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# IN VITRO EVALUATION OF SUGARCANE BY-PRODUCT BASED COMPLETE RATIONS*

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**ABSTRACT**

Forty two different complete rations were formulated by using the sugarcane by-products and other crop residues and evaluated through *in vitro* studies to select best combinations for preparation of complete rations for growth and milk production in buffaloes. Three graded Murrah buffalo bulls fitted with permanent rumen cannulae were used for *in vitro* evaluation of experimental rations. The average body weight of the buffalo bulls was 250 ± 1.0 kg. The fistulated buffalo bulls were maintained on a feeding regimen comprising of roughage and concentrate at 70:30 ratio. These animals were offered 2 kg of non-leguminous green fodder (Hybrid Napier) and concentrate mixture daily at 8.00 am and 1.00 pm, while sugarcane bagasse was offered throughout the day these complete rations were evaluated for *In vitro* Dry Matter Digestibility (IVDMD) %. These complete rations containing 20 per cent sugarcane trash, sorghum straw, paddy straw, urea treated sugarcane trash, pillipesara hay or sunhemp hay along with 40 per cent each of sugarcane tops and concentrate component. The average IVDMD (%) of sugarcane by-product based complete ration was 54.14 ± 4.73 (Table 7.)

**Key words:** Complete rations, *In vitro*, sugarcane by-products

India stands 2nd in sugarcane production in the world next to Brazil with an annual production of 265 million tons. The most important by-products of sugarcane farming are sugarcane tops and sugarcane trash, whereas sugarcane industry by-products are sugarcane bagasse, molasses, sugarcane sludge and press mud. Hence there is a possibility of utilizing the by-products of sugarcane farming and industry through livestock feeding systems to minimizing fodder shortage to livestock.

There was a gap between availability and requirements of the feedstuffs for enhance productivity of livestock and to narrow down this gap the unconventional feedstuffs like crop residues and agro-based industrial by-products, which are available in large quantities are being recommended by several research workers earlier.[4,5,6,7,9 & 11] To narrow down the gap of nutrients available and required, there is a need

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to develop technologies and explore possibilities of utilizing crop residues and agro-industrial by-products, which are not being used extensively so far for the purpose. Due to low nitrogen and high fibre content in the crop residues and also presence of toxins and anti- nutritional factors of these by-products, inclusion such new by-products in livestock feeding system has to be thoroughly investigated and evaluated for safer feeding to livestock. An attempt has been made through *in vitro* evaluation of sugarcane by-products based complete rations and the details of the research findings are furnished hereunder.

## MATERIALS AND METHODS

Forty two complete rations were formulated by using sugarcane tops and untreated and urea treated sugarcane trash (treated with 4% urea and 40% moisture for 21 days) and other crop residues like maize stover, jowar straw, paddy straw, and sun hemp hay, together with oil meals and concentrate ingredients.(Table 1-6) These complete rations were subjected to *in vitro* evaluation to determine the best combination of complete diets to test their suitability for growth and lactation in buffaloes.[10]

Three fistulated graded Murrah buffalo bulls were used for *in vitro* evaluation of experimental rations. The average body weight of these buffalo bulls were 250 ± 1.0 kg. The nutrient requirements of the experimental bulls were calculated as per recommendations.[1] The experimental animals were housed in individual stalls having facilities for feeding and watering. The fistulated buffalo bulls were maintained on a feeding regimen comprising of roughage and concentrate at 70:30 ratio. These animals were offered 2 kg of non-leguminous green fodder ( *Pennisetum purpureum* ) and concentrate mixture daily at 8.00 am and 1.00 pm, while sugarcane bagasse was offered throughout the day. Fresh drinking water was also provided throughout experimental period. Rumen liquor was collected from the rumen of cannulated Murrah buffalo bulls, which were maintained on a standard ration. Rumen liquor was collected at 8.00 am before offering feed and water. Sampling was done by drawing rumen contents from different portion of the rumen and filtering through a four-layered muslin cloth. The collected rumen liquor was transferred to a flask flushed with $CO_2$ and maintained at 37 to 39° C in an insulated jug. All the forty two complete rations were evaluated by using above technique.

### Method followed for In vitro work

Uniformly ground samples of 0.5 g each were taken into 100 ml centrifuge tubes fitted with rubber stoppers having Bunsen valve. To each tube 40 ml of Mc Doughals buffer solution was added followed by 10 ml of strained Rumen Liquor (SRL). Tubes designated, as reagent blanks were also included to which only nutrient buffer solution and rumen liquor was added as control. Carbon dioxide was flushed into the tubes for 10 seconds and the tubes were immediately stoppered and incubated at 39°C for 84 Hours. These tubes were swirled gently during incubation at 6 hours intervals to resuspend the substrate.

After 48 h of incubation, these tubes were centrifuged at 3000 rpm for 15 minutes. The supernatant fluid was discarded and 50 ml of freshly prepared pepsin solution was added to the residue in each tube and the tubes were incubated for 36 Hrs. At the end of incubation, these tubes were centrifuged and the residue was transferred to a crucible with minimum of water. Crucible and the residues were dried at 100°C and the weights were recorded. The percent IVDMD was calculated using the following formula.

$$\text{IVDMD (\%)} = \frac{\text{Sample dry matter-(undigested dry matter-dry matter of blank)}}{\text{Sample dry matter}} \times 100$$

## RESULTS AND DISCUSSION

The IVDMD values ranged from 63.40 ± 1.57 to 72.96 ± 5.10 per cent in complete rations ($CR_1$-$CR_7$) composed with different levels of sugarcane tops with sugarcane trash and balanced concentrate mixture. The IVDMD for complete rations ($CR_8$ – $CR_{14}$) prepared with different levels of maize stover with sugarcane tops and balanced concentrate mixture ranged from 25.17 ± 3.71 to 56.61 ± 2.05 per cent. The IVDMD values in complete rations ($CR_{15}$ – $CR_{21}$) composed with different levels of jowar straw with sugarcane tops and balanced concentrate mixture varied from 68.01 ± 0.16 to 74.17±1.15 per cent. For complete rations ($CR_{-22}$ - $CR_{-28}$) composed with different levels of paddy straw with sugarcane tops and balanced concentrate mixture the IVDMD values ranged from 37.05 ± 3.51 to 45.51 ± 3.32 per cent. For complete rations ($CR_{-29}$ - $CR_{-35}$) composed with different levels of urea treated sugarcane trash with sugarcane tops and balanced concentrate mixture ranged from 53.76 ± 1.82 to 62.36 ± 0.36 per cent. For complete rations ($CR_{-36}$ - $CR_{-42}$) composed with different levels of sunhemp hay with sugarcane tops and balanced concentrate mixture the IVDMD ranged from 43.33 ± 1.22 to 65.91 ± 2.83 per cent. Higher ($P<0.05$) IVDMD (%) was observed in complete rations $CR_3$ (sugarcane tops, sugarcane trash and balanced concentrate mixture), $CR_{11}$(sugarcane tops, maize stover and balanced concentrate mixture),$CR_{-17}$(sugarcane tops, jowar straw and balanced concentrate mixture), $CR_{24}$ (sugarcane tops, paddy straw and balanced concentrate mixture) , $CR_{-32}$ (sugarcane tops, urea treated sugarcane trash and balanced concentrate mixture) for lactating buffaloes and $CR_{38}$ (sugarcane tops, sun hemp hay and balanced concentrate mixture) which are suitable for feeding of growing bull calves and lactating buffaloes. The selected complete rations were designated as CR-I, CR-II, CR-III, CR-IV, CR-V and CR-VI, respectively. However, the results reported lower values of IVDMD for sugarcane trash based complete rations when compared to present study[2] and this might be due to optimum availability of Nitrogen to energy for the bacteria to show better digestibility coefficient. *In vitro* DM digestibility were showed a decreasing trend as the level of crop residue level increased, which might be due to higher lignin content of the crop residues.

The IVDMD (%) of complete rations containing either 20% of sugarcane trash / jowar straw / paddy straw / sunhemp hay along with 40% of sugarcane tops or 30% level of maize stover or urea treated sugarcane trash along with 30% level of sugarcane tops and concentrate component were 64.22 ± 0.68, 40.05±7.20, 68.01±0.16, 45.51±3.321, 62.23±0.27 and 59.81±2.38 optimum. Hence the selection of complete rations based on % IVDMD values with maximum quantity of roughage portion with optimum digestibility of that rations were taken in to consideration. The average IVDMD (%) of sugarcane by-product based complete ration was 54.14±4.73 (Table 7).Similar results reported for IVDMD values in PPF based complete rations.[1] However, results reported lower values for sugarcane trash based complete rations when compared to present study with regards to IVDMD.[3] In vitro DM digestibility followed a decreasing trend as the level of crop residue increased, which might be due to higher lignin content.

Table 1: Per cent ingredient composition of complete rations formulated with sugarcane tops, *Sugarcane trash* and balanced concentrate mixture ($CR_{-1}$ - $CR_{-7}$) for *in vitro* evaluation

| Name of ingredient | *Experimental complete rations* | | | | | | |
|---|---|---|---|---|---|---|---|
| **Roughages** | ***CR –1*** | **CR –2** | **CR- 3** | **CR- 4** | **CR - 5** | **CR -6** | **CR -7** |
| Sugarcane tops | 60 | 50 | 40 | 30 | 20 | 10 | 0 |
| **Sugarcane trash** | **0** | **10** | **20** | **30** | **40** | **50** | **60** |
| Balanced Conc. Mixture | | | | | | | |
| Maize | 5.8 | 5.8 | 5.0 | 5.8 | 5.8 | 5.8 | 5.8 |
| Groundnut cake | 16.0 | 17.0 | 16.8 | 18.0 | 18.0 | 18.5 | 18.5 |
| Sunflower cake | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Black gram chunni | 12.0 | 11.0 | 9.0 | 10.0 | 10.0 | 9.5 | 9.5 |
| Mineral mixture | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Salt | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 2 : Per cent ingredient composition of complete rations formulated with sugarcane tops, *Maize Stover* and balanced concentrate mixture ($CR_{-8}$ - $CR_{-14}$) for *in vitro* evaluation

| *Name of ingredient* | Experimental complete rations | | | | | | |
|---|---|---|---|---|---|---|---|
| **Roughages** | **CR- 8** | *CR - 9* | **CR -10** | **CR-11** | **CR –12** | **CR –13** | **CR- 14** |
| Sugarcane tops | 60 | 50 | 40 | 30 | 20 | 10 | 0 |
| **Maize Stover** | **0** | **10** | **20** | **30** | **40** | **50** | **60** |
| Balanced Conc. Mixture | | | | | | | |
| Maize | 5.8 | 4.8 | 8.8 | 5.8 | 5.8 | 5.8 | 5.8 |
| Gingly cake | 6.0 | 7.0 | 7.0 | 8.0 | 9.0 | 8.0 | 9.0 |
| Groundnut cake | 10.0 | 8.0 | 9.0 | 8.0 | 7.0 | 8.0 | 7.0 |
| Black gram chunni | 17.0 | 19.0 | 17.0 | 17.0 | 17.0 | 17.0 | 17.0 |
| Mineral mixture. | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Salt | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 3 : Per cent ingredient composition of complete rations formulated with sugarcane tops, *Jowar straw* and balanced concentrate mixture ($CR_{-15}$ - $CR_{-21}$) for i*n vitro* evaluation

| Name of ingredient | *Experimental complete rations* | | | | | | |
|---|---|---|---|---|---|---|---|
| **Roughages** | **CR- 15** | **CR - 16** | **CR -17** | **CR -18** | **CR- 19** | ***CR - 20*** | **CR -21** |
| Sugarcane tops | 60 | 50 | 40 | 30 | 20 | 10 | 0 |
| **Jowar straw** | **0** | **10** | **20** | **30** | **40** | **50** | **60** |
| Balanced Conc. Mixture | | | | | | | |
| Maize | 8.8 | 8.8 | 9.8 | 9.8 | 10.8 | 10.8 | 11.8 |
| Gingly cake | 6.0 | 5.0 | 4.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Groundnut cake | 12.0 | 13.0 | 14.0 | 15.0 | 14.0 | 13.0 | 13.0 |
| Black gram chunni | 12.0 | 12.0 | 11.0 | 11.0 | 11.0 | 12.0 | 11.0 |
| Mineral mixture. | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Salt | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 4 : Per cent ingredient composition of complete rations formulated with sugarcane tops, *Paddy straw* and balanced concentrate mixture ($CR_{-22}$ - $CR_{-28}$) for *in vitro* evaluation

| Name of ingredient | Experimental complete rations | | | | | | |
|---|---|---|---|---|---|---|---|
| Roughages | CR-22 | CR –23 | CR –24 | CR- 25 | *CR- 26* | CR - 27 | *CR -28* |
| Sugarcane tops | 60 | 50 | 40 | 30 | 20 | 10 | 0 |
| **Paddy straw** | **0** | **10** | **20** | **30** | **40** | **50** | **60** |
| Balanced Conc. Mixture | | | | | | | |
| Bajra | 5.8 | 5.8 | 5.8 | 5.8 | 5.8 | 5.8 | 5.8 |
| Gingly cake | 8.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Sunflower cake | 10.0 | 11.0 | 10.0 | 10.0 | 10.0 | 9.5 | 9.0 |
| Green gram Chunni | 15.0 | 15.0 | 16.0 | 16.0 | 16.0 | 16.5 | 17.0 |
| Mineral mixture. | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Salt | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 5 : Per cent ingredient composition of complete rations formulated with sugarcane tops, *urea treated sugarcane trash* and balanced concentrate mixture ($CR_{-29}$ - $CR_{-35}$) for *in vitro* evaluation.

| Name of ingredient | *Experimental complete rations* | | | | | | |
|---|---|---|---|---|---|---|---|
| Roughages | CR -29 | CR- 30 | CR -31 | CR –32 | CR-33 | CR –34 | CR –35 |
| Sugarcane tops | 60 | 50 | 40 | 30 | 20 | 10 | 0 |
| **Sugarcane Trash (Urea treated)** | **0** | **10** | **20** | **30** | **40** | **50** | **60** |
| Balanced Conc. Mixture | | | | | | | |
| Maize | 5.8 | 5.8 | 7.8 | 7.8 | 12.8 | - | - |
| Bajra | - | - | - | - | - | 16.8 | 26.8 |
| Gingly cake | 12.0 | 8.0 | 5.0 | 2.0 | - | - | - |
| Cottonseed cake | 10.0 | 10.0 | 11.0 | 14.0 | 11.0 | 8.0 | - |
| Sunflower cake | - | - | - | - | - | 14.0 | 12.0 |
| Black gram chunni | 10.0 | 15.0 | 15.0 | 15.0 | 15.0 | - | - |
| Mineral mixture. | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Salt | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 6: Percent ingredient composition of complete rations formulated with sugarcane tops, *Sun hemp hay* and balanced concentrate mixture ($CR_{36}$ - $CR_{42}$) for *in vitro* evaluation

| Name of ingredient | *Experimental complete rations* | | | | | | |
|---|---|---|---|---|---|---|---|
| **Roughages** | **CR- 36** | **CR- 37** | **CR - 38** | **CR -39** | **CR -40** | **CR- 41** | **CR-42** |
| Sugarcane tops | 60 | 50 | 40 | 30 | 20 | 10 | 0 |
| **Sun hemp hay** | **0** | **10** | **20** | **30** | **40** | **50** | **60** |
| Balanced Conc. Mixture | | | | | | | |
| Maize | 5.8 | 5.8 | 5.8 | 6.8 | 5.8 | 5.8 | 5.8 |
| Gingly cake | 9.0 | 9.5 | 8.5 | 8.0 | 8.5 | 8.0 | 6.5 |
| Groundnut cake | 7.5 | 7.0 | 8.0 | 8.0 | 7.5 | 8.0 | 9.5 |
| Cowpea chunni | 16.5 | 16.5 | 16.5 | 16.0 | 17.0 | 17.0 | 17.0 |
| Mineral mixture. | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| Salt | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 |
| | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

Table 7: IVDMD (%) of sugarcane by-product based complete rations

| *complete ration* | *Ratio of sugarcane tops and other crop residue* | | | | | | |
|---|---|---|---|---|---|---|---|
| | 60:0 | 50:10 | 40:20 | 30:30 | 20:40 | 10:50 | 0:60 |
| ***CR-I*** *(S.tops + **S.trash** + Balanced Conc.Mix.) ($CR_1$ - $CR_7$)* | **65.33** ±1.66 | **63.40** ±1.57 | **64.22** ±0.68 | **67.70** ±1.84 | **69.40** ±0.30 | **68.20** ±3.30 | **72.96** ±5.10 |
| ***CR-II*** (S.tops+***Maize stover***+Balanced Conc.Mix.)* ($CR_8$ - $CR_{14}$) | **25.17** $^{a}$ ±3.71 | **32.05** $^{ab}$ ±1.93 | **34.59** $^{ab}$ ±2.07 | **40.05** $^{abc}$ ±7.20 | **40.83** $^{abc}$ ±1.64 | **43.62** $^{bc}$ ±4.85 | **55.61** $^{c}$ ±2.05 |
| **CR-III** (S.tops+***Jowar straw***+Balanced Conc.Mix.) ($CR_{15}$ - $CR_{21}$) | **72.36** ±3.99 | **69.21** ±0.74 | **68.01** ±0.16 | **71.64** ±0.53 | **72.28** ±1.31 | **70.07** ±0.83 | **74.17** ±1.15 |
| **CR-IV** (S.tops+***Paddy straw***+Balanced Conc.Mix.) ($CR_{22}$ - $CR_{28}$) | **41.15** ±2.55 | **40.98** ±2.62 | **45.51** ±3.32 | **41.29** ±2.94 | **40.95** ±1.51 | **42.55** ±7.04 | **37.05** ±3.51 |
| ***CR-V*** (S.tops+***Urea treated S.trash*** +Balanced Conc.Mix.) ($CR_{29}$ - $CR_{35}$) | **55.48** ±0.02 | **53.76** ±1.82 | **55.72** ±1.31 | **62.23** ±0.27 | **60.97** ±2.92 | **60.97** ±0.54 | **62.36** ±0.36 |
| **CR-VI** (S.tops + ***Sunhemp hay*** + Balanced Conc.Mix.)* ($CR_{36}$ - $CR_{42}$) | **48.66** $^{ab}$ ±5.29 | **43.33** $^{a}$ ±1.22 | **59.81** $^{bc}$ ±2.38 | **65.91** $^{c}$ ±2.83 | **57.47** $^{bc}$ ±0.93 | **51.32** $^{ab}$ ±7.03 | **59.15** $^{bc}$ ±2.14 |
| **Overall mean of IVDMD (%) 54.14±4.73** | | | | | | | |

Each value is an average of 3 observations

$^{a,b,c}$ Values bearing different superscripts in a row differ significantly ($P<0.05$)*

## CONCLUSION

The sugarcane by-products were analysed for chemical composition and to fix the level of inclusion of by-products like sugarcane trash and tops the *in vitro* trial was conducted and concluded that these by-products can be included up to 30-40% in complete rations for buffaloes.

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