Performance of Crossbred Cattle Fed Chopped Green Sugarcane Tops and Supplemented with Wheat Bran or Lentil Chuni Concentrates

M. K. Gendley, P. Singh* and A. K. Garg

Animal Nutrition Division, Indian Veterinary Research Institute, Izatnagar-243 122, India

ABSTRACT : Fifteen crossbred cattle bulls of about 22-24 months age (mean body weight ranged from 291.0 to 298.1 kg) were randomly divided into 3 groups of 5 animals following randomized block design. Animals in group 1 were fed concentrate mixture containing wheat bran 97%, mineral mixture 2% and salt 1% plus *ad libitum* chopped green sugarcane tops (SCT) as a roughage source. Animals in group 2 were fed concentrate mixture containing lentil chuni 97%, mineral mixture 2% and salt 1% while group 3 concentrate contained wheat bran 48.5%, lentil chuni 48.5%, mineral mixture 2% and salt 1% plus *ad libitum* chopped green SCT to meet their maintenance requirements. During metabolism trial period, the mean total intake and digestibility of DM in groups 1, 2 and 3 was 8.09±0.41, 8.41±0.49 and 7.86±0.16 kg/d and 60.24, 63.24 and 65.05%, respectively. The intake of CP ($p<0.05$) and EE ($p<0.01$) was significantly higher in group 2 and group 1, respectively as compared to remaining 2 groups, which were comparable. Digestibility of CP and EE was significantly ($p<0.01$) higher in group 3 and that of CP was comparable with group 2. The intake and digestibility of total carbohydrates, NDF, ADF, Hemi-cellulose and cellulose were similar among 3 groups. The mean body weight changes in group 1, 2 and 3 were 173.4, 253.4 and 203.4 g/d, respectively, which was significantly ($p<0.05$) higher in group 2. The total nitrogen (N) and phosphorus (P) intakes were significantly higher in group 2 and group 1, respectively. The total volatile fatty acids, ammonia-N, trichloro-acetic acid precipitable nitrogen (TCA ppt.-N; $p<0.05$), total-N concentrations and pH were significantly ($p<0.01$) higher in group 3, however, pH and TCA ppt.-N was comparable with group 2 and 1, respectively. From the results, it may be deduced that the feeding of chopped green SCT supplemented with a concentrate mixture having both wheat bran (48.5%) and lentil chuni (48.5%) has shown a better performance with respect to intake and digestibility of nutrients and growth as well. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 10 : 1422-1427)***

Key Words : Green Sugarcane Tops, Crossbred Cattle, Intake, Digestibility and Balance of Nutrients, Rumen Parameters

INTRODUCTION

To mitigate the shortage of feeds and fodders and to make animal production viable and profitable, attempts have been made on improvement and utilization of various poor quality crop residues and non-conventional feeds and fodders. Among the various crop residues, sugarcane top is available in large quantity in tropical countries and can form a very good staple roughage source for the ruminants. Sugarcane top (SCT) includes growing point of sugarcane, a few upper nodes and accompanying leaves, which is a major by-product of the sugarcane industry. The production of SCT varies considerably with variety, age, growing conditions and management practices of sugarcane crop. In fact India stands second in sugarcane production in the world next to Brazil with annual yield of about 271 million tones (Anon, 1999). Since the SCT form about 15-20% of total sugarcane, about 40-50 million tones of sugarcane tops are available every year in India. Thus, these SCT can be used as animal feed during sugarcane harvesting season that covers almost 6-7 months (October to April) in a year (Joshi et al., 1995). Though, sugarcane tops are highly palatable with good intake characteristics but at present sugarcane tops are being utilized partially as animal feed owing to lower in protein content (Kutty and Prasad, 1980), lower level digestibility of nutrients (Patil et al., 1999) and poor minerals content (Joshi et al., 1995). However, it can effectively be used as a source of roughage in the diet of ruminants after supplementation with protein and mineral supplements.

The supplementation of SCT based diets should not only satisfy the need of rumen microbes for fermentable nitrogen (ammonia) and trace nutrients but also provide the sources of protein, glucose precursors and long chain fatty acids. Additionally as a source of bypass nutrients from the rumen fermentation is required to balance the need of animal production. Through supplementation sugarcane tops can largely alleviate the shortage of the green fodders. The feeding of green sugarcane tops as such have 4.09% DCP and 52.92% TDN, which was not able to meet out the nutrient requirement for maintenance of growing buffalo calves (Patil et al., 1999; Gendley et al., 2001). Further, Joshi et al. (1995) suggested that there is a great need to enrich sugarcane tops by protein, energy and mineral supplements to meet out the nutrient requirements. Present study was, therefore, conducted to assess the performance of crossbred cattle fed on *ad lib* chopped green SCT supplemented with wheat bran or lentil chuni and both.

* Corresponding Author : P. Singh. Tel: +91-581-442313, Fax: +91-581-457284, Email: putan@ivri.nic.up.in

Received February 1, 2002; Accepted April 30, 2002

MATERIALS AND METHODS

Selection of the animals and experimental design

Fifteen adult healthy crossbred cattle bulls of about 22 to 24 months of age (mean body weight ranged from 291.0 to 298.1 kg) were equally distributed into 3 groups following randomized block design (RBD).

Housing and management of the animals

Animals were housed in a well-ventilated, dry and pucca shed having individual mangers for feeding. Clean and fresh drinking water was given twice daily i.e. in the morning (10.30 h) and afternoon (14.30 h) taking all hygienic measures. During the period of metabolism trial, animals were kept and acclimatized in the metabolic cages having suitable provisions for the collection of urine and feces separately. The body weights were recorded before feeding and watering to observe changes in body weights. Intake was estimated by weighing the amount of concentrate and green chopped sugarcane tops offered and residues left by each animal.

Feeds and feeding schedule

In group 1, animals were fed concentrate mixture (%) containing 97 wheat bran, 2 mineral mixture and 1 common salt plus *ad libitum* chopped green sugarcane tops (SCT) as a roughage source. Animals of remaining two groups were fed concentrate mixture (%) containing 97 lentil chuni (group 2) and 48.5 wheat bran, 48.5 lentil chuni; mineral mixture and salt as in group 1 (group 3) plus *ad libitum* chopped green SCT to meet out the nutrient requirements (NRC, 1989). Experimental feeding was done for a period of 21 day followed by a metabolism trial.

Metabolism trial

At the end of 21 days of experimental feeding, to study the intake and utilization of nutrients and the balances of nitrogen, calcium and phosphorus, a metabolism trial was conducted for 6 days with 3 days as adaptation period. During this period, in addition to measuring intake the total collection was done regularly for 24 h.

Collection, sampling and preservation of the samples

The representative samples of the feeds offered (i.e. green chopped SCT and concentrate mixtures) and residue left during the metabolism trial were collected daily for 6 days for the determination of nutrients intake and also pooled for further various chemical analysis. The representative samples of the faeces voided by each animal was collected daily after thorough mixing. Suitable aliquots were taken for DM and nitrogen estimation, which were also pooled for 6 days (Schneider and Flatt, 1975). Faeces samples were preserved for N-estimation after mixing with 20% sulphuric acid in a glass bottle. The daily representative samples of urine excreted during 24 h from individual animal were collected and brought to the laboratory and suitable aliquoting of urine was done in duplicate and pooled daily in Kjeldahl flask containing 50 ml conc. sulphuric acid for nitrogen estimation. In the separate bottles, suitable aliquots in duplicate were collected and pooled for the estimation of calcium and phosphorus and kept under freezing conditions. The rumen liquor sampling was done after 21 days of the experimental feeding. Samples were collected at 4 hr post-feeding for 3 consecutive days from 2 animals in each group. Rumen liquor was collected by stomach tube and filtered with muslin cloth. Approximately 200 ml of the rumen liquor was collected from each animal and taken to the laboratory immediately for preservation and further analysis. After straining through muslin cloth, about 100 ml of SRL was preserved with 1 ml of concentrate sulphuric acid for estimation of nitrogen and its fractions, and about 50 ml of SRL was preserved with 3-5 drops of saturated mercuric chloride for the estimation of total volatile fatty acids (TVFA) and kept in the Defreezer until further analysis.

Analytical methods

The proximate principles in feeds, faeces and urine samples were analyzed as per AOAC (1995). Fibrous constituents viz. NDF, ADF and ADL were estimated (Van Soest et al., 1991). The TCHO fraction was arrived at by subtracting CP and EE from the OM (Sniffen, 1988) and calcium content (Talapatra et al., 1940) and phosphorus content (AOAC, 1995) in feeds, faeces and urine samples were determined from the mineral extract prepared. Immediately after taking to laboratory, the pH of the rumen liquor samples was recorded by pre-calibrated digital pH meter (Decibel, DP -510). The TVFA in the SRL was determined following the procedure of Burnett and Reid (1956) using Markham's distillation apparatus. Total nitrogen, TCA soluble-N and ammonia-N was determined by Kjeldahl method. The data were analyzed statistically using analysis of variance technique (ANOVA) and the differences between means were compared using critical difference (Snedecor and Cochran, 1968).

RESULTS AND DISCUSSION

Chemical composition

The proximate principles and fibre fractions in green sugarcane tops, wheat bran and lentil chuni have been presented in Table 1. The chemical composition and fibre fractions of chopped green SCT was within normal range and corroborated well with the earlier observations (Pradhan, 1976; Sen et al., 1978; Kutty and Prasad, 1980; Patil et al., 1999; Garg et al., 2000; Gendley et al., 2001).

Table 1. Mean chemical composition of various feeds and fodders (% DM basis)

Particulars	SCT	WB	LC	WB+LC
OM	92.25	91.43	90.22	90.83
CP	4.42	14.17	18.30	16.28
EE	2.00	3.81	1.40	2.61
TCHO	85.83	73.45	70.52	71.93
NDF	76.96	45.01	53.00	49.01
ADF	40.76	14.28	35.89	25.09
ADL	6.69	4.32	7.40	5.86
Calcium	0.60	0.28	0.54	0.41
Phosphorus	0.25	0.90	0.56	0.73
Acid insoluble ash	3.25	1.56	3.65	2.61

SCT-Green chopped sugarcane tops, WB- Wheat Bran, LC- Lentil Chuni.

Chaudhary et al. (1972) also reported chemical composition of SCT, which was similar in respect of crude protein, total ash, hemicellulose and ADF, but ether extract and NDF values were slightly lower than the present values. Kevelenge et al. (1983) reported a chemical composition of SCT, which was slightly lower for OM, NDF and ADL and slightly higher for ADF and cellulose than the present composition of SCT. The present composition of sugarcane tops (Table 1) in respect to fibre was higher as compared to fibre fractions (NDF, ADF, HC and CL) reported by Godoy and Elliott (1981). Rane et al. (1988) reported higher content of CP and ether extract but lower total ash, Ca and P than the present chemical composition of wheat bran. Morrison (1956) has given a higher value for CP, ether extract and P but lower for total ash and calcium in wheat bran than present value. Dhakad (2001) reported higher value (%) for OM 95.36, CP 18.76, cellulose 9.00 and P 1.10 and lower value for EE 2.4, TCHO 72.10, total ash 4.64, NDF 37.50, ADF 10.26, ADL 1.26, hemicellulose 27.24 and Ca 0.13 than that of present experiment. These differences in chemical composition of SCT may be due to various factors like harvesting time, variety and cultivars of sugarcane, levels of irrigation and fertilizers, etc.

Chemical composition of lentil chuni is in agreement with the values reported by Mathur and Gupta (1971) and Rane et al. (1988), however, Mathur and Gupta (1971) reported a higher value for EE, total ash and lower value for CP and P but almost similar value for Ca and other nutrients. On the other hand, Rane et al. (1988) reported similar value for P and lower value for CP but higher value for EE, total ash and Ca than that of present value of lentil chuni.

Feed intake pattern

The mean intake of dry matter during metabolic trial was 6.83±0.34, 7.11±0.43 and 6.56±0.14 through chopped green SCT and 1.27±0.09, 1.30±0.07 and 1.30±0.07 kg/d through concentrate mixtures in group 1, 2 and 3, respectively (Table 2). The mean intake of total dry matter during trial period was 8.09±0.41, 8.41±0.49 and 7.86±0.16 kg/d in respective groups. Whereas on the basis of per 100 kg live weight and metabolic body size (kg $W^{0.75}$), it was 2.79±0.08, 2.85±0.07, 2.64±0.13 kg/d and 115.36±2.57, 118.01±3.26 and 110.43±4.05 g/d in group 1, 2 and 3, respectively. The mean intake of dry matter through chopped green SCT, concentrates and total dry matter on g/d, g/100 kg and per kg metabolic weight basis did not show any significant difference among 3 groups (Table 4). It indicated that supplementation of either wheat bran or lentil chuni or a mixture of both (50:50) had no effect on dry matter intake of the animals rather showed improvement in comparison to sole feeding of SCT as observed by Gendley et al. (2001).

Table 2. Mean nutrient intake and digestibility coefficient of different nutrients in various groups

Items	Group 1 (WB)	Group 2 (LC)	Group 3 (WB+LC)	SEM
Dry matter intake (kg /d)				
Green sugarcane tops	6.83	7.11	6.56	0.48
Wheat bran/Lentil Chuni	1.26	1.30	1.30	0.03
Total	8.09	8.41	7.86	0.49
Digestibility (%)				
DM	60.24	63.24	65.05	6.95
OM	62.51	66.42	67.66	2.38
CP**	46.21^{b}	56.61^{a}	57.89^{a}	4.10
EE**	61.50^{b}	60.41^{b}	68.12^{a}	5.33
TCHO	63.65	67.32	68.42	2.47
NDF	57.28	62.55	63.72	2.93
ADF	58.41	61.15	63.84	2.57

Means having different superscripts in a row differ significantly ** $p<0.01$, * $p<0.05$.

The animals consumed about 52 to 68% higher DMI over and above the maintenance requirement in comparison to recommendation of NRC (1989). The dry matter intake is in agreement with the earlier observations as reported by Ferreiro and Preston (1976) who found 2.6 kg DMI/100 kg body weight and Patil et al. (1999) observed DMI 103.08 g/kg $W^{0.75}$ in buffalo calves fed green chopped SCT. Similarly Montpellier and Preston (1977) found 2.78 kg DMI/100kg body weight in SCT fed animals. Further, Aroeira et al. (1995) observed 2.55 kg DMI/100 kg body weight in Zebu cows fed on SCT with 1% urea and 1kg cottonseed meal/d.

Digestibility of nutrients

The digestibility of all the nutrients was similar ($p>0.05$) among 3 groups except CP digestibility, which was significantly ($p<0.05$) higher in group 3 and 2 as compared to group 1 (Table 2). In group 1, lowered

Table 3. Metabolism of nitrogen, calcium and phosphorus (g/d) in various groups

Items	Group 1 (WB)	Group 2 (LC)	Group 3 (WB+LC)	SEM
Nitrogen intake*	74.86 [b]	85.33 [a]	75.61 [b]	4.33
N voided in feces	40.29	36.98	31.97	3.79
N excreted in urine*	19.3 [b]	21.50 [ab]	25.80 [a]	1.71
N retained*	15.28 [b]	26.85 [a]	18.00 [b]	4.36
Calcium intake	45.58	50.41	45.98	2.74
Ca voided in feces	31.07	33.34	26.85	3.20
Ca excreted in urine*	2.73 [b]	4.13 [a]	3.74 [ab]	0.58
Ca retained	11.77	12.94	15.38	2.68
Phosphorus intake**	28.60 [a]	24.91 [b]	25.56 [b]	1.24
P voided in feces	16.15	13.27	13.67	1.74
P excreted in urine*	0.71 [a]	0.38 [ab]	0.20 [b]	0.19
P retained	11.74	11.26	11.69	1.20

Means having different superscripts in a row differ significantly ** p<0.01, * p<0.05.

Table 4. Mean growth rate, plane of nutrition and nutritional value of different diets in various groups

Items	Group 1 (WB)	Group 2 (LC)	Group 3 (WB+LC)	SEM
Initial body weight (kg)	286.20	288.80	292.00	16.85
Final body weight (kg)	291.00	296.40	298.10	17.61
Average daily gain (g)*	173.4[b]	253.4[a]	203.4[ab]	27.82
Average body weight during trial (kg)	290.40	295.00	297.45	6.16
Metabolic body weight (kg $W^{0.75}$)	70.23	71.10	71.54	-
DM intake (kg/100 kg body weight)	2.79	2.85	2.64	0.17
CP intake (g/d)*	467.9[b]	533.3[a]	473.2[b]	27.43
DCP intake (g/d)**	216.1[b]	302.2[a]	274.2[a]	28.09
TDN intake (kg/d)	4.79	5.29	5.06	0.11

Means having different superscripts in a row differ significantly ** p<0.01, * p<0.05.

Table 5. Mean rumen biochemical parameters in various groups

Items	Group 1 (WB)	Group 2 (LC)	Group 3 (WB+LC)	SEM
pH**	6.45[b]	6.69[a]	6.68[a]	0.06
TVFA (meq/dl)**	10.25[c]	11.20[b]	12.70[a]	0.15
N-fractions (mg/dl)				
Ammonia-N**	9.28[c]	11.87[b]	13.27[a]	0.12
TCA ppt.-N*	71.10[ab]	60.90[b]	84.80[a]	2.58
TCA soluble-N	36.40	51.10	42.70	6.89
Total-N**	107.50[b]	112.00[b]	127.50[a]	1.57

Means having different superscripts in a row differ significantly ** p<0.01, * p<0.05.

digestibility of CP may be due to the quality of protein particularly amino acid composition. It is further evident from the higher (p<0.01) digestibility of CP in group 3, where animals were fed wheat bran and lentil chuni at a ratio of 50:50. The digestibility of EE was significantly (p<0.01) higher in group 3 as compared to group 1 and 3, which were comparable (Table 2). The digestibility coefficients of all the nutrients were within the normal range as reported by different earlier workers (Montpellies and Preston, 1977; Joshi et al., 1995; Patil et al., 1999; Gendley et al., 2001), where animals were fed green sugarcane tops as a whole and supplemented with different feed ingredients. It may be deduced from the digestibility that supplementation of SCT either lentil chuni or mixture of both by and large did influence the digestibility of CP and EE but the digestibility of other nutrients remained unaffected.

Plane of nutrition

The DM and TDN intakes per kg metabolic body weight were comparable among 3 groups, but CP and DCP intakes were significantly lower in group 1 than group 2. It indicated that the source of supplementation had a substantial impact on the intake of CP and DCP because it has more CP content in comparison to wheat bran. Lentil chuni and wheat bran are the legume and cereal by-products, respectively thus, intake of CP and DCP is variable among 3 groups. It suggests that legume by-products are superior to cereal by-products so far as protein availability is concerned.

Intake of DM, CP and TDN in present study was over and above the maintenance requirements as recommended by NRC (1989), where it was reported that requirement for maintenance of mature breeding bulls (300 kg body weight) is about 74.64 g DM, 41.06 g TDN and 7.46 g CP per day per kg metabolic body weight. It has suggested that the SCT could be used for feeding of productive animals along with proper protein and energy supplementation. Further observed that body weight changes of animals in group 1, 2 and 3 were 173.4, 253.4 and 203.4 g/d (Table 4), which indicated that SCT supplementation required protein more critically as compared to energy supplementation.

Balances of nutrients

The intake of N was significantly higher (p<0.01) in group 2 as compared to group 1 and 3 obviously due to supplementation of lentil chuni in this group (Table 3). Though, N voided in feces as % of N intake was substantially (53.82%) higher in group 1 but was not significantly different. However, N excretion through urine in group 1 was significantly lower (p<0.05) in comparison to group 3, which was comparable to group 2 (Table 3). It indicated that in group 1 absorbed N was more efficiently utilized by the animals as compared to group 3. This may be due to supplementation of wheat bran as a source of energy. However, the balance of N was significantly (p<0.05) higher in group 2 as compared to group 1 and 3.

The Ca and P balances were positive and did not differ significantly among 3 groups (Table 3). This indicated that deficient SCT in Ca and P (Gendley et al., 2001) was requiring supplementation of Ca and P to maintain positive balances of these minerals and to get the optimum production potential of animals. Joshi et al. (1995) have also reported SCT as poor source of minerals particularly phosphorus. Therefore, it is suggested that animals, which are being fed on *ad libitum* green SCT must be given Ca and P supplementation for obtaining good animal production.

Rumen fermentation pattern

The values of pH, TVFA, NH_3-N, total-N and TCA ppt-N were significantly ($p<0.01/p<0.05$) higher in group 3. However, TCA soluble-N was similar ($p>0.05$) in all the 3 groups. It indicated that the rumen fermentation was more appropriate in group 3, where animals were fed 48.5% lentil chuni and 48.5% wheat bran (supplementation of both protein and energy source). These results are in agreement to the earlier findings of Aroreira et al. (1993) and Gonzalez and Munoz (1997) who fed SCT supplemented with urea and cotton seed/rice meal.

CONCLUSION

From the results, it may be deduced that the feeding of *ad libitum* chopped green SCT supplemented with a concentrate mixture having both wheat bran (48.5%) and lentil chuni (48.5%) has shown a good performance with respect to intake and digestibility of nutrients and growth as well.

ACKNOWLEDGEMENT

The authors are thankful to the NATP for providing a financial assistance for carrying out the present study.

REFERENCES

Anonymous. 1999. Indian Sugar Mill Association, New Delhi.

AOAC. 1995. Animal feeds : In official methods of analysis of AOAC international, Vol. I, (16th edn). Edited by Patricia Cunniff. Virginia 22201-3301, USA.

Aroreira, L., J. M., F. C. F. Lopes, M. D. S. Dayrell, R. S. Lizieire and M. P. Torres. 1995. Digestibility, degradability and gastrointestinal transit time of sugarcane and urea based diets and of cotton seed meal in dutch and zebu dairy cow. Revista da Sociedade Brasileira de Zootecnia, 24:1016-1026.

Barnett, A. J. G. and R. L. Reid. 1956. Studies on the production of volatile fatty acids from grass by rumen liquor in an artificial rumen. I. The volatile fatty acid production. J. Agric. Sci. 48:315-318.

Chaudhary, K. C., K. C. Sharma, S. P. Ahuja and I. S. Bhatia. 1972. A note on the *in vitro* utilization of sugarcane (Sacchacrum officinarum) tops compared with other fodders for cattle. Indian J. Anim. Sci. 42:671-673.

Dhakad, A., A. K. Garg and P. Singh. 2001. Performance of growing lambs fed on low grain /grainless diets. Small Rumin. Res.(accepted).

Ferreiro, H. M. and T. R. Preston. 1976. Fattening cattle with sugarcane : The effect of different proportion of stalk and tops. Trop. Anim. Prod. 1:31-38.

Garg, A. K., P. Singh and D. K. Agrawal. 2000. NATP Annual Report, Animal Nutrition Division, Indian Veterinary Research Institute, Izatnagar-342 122, India.

Gendley, M. K., P. Singh and A. K. Garg. 2001. Performance of crossbred cattle fed solely on chopped green sugarcane tops and supplemented with concentrate mixture or urea molasses liquid diet. Anim. Feed Sci. Technol. (submitted).

Godoy, R. and R. Elliott. 1981. Effect of tropical forage on rumen function and flow of nutrients to the proximal duodenum in cattle fed a molasses urea diet. Trop. Anim. Prod. 6:159-166.

Gonzalez, R. and E. Munoz. 1997. Nitrogen supplementation in certain ruminal indicators of sugarcane diets. Cuban. J. Agric. Sci. 31:265-268.

Joshi, A. L., D. V. Rangnekar, M. Singh, S. S. Kundu, S. R. Ambekar and A. V. Bendigeri. 1995. Sugarcane tops. Feeeding of ruminants on fibrous crop residues, ICAR, New Delhi.

Kevelenge, J. E. E., A. N. Said and B. Kiflewahid. 1983. The nutritive value of four area farm byproducts commonly fed to daily cattle by small scale farmes in Kenya. The utilization of nutrients by wether sheep. Trop. Anim. Prod. 8:171-179.

Kutty, K. P. A. and D. A. Prasad. 1980. Studies on improving nutritive value of sugarcane tops with urea or dried poultry waste by ensiling technique. Indian J. Anim. Sci. 50:189-193.

Mathur, M. L. and B. N. Gupta. 1971. Review of research work carried out in animal nutrition from 1995 to 1971, Eastern Regional Station, N.D.R.I., (I.C.A.R.) Kalyani (Nadia), p. 248.

Montpellier, F. A. and T. R. Preston. 1977. Digestibility of tops, rind, derinded stalk and the entire plant of sugarcane. Trop. Anim. Prod. 2:13-17.

NRC 1989. Nutrient requirements of dairy cattle. National Research Council. (6th revised ed.) National Academy Press, Washington, DC.

Patil, N. V., V. B. Kharadi, P. M. Desai and B. M. Desai. 1999. Comparitive nutritional value of fresh and sundried sugarcane tops in buffalo calves. Indian J. Anim. Nutr., 16:259-266.

Pradhan, K. 1976. Chemical composition and *in vitro* nutrient digestibility (in percent of dry matter) of straws/stovers. In: Review of Animal Nutrition Research (1970-1975). H.A.U. Hissar, 1:16.

Rane, A. S., M. K. Mehta, R. K. Jain and M. U. Bhaid. 1988. Note on proximate constituents of common agro-industrial by products of Malwa regoin of Madhya Pradesh. Ind. Vet. J. 65: 441-444.

Schneider, B. H. and W. P. Flatt. 1975. Evaluation of Feeds Through Digestibility Experiments. The University of Georgia Press, Athens, pp. 57-78.

Sen, K.C., S. N. Ray and S. K. Ranjhan. 1978. Nutritive value of Indian cattle feeds and the feeding of Animals. ICAR, New Delhi.

Snedecor, G. W. and W. G. Cochran. 1968. Statistical methods (6th edn.). Oxford and IBH Publising Co., Bombay.

Sniffen, C. J. 1988. Proceedings of Application of Nutrition in Dairy Practice, American Cyanamide Co., Wayne, New Zealand.

Talpatra, S. K., S. C. Roy and K. C. Sen. 1940. Estimation of phosphorus, chlorine, calcium, magesium, sodium and potassium in feeding stuff. Indian J. Vet. Sci. Anim. Husb., 10:243-258.

Van Soest, P. J., J. B. Robertson and B. S. Lewis. 1991. Methods for dietary fibre, neutral detergent fibre and non-starch polysacharides in relation to animal nutrition. J. Dairy Sci. 74: 3583-3597.

1430