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# Nutritional evaluation of sugarcane (*Saccharum officinarum*) trash as dry fodder source for cattle

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ABSTRACT

The present experiment was conducted in two phases. In the first phase, sugarcane (*Saccharum officinarum*) trash (ST), rice (*Oryza sativa*) straw (RS) and finger millet (*Eleusine corocana*) straw (FMS), and their respective diets comprising 70% dry ST, 20% paragrass (*Brachiara mutica*) and 10% concentrate mixture were evaluated by *in vitro* gas production techique (IVGPT). The gas production, DMD and OMD were less in ST followed by RS and FMS. Significantly lower acetate, propionate, butyrate, total volatile fatty acids and A:P was recorded in ST followed by RS and FMS. Similar trend was noticed in case of total mixed rations (TMR). In the second phase, ST based total mixed ration was evaluated against conventional FMS based ration. Crossbred cattle (10; average BW 318±19 kg) were divided into 2 groups. Group I was offered TMR comprising 70% FMS whereas in group II, FMS was replaced by ST. The digestibility of DM, OM and NFE was lower in cattle fed ST as compared to FMS. Digestible CP of the diets remained same in both groups, however, TDN value was more in case of FMS based TMR. Ca, P, Zn absorption was found to be similar in both the groups. However, Mg and Cu absorption was more in ST based TMR. We can conclude that overall nutritive value of ST was lower than FMS, hence, ST is recommended for feeding as an alternate dry fodder under scarcity situations.

**Key words**: Cattle, Digestibility, Fodder, Mineral absorption, Sugarcane dry trash

One of the important sugarcane residues is the leaves, which are usually left in agricultural fields during sugarcane harvesting. The dried leaves, called sugarcane trash (ST), are produced in abundance and left in the field. Sometimes, leaves are burnt in the fields, which produce fly ash which severely damages soil microbial diversity, and raise environmental concerns (Suma and Savitha 2015). Forages like ST are generally adequate in meeting requirements for sub-maintenance levels of ruminant livestock as there is generally a decrease in N content and its digestibility, due to increase in fibre and lignin contents (Arthington and Brown 2005). Post-harvest sugarcane residues (SCR) including sugarcane tops, dry and green leaves and cane bits, are widely used by farmers in sugarcane producing countries (Naseevan 1988). It is an important forage resource for ruminants during the dry season in tropical countries. Silage making is difficult because of low soluble carbohydrate content and the bulkiness necessitates chopping and, therefore, silage making would be too expensive for farmers. In India, about 7–10 million tonnes of dry ST is expected to be available at the time of harvest. Due to non-availability of labour, farmers often leave the ST in the field after harvest of sugarcane and sometimes burn to prepare the land for the next crop. Keeping in the view the potential availability of ST, an experiment was conducted in two phases to evaluate the ST based total mixed ration replacing conventional FMS for male adult crossbred cattle.

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## MATERIALS AND METHODS

The study was conducted in two phases. In the first phase, ST and their respective diets were subjected to *in vitro* evaluation along with RS and FMS. Two important cereal straws predominant in this region, viz. FMS and RS were taken as control dry fodder sources while, ST was taken as experimental fodder source. Three dry fodders and their total mixed rations (dry fodder 70%; para grass (*Brachiara mutica*) 20%; concentrate mixture (crushed maize grain (*Zea mays*) 35%; groundnut (*Arachis hypogea*) cake 32%; rice (*Oryza sativa*) bran 15%; wheat (*Triticum aestivum*) bran 15%; mineral mixture 2% and common salt 1%) were subjected to *in vitro* gas production test (IVGPT) as described by Menke and Steingass (1988). In the second phase, ST based diet was compared with FMS in terms of nutritive value and rumen fermentation pattern so as to suggest its usage as dry fodder source as a part of total mixed ration.

Two respective TMRs [FMS based (Group I) and ST based (Group II)] were offered @ 2% of the BW to 10 male dairy cattle two groups (n=5) to support maintenance requirements of cattle (ICAR 2013). The chaffed ST was included as sole roughage source at 70% (DM) of diet replacing FMS. After a preliminary period of 21 days, a digestion trial of 6 days duration was conducted. During the 6 days period, intake of feed and total faecal matter voided by each animal was recorded. In the morning (9:00 h), the faeces were mixed thoroughly and aliquots were taken for dry matter (1/100) and nitrogen (1/500). After the digestion trial, rumen liquor were collected twice on 3 consecutive days (pre-feeding and post-feeding) to study the effect on biochemical metabolites and protozoa populations.

Twenty four hour gas production (ml) was recorded and contents quantitatively transferred and refluxed with 100 ml of double strength neutral detergent solution (assayed without heat-stable amylase and expressed inclusive of residual ash) for 60 min for finding out true dry matter digestibility (Van Soest *et al.* 1991). The finely ground samples of feed, feed residue and faeces were analyzed for CP, total ash (AOAC 2010), NDF and ADF (Van Soest *et al.* 1991). Minerals such as Ca, P, Mg, Cu and Zn were estimated by ICP-OES. The 0 and 6 h post-feeding rumen liquor samples were analysed for pH after straining through 4 layered muslin cloth. The ammonia nitrogen ($NH_3$-N) was estimated in the collected rumen liquor samples (Park *et al.* 2009, Rao and Soren 2015). Individual fatty acids such as acetate, propionate and butyrate in incubation medium and rumen liquor samples were estimated using gas chromatograph (Agilent-7890 A) equipped with flame ionization detector (FID) and column (Agilent J&W DB-WAX GC Column 40 m × 0.18 mm × 0.30 µm). The rumen ciliates were identified according to Hungate (1966). The protozoa numbers were calculated as described by Kamra *et al.* (1991).

Data obtained on various parameters were subjected to one way analysis of variance (Snedecor and Cochran 1994). The statistical software SPSS version 21.0 (SPSS Inc., Chicago, IL, USA) was used for analysis of data and analysis of variance assuming for independent constant variance structure with post-hoc Duncan test to find the pair wise significance between treatments. Results were expressed as mean±SE. A P-value of less than or equal to 0.05 was accepted to indicate statistical significance.

## RESULTS AND DISCUSSION

*Chemical composition of ingredients:* The CP (%) in the dry fodder/straw ranged from 3.54 to 4.53 whereas EE (%) varied from 1.04 to 1.49. All the 3 dry fodder/straw used in the study had almost similar nutrient profiles in terms of crude fibre, NDF, ADF and hemicellulose. However, ST contained lower Ca, P, Zn and Cu and higher Mg compared to FMS (Table 1). The values of CP, NDF, ADF and IVDMD in ST in present study are similar to those reported earlier (Hasoun *et al.* 2002). The CP values of 28 cloned varieties of ST ranged from 1.50 to 5.43% in 3$^{rd}$ cut. Higher CP of ST is due to heavy application of nitrogenous fertilizers (Sharma *et al.* 2012).

*Total gas production, digestibility and fermentation metabolites:* Under *in vitro* conditions, ST and its diet

Table 1. Chemical composition of ingredients (% DM)

| Parameter | FMS | RS | ST | Para grass | Concentrate mixture |
|---|---|---|---|---|---|
| Organic matter | 92.12 | 84.76 | 93.40 | 92.39 | 83.78 |
| Crude protein | 3.65 | 4.53 | 3.54 | 2.92 | 20.89 |
| Ether extract | 1.39 | 1.04 | 1.49 | 1.40 | 2.41 |
| Crude fibre | 30.71 | 33.56 | 32.34 | 35.43 | 6.37 |
| NDF | 75.54 | 74.15 | 79.49 | 77.13 | 40.75 |
| ADF | 45.21 | 51.29 | 52.57 | 50.34 | 20.48 |
| Hemicellulose | 30.33 | 22.86 | 26.92 | 26.79 | 20.27 |
| *Mineral composition* | | | | | |
| Calcium (%) | 1.15 | – | 0.66 | 0.42 | 0.87 |
| Phosphorus (%) | 0.28 | – | 0.10 | 0.26 | 1.27 |
| Magnesium (%) | 0.17 | – | 0.28 | 0.52 | 0.66 |
| Zinc (ppm) | 23.47 | – | 10.15 | 20.22 | 405 |
| Copper (ppm) | 5.07 | – | 3.98 | 4.98 | 38.74 |

FMS, Finger millet straw; RS, rice straw; ST, sugarcane trash.

Table 2. Total gas production, digestibility, fermentation metabolites incubated with ST, FMS and RS alone or in total mixed rations

| Treatment | Total gas (ml/200 mg of substrate in 24 h) | IVDMD | TVFA (mM/litre) | Acetate (mM/litre) | Propionate (mM/litre) | Butyrate (mM/litre) | Acetate to Propionate ratio (A:P) |
|---|---|---|---|---|---|---|---|
| FMS | $11.12^{c}$±0.43 | $46.55^{c}$±0.58 | $37.95^{bc}$±1.36 | $22.97^{b}$±0.91 | $12.09^{bc}$±0.66 | $2.89^{c}$±0.11 | $1.91^{b}$±0.09 |
| RS | $7.91^{b}$±0.43 | $43.95^{bc}$±1.52 | $34.32^{b}$±4.03 | $21.83^{b}$±2.48 | $10.32^{b}$±1.30 | $2.16^{b}$±0.25 | $2.13^{c}$±0.03 |
| ST | $5.41^{a}$±0.88 | $34.88^{a}$±0.94 | $26.75^{a}$±1.04 | $17.48^{a}$±0.64 | $7.58^{a}$±0.34 | $1.69^{a}$±0.07 | $2.31^{d}$±0.04 |
| FMS TMR | $14.56^{d}$±0.25 | $52.72^{d}$±1.00 | $49.34^{e}$±0.74 | $28.84^{d}$±0.41 | $17.07^{d}$±0.30 | $3.44^{d}$±0.06 | $1.69^{a}$±0.02 |
| RS TMR | $12.72^{c}$±1.01 | $47.58^{c}$±1.40 | $45.49^{de}$±1.04 | $27.09^{cd}$±0.60 | $15.49^{d}$±0.38 | $2.91^{c}$±0.06 | $1.75^{a}$±0.01 |
| ST TMR | $8.52^{b}$±0.24 | $39.99^{b}$±2.67 | $40.41^{cd}$±0.52 | $24.89^{bc}$±0.22 | $12.81^{c}$±0.27 | $2.71^{c}$±0.05 | $1.94^{b}$±0.02 |
| Significance | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |

FMS, Finger millet straw; RS, rice straw; ST, sugarcane trash; FMS TMR, finger millet straw based total mixed ration; RS TMR, rice straw based total mixed ration; ST TMR, sugarcane trash based total mixed ration.

resulted in lower (P<0.01) gas production, DMD, OMD, total volatile fatty acids and individual fatty acids in terms of acetate, propionate, butyrate (mM/liter) compared to RS followed by FMS. The acetate to propionate ratio (A:P) ranged from 1.91 to 2.31 in different straws and 1.69 to 1.94 in TMR of different straws being wider in ST and its TMR (Table 2). Similar to our study, Singh *et al.* (2012) obtained IVDMD of 35.3% in case of Sugarcane tops. Suzuki *et al.* (2010) evaluated 2 varieties of sugarcane at different growth stages in subtropical Japan as alternate to sugarcane tops and oaten hay. The variety developed for cattle feed can be harvested early compared to the traditional variety due to faster rate of reduction of effective degradability of neutral detergent fibre with advancing maturity.

*Plane of nutrition, nutrient digestibility and nutritive value:* Intake of ST was similar compared to FMS (4.21 versus 4.51 kg per day). Total tract digestibility of DM and OM was lower (P<0.01) in ST based TMR compared to FMS based TMR. In case of CP, CF and EE digestibility, both the TMR groups had shown similar values (P>0.05). Digestible CP of the diets was similar in both groups, however, TDN value was more (P>0.05) in case of FMS based diet (Table 3). The Ca, P, Zn absorption was similar (P<0.05) in both the groups. However, Mg and Zn absorption was more (P<0.05) in ST based TMR. Around 3.5–3.7 kg/day DMI was recorded when ST was offered *ad lib.* for heifers (Hasoun *et al.* 2002). However, lower values were reported (1.36 – 2.72 kg/day) in buffalo calves of 6–8 months age. The reason could be the age of animals. Comparatively lower digestibility of DM, OM was observed in present study while Sharma *et al.* (2012) reported higher digestibility of DM, OM in buffalo calves fed 80% SCT along with 20% concentrate or mustard cake. Probably our experimental animals were quite old which resulted in lower digestibility. Series of experiments were conducted by Ortiz-Rubio *et al.* (2007) for maximizing the intake of sugarcane tops in Zebu cattle using different sources of nitrogen and/or energy supplements. Poultry manure as nitrogen source increased intake of ST whereas Taiwan grass had a substitution effect.

*Rumen fermentation pattern:* No significant differences were observed (P>0.05) in pH and ammonia-nitrogen between FMS and ST based diets. Propionate and total volatile fatty concentrations were more (P<0.05) in FMS based diets compared to ST based diets without effects on acetate and butyrate concentrations. The protozoan populations in terms of holotrichs and spirotrichs were also similar (P>0.05) in both the diets (Table 4). Ortiz-Rubio *et*

Table 3. Plane of nutrition, nutrient digestibility and nutritive value in crossbred cattle fed TMR with ST and FMS

| Parameter | Group I (FMS) | Group II (ST) | Significance |
|---|---|---|---|
| Average BW (kg) | 310±19 | 327±13 | 0.49 |
| *Dry fodder (DM) intake* | | | |
| kg/day | 4.21±0.16 | 4.51±0.20 | 0.29 |
| % BW | 1.38±0.11 | 1.38±0.11 | 0.96 |
| *Nutrient digestibility (%)* | | | |
| DM | 58.03±0.38 | 51.71±0.66 | 0.01 |
| CP | 69.92±2.44 | 66.46±1.08 | 0.84 |
| CF | 62.78±1.52 | 60.59±0.94 | 0.26 |
| OM | 60.32±0.32 | 54.28±0.68 | 0.01 |
| EE | 63.84±3.14 | 52.64±4.89 | 0.09 |
| *Plane of nutrition (%)* | | | |
| DCP of TMR | 3.68±0.13 | 3.49±0.06 | 0.20 |
| TDN of TMR | 57.27±0.30 | 54.45±0.78 | 0.07 |
| *Mineral absorption in gut* | | | |
| Calcium | 20.92±1.13 | 29.74±4.34 | 0.09 |
| Phosphorus | 31.84±0.77 | 36.20±4.89 | 0.41 |
| Magnesium | 14.96±3.12 | 51.35±1.92 | 0.01 |
| Zinc | 36.47±6.12 | 41.54±3.93 | 0.51 |
| Copper | 21.08±4.74 | 42.35±4.89 | 0.01 |

FMS, Finger millet straw; ST, sugarcane trash.

Table 4. Rumen fermentation pattern of crossbred steers receiving FMS and ST based diets

| Parameter | FMS | | ST diet | | Main effect | | T × P |
|---|---|---|---|---|---|---|---|
| | Before feeding | Post feeding | Before feeding | Post feeding | Treatment (T) | Period (P) | |
| *Rumen metabolites* | | | | | | | |
| pH | 6.86±0.03 | 6.70±0.03 | 6.92±0.04 | 6.71±0.04 | 0.35 | 0.01 | 0.55 |
| Ammonia nitrogen (mg/100 SRL) | 7.19±0.38 | 8.88±0.57 | 7.26±0.60 | 9.66±0.62 | 0.45 | 0.01 | 0.53 |
| Total volatile fatty acids (mmol/lit of SRL) | | | | | | | |
| Acetate | 84.57±3.70 | 95.16±2.83 | 73.35±4.07 | 82.82±4.71 | 0.07 | 0.02 | 0.89 |
| Propionate | 24.90±1.02 | 29.57±1.96 | 18.68±3.50 | 23.44±3.15 | 0.03 | 0.09 | 0.99 |
| Butyrate | 4.28±0.33 | 4.39±0.97 | 4.87±0.65 | 4.65±0.37 | 0.51 | 0.94 | 0.80 |
| Total | 113.75±4.80 | 129.13±5.42 | 96.89±7.42 | 110.91±7.45 | 0.01 | 0.03 | 0.92 |
| *Rumen Protozoa (×$10^5$/ml SRL)* | | | | | | | |
| Holotrichs | 0.21±0.04 | 0.25±0.03 | 0.41±0.18 | 0.70±0.27 | 0.06 | 0.33 | 0.47 |
| Spirotrichs | 2.19±0.41 | 2.74±0.38 | 2.49±0.55 | 2.66±0.89 | 0.66 | 0.77 | 0.98 |
| Total | 2.40±0.44 | 2.99±0.39 | 2.90±0.67 | 3.36±0.99 | 0.53 | 0.42 | 0.95 |

FMS, Finger millet straw; ST, sugarcane trash.

*al.* (2007) observed increase in rumen ammonia nitrogen due to addition of nitrogen source to ST based diets in Zebu cattle. They further recommended supplying 100 g poultry manure/kg DM, 8 g urea/kg DM or 500 g/d of high nitrogen/energy supplement to satisfy the needs of rumen micro organisms for fermentable nitrogen in ST diets. Thus, supplementation strategies need to be devised carefully whenever poor quality roughages are fed in large proportion of dry matter intake.

The nutritive value in terms of total gas production, *in vitro* dry matter digestibility of ST was lower than the FMS and RS. However, it can be incorporated in the total mixed rations by mixing with concentrate ingredients and seasonal green fodder for maximizing intake.

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