inácio, D.F., das Neves Mota, K.C., da Costa Júnior, M.B., da Rocha, L.F., Lara, L.B. and de Oliveira Fontes, D. 2017. Effect of dietary inclusion of dried or autoclaved Sugar cane bagasse and vinasse on live performance and in vitro evaluations on growing rabbits. *Anim. feed Sci. and Technol.* **230:**87-95.

Gado, H.M., Metwally, H.M., El-Basiony, A.Z., Soliman, H.S. and El Galil, E.A. 2007. Effect of biological treatments on Sugar cane bagasse digestibility and performance of Baldi goats. *Egyptian J. Nutr. and Feeds,* **10**: 535-551.

Hamada, T., S. Maeda, and K. Kameoka. 1976. Factors influencing growth of rumen, liver, and other organs in kids weaned from milk replacers to solid foods. *J. Dairy Sci.* **59**:1110–1118.

Hodgson, J. 1971. The development of solid food intake in calves. 1. The effect of previous experience of solid food, and the physical form of the diet, on the development of food intake after weaning. *Anim. Prod*. **13**:15–24.

Horton, G.M.J., Pate, F.M. and Pitman, W.D. 1991. The effects of steam-pressure treatment, pelleting and ammoniation on the feeding value of Sugar cane bagasse for cattle. *Canadian J of Anim Sci*. **71**:79-86.

Hozhabri, F. and Singhal, K. K. 2006. *In vitro* evaluation of Sugar cane bagasse in complete feed. *Indian J. Anim. Nutr.* **23**: 88-93.

ICAR. 2013. *Nutrient requirement of cattle and buffalo.* Indian Council of Agriculture and Research, New Delhi, 30-34p.

Jayal, M.M. and Kehar, N.D. 1962. A study on the nutritive value of mulberry (Morus indica) tree leaves. *Indian J. Dairy Sci.,* **15:**21-27.

Jini.K.S 2012. Effect of phase feeding on growth in pre-ruminant crossbred calves M.V.Sc thesis, Kerala Veterinary and Animal Sciences University, Pookode, 89p.

Jith, J.M. 2004. Effect of replacing dried fish with lysine and methionine in the calf starter on the growth performance of crossbred calves. *M.V.Sc thesis,* Kerala Agricultural University, Thrissur, 56p.

Jong, H.H. and Vegeter, J.J. 1950. Determination of serum proteins with the biuret test . *Pharm. weekbl.* **85**: 755-764.

Khan, S.R., Singhl, S.K. and Mudgal, V., 2010. Effect of feeding complete rations on the performance of lactating crossbred cows. *Indian J. of Anim. Nutr*. **27:**261-264.

Kishore, K.R., Kumar, D.S. and Ramana, J.V. 2013. Effect of feeding crop residue based complete rations on nutrient utilization in buffalo bulls. *Int. J. of Agric. Sci. & Vet. Med.* **1**:22-25.

Kishore, K.R., Kumar, D.S., Ramana, J.V., Ravi, A. and Rao, E.R.. 2016. A comparative study on nutrient utilization in Murrah buffalo bulls fed conventional and crop residue based complete rations. *Buffalo Bull.* **35**: 587-594.

Lailer, P.C., Dahiya, S.S., Lal, M. and Lal, D. 2010. Effect of complete feed blocks on growth performance of Murrah male calves. *Indian J. of Anim. Nutr.* **27**: 220-223.

Majumdar, B.N. and Mamin, S.A. 1960 *Indian J. Dairy Sci*. **1**:16-19.

Marshall, S.P. and Van Horn, H.H. 1975. Complete Rations for Dairy Cattle. II. Sugar cane Bagasse Pellets as Roughage in Blended Rations for Lactating Cows1, 2, 3. *J. of Dairy Sci.* **58**(6): 896-900.

Mia, W.H., Sahai, B., Majumdar, B.N. and Kehar, N.D. 1960. Studies on tree leaves as cattle fodder. 3. The nutritive value of Bargad leaves (Ficus bengalensis). *Indian J. Dairy Sci*. **13**. pp.1-8.

Mogea, J., Seibert, B. and Smits, W. 1991. Multipurpose palms: the sugar palm (Arenga pinnata (Wurmb) Merr.). *Agroforestry Syst*. **13**:111-129.

Molina, E., Boza, J. and Aguilera, J.F. 1983. Nutritive value for ruminants of sugar cane bagasse ensiled after spray treatment with different levels of NaOH. *Anim. Feed Sci. and Technol.* **9**:1-17.

Muralidharan VK, Ganapathy MM, Velayudhan KC and Amalraj VA. 1997. Collecting jackfruit germ plasm in Western Ghats. *Indian J. Plant Genet. Resour.* **10**: 227-231.

Naknean, P., Meenune, M. and Roudaut, G. 2010. Characterization of palm sap harvested in Songkhla province, Southern Thailand. *Int. Food Res. J.* **17**:45-47

National Research Council, 2001. Nutrient requirements of dairy cattle: 2001. *National Academies Press*. pp. 258-280

Nocek, J. E., J. H. Herbein, and C. E. Polan. 1980. Influence of ration physical form, ruminal degradable nitrogen and age on rumen epithelial propionate and acetate transport and some enzymatic activities. *J. Nutr*. **110**:2355–2364.

Pachauri, V.C., Mahanta, S.K., Singh, S. and Malviya, D.R., 1997. Nutritional evaluation of three varieties of berseem in sheep. *Forage Res.* **23**: 39-43.

Pandya, P.R., Gupta, R.S.. Talpada, P.M., Patel, G.R., and Desai, M.C. (2005). Effect of complete feeds based on wheat straw and Prosopis juliflora pods on growth and reproductive performance of growing crossbred heifers. *Indian J. Anim. Sci*. **75**: 56-59.

Pandya, P.R., M.C. Desai., G.R. Patel., P.M. Talpada., M.B. Pande and P.M. Parnerkar. 2009. Economical rearing of crossbred calves on complete feeds, based on Sugar cane bagasse and non-conventional feeds. *Indian J. Anim. Nutr*., **26**:211-215.

Pate, F.M., 1982. Value of treating bagasse with steam under pressure for cattle feed. *Trop. Agri.* **4**: 16-21

Pate, F.M., Alvarez, J., Phillips, J.D. and Eiland, B.R. 2002. Sugar cane as a cattle feed: production and utilization. *Bull.* 844p.

Raja, D. 2005. Utilization of urea at different stages of development of rumen in weaned calves. *M.V.Sc. thesis*, Kerala Agricultural University, Thrissur, 76p.

Raja, W., Medhi, D., Bhat, A.S., Hussain, J. and. 2010. Comparative study on the nutritive values of oats and maize silages in crossbred growing calves. *Indian J. of Anim Res.* **44**:21-23

Randel, P.F. 1972. A comparison of the digestibility of two complete rations containing either raw or alkali-treated Sugar cane bagasse. *The J. of Agric. of the University of Puerto Rico*, **56**:18-25.

Rani, K.J. 2006. Effect of restricted milk feeding on blood biochemical profile in cross bred calves. *M.V.Sc thesis*, Kerala Agricultural University, Thrissur, 70p.

Raut, R.G., Rekhate, D.H. and Dhok, A.P. 2002. Nutrient utilization in goats fed arhar (Cajanus cajan) straw based complete feed pellets. *Indian J. of Anim. Nutr.* **19**:135-139.

Reddy, G.V.N., K.J. Reddy and D. Nagalakshmi. 2002. Effect of expander-extruder processed complete diet containing sugar cane bagasse on growth and nutrient utilization in Ongole bull calves. *Indian J. Anim. Sci*., **72**:46409

Reddy, M.R., Chandrasekharaiah, M., Govindaiah, T. and Reddy, G.V.N. 1993. Effect of physical processing on the nutritive value of Sugar cane bagasse in goats and sheep. *Small Rum. Res.***10**:25-31.

Rungrodnimitchai, S. 2011. Novel source of pectin from young sugar palm by microwave assisted extraction. *Proc. Food Sci.***1:**1553-1559.

Saenphoom, P. 2016. Nutritive Value, Digestibility and Gas Production of Fermented Sugar Palm Peel with Pineapple Peel. *Sci. Engng. and Hlth. Stud.* **10**: 32-37.

Sallam, S.M.A., Nasser, M.E.A., El-Waziry, A.M., Bueno, I.C.S. and Abdalla, A.L. 2007. Use of an in vitro rumen gas production technique to evaluate some ruminant feedstuffs. *J. Appl. Sci. Res*, **3**:34-41.

Sath, K., Borin, K. and Preston, T.R. 2008. Survey on feed utilization for cattle production in Takeo province. *Livestock Res. for Rural Dev*. **20**:23-27.

Senani, S., Jayapal, N., Samanta, A.K., Kolte, A.P., Sridhar, M., Suresh, K.P. and Sampath, K.T. 2013. Value addition to Sugar cane bagasse: xylan extraction and its process optimization for xylooligosaccharides production. *Ind. Crops and Products*. **42:**14-24.

Seshaiah, C.V., Rao, S.J., Reddy, Y.R., Nagalakshmi, D., Mahender, M. and Harikrishna, C. 2013. Effect of feeding processed sweet sorghum (Sorghum bicolour (L) moench) crushed residue based complete ration on growth performance and feeding behavior of murrah buffalo calves. *Vet. Wld* **6**: 151

Snedecor, G.W. and Cochran, W.G. 1994. *Statistical Methods* (8th Ed.). The Iowa state university press, Ames, Iowa, USA, 314p.

Venkatesh, D. and Venkateswarlu, M., 2017. An Overview of the Indian Sugar Industry. *BIMS Int. J. Social Sci. Res.,* **2**: 11-16.

Vinu, M.N. 2012. Dietary supplementation of organic selenium in crossbred calves. *M.V.Sc thesis*, Kerala Veterinary and Animal Sciences University, Pookode, 97p.

Waje, S.H., S.K. Singh and V. Mudgal. 2010. Effect of using forest grass based complete rations on growth and nutrient utilization in growing crossbred calves. *Anim. Nutr. Feed Techn.* **10**: 229-234.

Zade, M.S., Dabiri, N., Fayazi, J. and Pour, M.B. 2009. Determination of optimum level of steam pressure hydrolyzed pith bagasse in feeding of crossbred beef. *Res. J. of Biological Sci.* **4**: 773-776.

Zadrazil, F. and Puniya, A.K. 1995. Studies on the effect of particle size on solid-state fermentation of Sugar cane bagasse into animal feed using white-rot fungi. *Bioresource Technol.* **54**: 85-87.

ABSTRACT

NUTRITIVE EVALUATION OF PALMYRA (*Borassus flabellifer*) SEED HUSK AND SUGAR CANE (*Saccharum officinarum*) BAGASSE IN CROSS BRED CALVES

SANOODH MOHAMMED AV

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Kerala Veterinary and Animal Sciences University

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COLLEGE OF VETERINARY AND ANIMAL SCIENCES

MANNUTHY, THRISSUR- 680651

KERALA, INDIA

ABSTRACT

An experiment was conducted to assess the effect of 50 percent replacement of green grass with Palmyra seed husk or sugar cane bagasse in complete feed on growth in crossbred calves. Three complete rations having 70:30 concentrate: roughage ratio, with grass (T1), 50 per cent replacement of grass with Palmyra seed husk (T2) and 50 per cent replacement of grass with sugar cane bagasse (T3) on dry matter basis, as roughage source were prepared and evaluated for their nutritive value. Eighteen healthy female cross bred calves, six to seven months of age were selected from ULF, Mannuthy as uniformly as possible with regard to age and weight, and randomly allotted to three dietary treatments T1, T2 and T3 and fed with respective experimental rations as per NRC (2001) for a period of 90 days. The animals were fed twice daily and the balance of feed was collected for obtaining daily dry matter intake. The record of daily feed intake and fortnightly bodyweight of all the experimental animals were maintained throughout the experimental period. At the end of the feeding trial a digestibility trial for five days was conducted by total collection method. Feed, fodder and dung samples were analysed for proximate principles (AOAC, 2012). Blood samples were collected from the experimental animals at the beginning and end of the trial and was analysed for serum calcium, serum phosphorus, glucose, blood urea nitrogen, serum total protein, albumin (using standard kits) and haemoglobin (using blood analyser).

The bodyweight gain obtained was 43.40± 2.44, 36.78± 1.64, 42.38± 2.39 Kg in 90 days period. There was no significant difference ($P>0.05$) in the fortnightly body weight and average daily gain. Dry matter intake per Kg metabolic body weight was significantly lower in T3 animals in all the fortnights compared to the T1

and T2. The feed conversion efficiency obtained were 4.87 ±0.18, 5.61 ±0.28 and 4.76 ±0.12 and was higher ($P<0.01$) for T1and T3. The digestibility trial revealed that all the three treatments had similar dry matter, crude protein, neutral detergent fibre, acid detergent fibre digestibility ($P>0.05$) while the ether extract digestibility was higher ($P<0.01$) for T3 than that of T1 andT2 ration. Cost of production when calculated in terms of feed cost per kg body weight gain was lower for T3 and T2 than that of T1.

Hence, the study indicated that the calves could be raised on 50% replacement of green grass with Palmyra seed husk or sugar cane bagasse with optimum weight gain. However, the feed efficiency on 50% replacement of Palmyra was lower and cost of feed/kg body weight gain was lowest in calves fed on sugar cane bagasse.