V. DISCUSSION

GROWTH TRIAL I

5.1 Chemical composition of sorghum stover

The detailed chemical composition of sorghum stover (untreated and urea treated), GNC and jowar used in the two growth trials of this study are presented in Tables, (4.1) and (4.10). The results of the proximate analyses and the forage fibre fractions of the sorghum stover reported in this study are within the range of values reported by Mahantesh (2006), Sanjay (2007) and Venkatesh et al. (2008). The ADL content was lower in the present study when compared to the reported values of Ramachandra et al. (2002) and Dhore et al. (2005). The 2 per cent urea treated stover also contained similar composition except for CP content which was increased by 5.34 units in treated stover from 3.19 per cent in untreated stover. Addition of urea increased the CP content of stover. Reddy et al. (1988), Kanade et al. (1992) and Rakesh Kumar and Sharma (2001) also observed similar rise in CP content of straw or stover after urea or ammonia treatment. These workers have also reported changes in NDF, ADF, cellulose or hemicellulose content after urea or ammonia treatment. There were no such changes observed in the present study. This might be due to the type of urea treatment in the present study where in, the urea treatment was done just before feeding to the animals whereas, in other studies urea ammoniation was done for longer durations and stored, prior to feeding to the animals. The chemical composition of GNC and sorghum grain used in this study are comparable to the values reported in the data base of feed composition of tropical feedstuffs by Krishnamoorthy et al. (1995).
5.2 Dry matter intake

The mean total feed DMI in different treatment groups were 3.17, 3.19, 3.94 and 3.86 kg in T-1, T-2, T-3 and T-4 groups, respectively. The mean total DMI as per cent body weight for treatment groups were 1.74, 1.77, 2.20 and 2.15 per cent T-1, T-2, T-3 and T-4 groups, respectively. The mean total DMI per metabolic body weight (g/kg BW$^{0.75}$) observed in treatment groups were 63.77, 64.71, 80.21 and 78.35 g for T-1, T-2, T-3 and T-4 groups, respectively. The DMI (per day or as per cent BW or per metabolic BW) was higher for calves in T-3 and T-4 group due to the supplementation of GNC.

The mean stover DMI for treatment groups were 3.17, 3.19, 3.20 and 3.11 Kg in T-1, T-2, T-3 and T-4 groups, respectively. The mean total DMI as per cent body weight for treatment groups were 1.74, 1.77, 1.78 and 1.72 per cent T-1, T-2, T-3 and T-4 groups, respectively. The mean total DMI to the metabolic body weight observed in treatment groups were 63.77, 64.71, 64.87 and 63.00 g in T-1, T-2, T-3 and T-4 groups, respectively. The stover DMI (Total, as per cent body weight or metabolic body weight) was found to be non significant. Therefore the GNC had no stimulatory effect on DMI of sorghum stover. Although GNC provided rumen degradable protein (RDP) and possibly contributed to the peptide pool of the rumen, the high solubility/degradability characteristics of GNC protein might have resulted in the decreased utilization and had apparently no effect on ruminal fermentation and forage DMI of sorghum stover. Therefore, the additional gain observed in T-3 and T-4 might not be due to difference in protein source (urea and GNC) and possibly due to the difference in the energy intake.
A similar DMI of sorghum stover imply that addition of RDP by the GNC supplementation had no beneficial effect on the stover roughage DMI. While some studies have reported similar DMI of urea treated sorghum stover in the growing calves as in the present experiment (Waghmare et al., 1987; Ramachandra et al., 2002; Patel et al., 2007). Reddy et al. (1989) reported higher DMI for sorghum stover in crossbred bulls when ammoniated sorghum stover was fed. The increased intake of stover was attributed to the feeding of complete feed and method of urea treatment (urea ammoniation) rather than urea treatment per se.

5.3 Body weight gain

The ADG of the experimental calves in different treatment groups are presented in Table (4.2). The ADG observed was 144.05, 169.64, 372.62 and 360.71 g in T-1, T-2, T-3 and T-4 groups, respectively. Calves in T-1 and T-2, fed only sorghum straw gained significantly lower BW compared to T-3 or T-4 calves supplemented with GNC. The ADG of calves fed only urea treated stover (T-1 and T-2) observed in this study was similar to the ADG observed by Rajan Gupta et al. (1984), and Krishnappa (1989).

The difference in the ADG of calves fed only ureatreated stover (T-1 and T-2) and untreated stover plus GNC supplemented (T-3 and T-4) calves was about 210 g. Supplementation of 800 g of GNC provided additional protein and extra energy to the calves. The ADG of 210 g in these animals (T-3 and T-4) seems reasonable, since animals were expected to gain about 230 g per day with the extra ME provided by the supplementation of GNC (8.4 MJ per day) (NRC, 2001).
It was not possible to explain from this experiment whether the protein or energy component of the GNC was beneficial for the body weight gain of calves, since there was no negative control group (fed only untreated sorghum stover) of calves in this experiment. Nevertheless, unlike ureatreated diets (T-1 and T-2), supplementation of GNC (treatments T-3 and T-4) should provide a source of amino acid and peptide in the rumen. Peptides and amino acids are the required nutrients for the ruminal bacteria (NRC, 2001) and researchers have observed improved microbial growth or efficiency when peptides or amino acids replaced ammonia or urea as the sole or major source of N (Cotta and Russel, 1982; Russel and Sniffen, 1984; Griswold et al., 1996). Maeng and Baldwin (1976) reported increased microbial yield and growth rate on 75 per cent urea + 25 per cent amino acid N as compared to 100 per cent urea. In this experiment, the beneficial effect of GNC supplementation by providing amino acids and peptides is unlikely, since many reports have demonstrated that the stimulation and enhanced microbial growth will occur only when amino acids and peptides are supplied with rapidly degrading energy or fibre substrates (Argyle and Baldwin, 1989; Russel et al., 1992; Chikunya et al., 1996). Therefore, the beneficial effect of GNC supplementation by providing amino acids and peptides is unlikely since the sorghum stover (slow degrading fibre) was the sole ingredient of the diet.

5.4 Digestibility of nutrients and nutritive value

The mean digestibility of nutrients in the experimental calves of different treatment groups are presented in Table (4.9). There was no difference in the digestibilities of DM, OM, CP, NDF, ADF, cellulose or hemicellulose among the treatment groups. Previous reports indicated that the addition of protein sources would
provide a source of branched amino acids (or branched fatty acids) which are considered
growth promoters for cellulolytics in the rumen (Beever et al., 1990; Kamra and Pathak,
1996). In the present study, the addition of protein supplement (GNC) perhaps did not
influence the growth or activity of cellulolytic rumen bacteria and consequently no effect
on the digestibilities of cellulose or hemicellulose components of the fibre. The DOMD
(or ME calculated from the DOMD of the diet) content of the diet was also similar among
different treatment groups. The mean digestible crude protein intake observed in
treatment groups were 158.92, 167.44, 250.62 and 245.27 g in T-1, T-2, T-3 and T-4
groups, respectively. There was a statistically significant (P≤0.05) difference in treatment
groups with regard to digestible crude protein intake. The calves fed on T-1 and T-2 diet,
consumed significantly lower (P≤0.05) DCP than those fed on T-3 and T-4. A non
significant difference was observed between T-1, T-2 and T-3, T-4. Higher DCP intake
by groups T-3 and T-4 was obviously due to the supplementation of GNC to these calves.
Different forms of CP (urea or GNC) exerted no influence on the digestibility of the
nutrients or DMI of sorghum stover. The mean digestible crude protein (per cent) of
treatment diets were 5.07, 5.33, 6.13 and 6.17 per cent in T-1, T-2, T-3 and T-4 groups,
respectively. There was statistically significant (P≤0.05) difference in treatment diets
with regard to digestible crude protein. T-1, T-2 consumed significantly (P ≤ 0.05) lower
digestible crude protein than those in T-3 and T-4. The mean NDF intake observed in was
2.07, 2.07, 2.49 and 2.43 kg in T-1, T-2, T-3 and T-4 groups, respectively. T-3, T-4
consumed significantly (P ≤ 0.05) higher NDF than T-1 and T-2, which was due to
supplementation of GNC to T-3 and T-4 groups.
The digestibility and nutritive value of the sorghum stover (T-1 and T-2) are comparable to the earlier works of Waghmare et al. (1987), Ramachandra et al. (2002) and Patel et al. (2007) wherein DCP and TDN contents were assessed for treated and untreated sorghum stover. The higher values of DCP reported by other workers (Natarajan et al., 1994; Sheela et al., 2004) was due to the higher percentage of urea (4 per cent) used for urea ammoniation of straw in those studies. Higher DOMD values of sorghum stover (about 60 per cent) in this experiment may be due to higher quality of sorghum stover used in this study. Since, Badve et al. (1993), pointed out that differences in the nutritive value of sorghum stover occurred due to genotype, environmental factors, location and season.

5.5 Feeding Frequency

Effect of feeding frequency was studied in this trial, with two feeding frequencies (2 times feeding vs. 6 times feeding per day) across four treatment groups. There were no differences in the performance parameters like body weight, ADG, DMI of stover, DCP intake, NDF intake, nutrient digestibility, nutritive value among T-1 and T-2 group or T3- and T-4 groups, indicating that feeding frequency has no advantage on production performance of the calves. Robinson (1989) observed benefits like increased efficiency of microbial fermentation and increased feed intake due to increasing the number of meals per day in dairy cows. Nevertheless, no such beneficial effects have been observed in growing calves in this study. The results of the present study corroborated with the findings of Madhav and Jaikishan (1990), Yadav and Mathur (2002), Teller et al. (2004) and Zali and Ganjkhanlou (2007) who also reported no significant advantage in terms of digestibility and nutritive value with increased feeding frequency.
The expeller groundnut cake used for supplementing the calves in treatment groups T-3 and T-4 contained 6.23 per cent ether extract. Significant increase in body weight gains in these groups of calves (compared to no supplementation) could also be due to significantly higher energy intake by calves. Since the fat supplementation reduces the methane production in dairy cows, it is also likely to increase the efficiency of energy utilization, resulting in body weight gains. Improvement in gross energy utilization by supplementing fats was reported by Johnson and Johnson (1995), McGinn et al. (2004), Beauchemin and McGinn (2006) and Beauchemin et al. (2008).

The mean BW of experimental calves during first trial was 181 kg. ARC (1984) suggested a daily allowance of 29 MJ ME, 225 g RDP for zero gain and 37 MJ ME, 290 g RDP for 250 g gain per day for 200 kg BW growing calves. The ME (MJ) and CP (g) intake in the present study was 28.77, 266.16; 29.42, 266.32; 36.88, 403.18 and 35.44, 400.11 in T-1, T-2, T-3 and T-4 groups, respectively. The RDP requirement provided in the form of urea-CP was less in T-1 and T-2 than ARC (1984). Since the NDFD was not affected and similar in all the four treatment groups, it may be suggestive of sufficient recycling of nitrogen in T-1 and T-2 groups (Cotta and Russel, 1982; Russel and Sniffen, 1984; Griswold et al., 1996).

**GROWTH TRIAL II**

**5.6 Chemical composition of sorghum stover**

The chemical composition (proximate analyses and fibre fractions) of untreated sorghum stover and sorghum grain are presented in Table (4.10). All the values reported for untreated sorghum stover are within the range and in agreement with the published
reports of Mahantesh (2006), Sanjay (2007) and Venkatesh et al. (2008). The ADL content was low in the present study when compared to the reported values of Ramachandra et al. (2002) and Dhore et al. (2005). The composition of 2 per cent urea treated stover was also similar except for CP content which increased to 8.50-8.58 per cent from 3.19 per cent in untreated stover. Reddy et al. (1988), Kanade et al. (1992) and Rakesh Kumar and Sharma (2001) observed similar rise in CP content of straw or stover after urea or ammonia treatment. The chemical composition of sorghum stover was not altered by enzyme or Tween 80 treatment. Dean et al. (2003) also made similar observations for Bermuda grass where ammonia application did not increase the CP content in enzyme treated grass.

5.7 Dry matter intake

The objective of this trial was to determine the effect of supplementing enzyme premix and Tween-80 to urea treated sorghum stover with hypothesis that supplementation of sorghum grain can be replaced by the use of premix. The experiment comprised of three groups of calves, all of them fed urea treated sorghum straw as a basal roughage feed. Group T-1 was fed 2 per cent urea treated sorghum stover along with enzyme and Tween-80. Group T-2 was fed the same diet as T-1 plus supplemented with 400 g of ground sorghum grain per day. Group T-3 was fed with 2 per cent urea treated straw along with 400 g ground sorghum grain. Since a group of calves was maintained exclusively on feeding urea treated sorghum stover in the previous experiment (growth trial I), negative control was not used in this growth trial. Tween-80 was added along with the enzyme as a surfactant, to facilitate the action of enzyme. Sorghum grain was used as an energy source, since sorghum grain is a locally available cereal grain for
feeding cattle. The objective of using supplementing sorghum grain along with the enzyme in T-2 group was to examine, if the addition of cereal grain as a source of fermentable energy would suppress and offset the activity of enzyme. The enzyme was added at the rate 0.5 per cent level as recommended by the manufacturer.

The intake of total DMI and the intake of sorghum stover by calves in different treatment groups have been presented in Table (4.11). There was no difference in the mean total DMI (kg), when expressed as either kg per day or as per cent body weight, among different treatment groups. The mean daily intake (kg) of sorghum stover was significantly higher in T-1 (1.96) group of calves, followed by T-2 (1.50) and T-3 (1.38). Supplementation of enzyme increased the stover intake of calves in group T-1, indicating that the supplementation of fibrolytic enzyme was beneficial. The increased digestibility of NDF and ADF in this group (Table 4.11) and increased sorghum stover intake might be due to increased fermentation in the rumen and rapid rumen outflow. The stover DMI was lower in groups T-2 and T-3 compared to group T-1, however there was no significant difference between T-2 and T-3 groups. These observations coupled with the similar NDF and ADF digestibilities between T-2 and T-3 groups indicate that the supplemental benefit of enzyme was equivalent in terms of supplementing sorghum grain (T-3), and that the beneficial effect of the enzyme was suppressed by the sorghum grain supplementation (T-2). If there was no such suppressing effect by the grain, the sorghum DMI (and in turn the total DMI) would have been higher (due to sorghum grain supplementation) in T-2 group, compared to T-1. Nowak et al. (2003) also observed that the enzyme supplementation had minimal or no effect when barley was supplemented to the hay based diets. Contrary to the findings of this study, Giraldo et al.
(2008) and Singh and Das (2009) also reported that enzyme supplementation did not affect DMI in sheep fed with grass hay based diet.

5.8 Body weight gain

The mean ADG of different treatment groups of calves are presented in Table (4.11). The ADG was 279.16, 293.45 and 276.19 g for T-1, T-2 and T-3 groups, respectively. There was no significant difference in the ADG of calves among the different treatment groups. The ADG of T-1 group (280 g, Table 4.11) fed ureatreated sorghum stover along with the enzyme was higher than the ADG of T-1 group (157g, Table 4.9) in the growth trial I, where in the calves were fed only urea treated sorghum stover. These results indicate that the enzyme supplementation to the urea treated sorghum stover could be beneficial to increase the ADG in growing Deoni calves, by about 123 g per day.

5.9 Nutrient digestibility and nutritive value

The effect of supplementing cellulolytic enzyme and Tween-80 on the digestibility of nutrients and nutritive value of the urea treated sorghum stover diet was studied. Digestibility estimate of the nutrients and the DOMD and the DCP content of the various diets are presented in Table (4.11). DOMD content was 65.87, 61.70 and 57.98 per cent for T-1, T-2 and T-3 diets respectively. The DOMD was significantly higher \((P \leq 0.05)\) in T-1 diet compared to T-2 or T-3 diets. The ME (MJ/kg DM) calculated from DOMD was 9.96, 9.33 and 8.77 T-1, T-2 and T-3, respectively. The digestibilities of DM, OM, CP, NDF, ADF and hemicellulose were significantly higher in T-1 diet in which only sorghum stover was fed which was top dressed with enzyme
premix and Tween 80 (P≤0.05). The DCP (%) of diet were also significantly (P≤0.05) higher in T-1 group when compared to other groups. Similar effect of increasing digestibilities of nutrients due to enzyme supplementation was observed by Balci et al. (2007) and Singh and Das (2009). These findings suggest that only enzyme application to ureatreated sorghum stover resulted in better utilization and grain supplementation to it would result in depression of digestibility and nutrient utilization. The depression in digestibility by supplementing cereal grains was also reported by Lusby et al. (1976), Kartchner (1980) and Chase and Hibberd (1987). However, Krause et al. (1998) reported that enzyme supplementation to straw based diet with grains was found to be beneficial.

5.10 Total protozoal count

The mean total protozoal count observed was 1.24 x 10^5, 1.53 x 10^5 and 2.24 x 10^5 in T-1, T-2 and T-3 groups, respectively. Significantly higher (P≤0.05) protozoal count was recorded in T-3 group compared to T-1 and T-2 whereas the difference in the protozoal count between T-1 and T-2 groups were found to be non significant. The significantly reduced number of protozoa in T-1 and T-2 groups may be due to the effect of Tween-80 supplementation (Hwang et al., 2008). The better responses in these groups could be due to addition of fibrolytic enzymes and increase in the number of bacteria consequent to decrease in protozoal numbers, possibly associated with reduction in methane production Jack (2002) and Wanjae et al. (2005)

5.11 Total volatile fatty acids

The mean TVFA concentration in the ruminal fluid observed was 77.68, 85.96 and 76.50 mMol/l in T-1, T-2 and T-3 respectively. Significantly higher (P≤0.05) TVFA
concentration was observed in T-2 compared to T-1 and T-3. However, the differences between the T-1 and T-3 groups were found to be non significant. The mean TVFA observed was 65.10, 85.37 and 89.47 mMol/l at initial, six weeks and end of experiment. Higher TVFA in T-2 may be due to the grain supplementation combined with enzyme application to stover. Comparable TVFA values of the T-1 and T-3 suggests that either grain or enzyme treatment had similar effect. Wanjae et al. (2005) and Hwang et al. (2008) reported significantly higher TVFA in enzyme and Tween 80 supplemented diets.