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RESEARCH PAPER

Assessment of Banana Stem (*Musa paradisiaca*) and Urea Treated Paddy Straw Based Complete Rations for Growing Crossbred Calves

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ABSTRACT

In the present study, use of banana stem with urea treated and untreated paddy straw to formulate complete rations were evaluated for crossbred calves. Fifteen weaned crossbred (HF×Jersey) male calves with average body weight 87.7 kg were divided into three groups viz. C, T_1 and T_2 comprising five animals in each group and fed for 90 days. Two isonitrogenous and isocaloric complete ration (T_1 and T_2) using 20% banana stem, 30% untreated and urea (3%) treated paddy straw with concentrate ingredients at the ratio of 50:50 roughage and concentrate were prepared. Calves belongs to control (C) group were fed with standard concentrate mixture. Calves of T_1 and T_2 groups were fed with complete ration. The DMI per animal per day, per 100 kg body weight and per kg $W^{0.75}$ were comparable among the groups and no significant difference was observed between the groups. Non significant difference were observed among the groups in respect of digestibility coefficient of DM, OM and NFE but there was significant difference ($P<0.05$) in CP, EE, CF, NDF and ADF among the groups and the values were higher in T_1 and T_2 group as compared to control group. Calves of different groups were in positive balance of N, Ca and P, however significant different were observed among the group in respect of balance and retention of N, Ca and P. The FCE was significantly lower in T_1 and T_2 groups as compared to the control group C. The feed cost per kg gain in body weight was ₹ 155.86, ₹ 173.99 and ₹ 153.44 for C, T_1 and T_2 group, respectively. In conclusion, the banana stem can be used upto 20% in the paddy straw based complete rations for growing calf without any adverse effect.

HIGHLIGHTS

- The scarcity of feed and fodder for livestock feeding led to the utilization of non-conventional and non-competitive crop residues and agro-industrial by-products.
- The non-conventional crop banana stem @ 20% can be used in the paddy straw based complete rations to fed growing calf.

Keywords: Banana stem, Paddy straw, Urea treatment, Ration, Calves

The success of livestock production depends on supply of adequate, balanced and economical feeding of the livestock. The scarcity of feed and fodder, escalating demand of concentrate feed ingredients for human consumption and ever increasing cost has led to the utilization of non-conventional and non-competitive crop residues and agro-industrial by-products in livestock feeding (Waje *et al*. 2010). The exploration of new feed resources which do not compete with human food chain is a continuous activity where the utilization of crop residues plays a crucial role. Paddy straw are poor in palatability and nutritive value due

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to low levels of crude protein and high level of structural polysaccharides which can be overcome by incorporating it in the complete ration for the ruminants as such after physical and chemical treatment. Khejorsat and Wanapat (2010) reported that treating paddy straw at least with 3% urea improved overall intake, nutrient digestibility. India is the largest producer of banana contributing 27% of world's banana production (Mohapatra *et al*. 2010) and a residual biomass (stem and leaves) of 13–20 tonnes dry matter per hectare per year is available. Banana stem is a by-product obtained from banana plants after harvesting of the fruit. At present, they are thrown out as waste on roadsides, or allowed to rot away or burnt in the field except to a little extent use as fuel. Banana stem is rich source of fibre, potassium and vitamin B_6 with CP content about 7%. There are limited available information on utilization of banana stem in growing and productive ruminants, except the use of whole banana plants in maintenance ration (Gupta *et al*. 2001) and stem in complete ration for adult local cattle (Amarnath and Balakrishnan 2007) and to replace finisher ration of pig (Saikia and Goswami 2003).

In Assam, though there is shortage of concentrate and green roughage, but there is abundant paddy straw and banana stem available with the banana and paddy cultivated farmers. Leaves and trunks of banana plants grown by farmers as cash crop are relished by cattle and animal can be maintained by feeding whole banana plants alone during the scarcity period like flood in Assam. However, chaffing and cooking with small quantity of rice or wheat bran improved their palatability and intake (Saikia 2004).

Ramachandran *et al*. (2007) pointed that crop residues will provide more than 70% of the feed resources for Indian livestock by the year 2020. However, these crop residues are referred as low grade roughage having limitation with respect to its utilization in ruminant system. High percentage of structural carbohydrate and low nitrogen content of these roughages result in low palatability and poor nutrient utilization in ruminants. However, incorporation of these poor quality roughages in complete diets improves both palatability and nutrient utilization. The complete feed is a quantitative mixture of all dietary ingredient, blended thoroughly maintaining proper roughage and concentrate ratio preventing separation and selection. It is fed as sole ration to meet the requirements of all nutrients except water. Complete feed with the use of fibrous crop residue is a noble way to increase the animal production performance. It improves feeding value of a poor quality crop residues simplifies feeding, control ratio of roughages to concentrate, provide uniform feed intake, reduces the feed wastages and cost of feeding (Lailer *et al*. 2010). Further, complete feed improves nutrient utilization by creating stable rumen environment for fermentation, minimal fermentation losses, and minimal fluctuation in release of ammonia which supports more efficient utilization of ruminal non-protein nitrogen. Considering the above facts, the present experiment has been planned to evaluate banana stem, urea treated and untreated paddy straw based complete rations compared to conventional feeding system in growing crossbred calves with the objective to study the comparative nutrient utilization, performance and economics of crossbred calves on feeding banana stem, untreated and urea treated paddy straw based complete rations.

MATERIALS AND METHODS

The experiment was conducted in the experimental animal shed of Instructional Livestock Farm (Cattle), College of Veterinary Science, Assam Agricultural University, Khanapara. Animal trial has been conducted under the approval of established standard of the Institutional Animal Ethics Committee (IAEC), with (approval number, 121/IAEC/18), constituted as per the article number 13 of the Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) rules laid down by the Government of India. Eighteen (18) weaned cross-bred (Holstein Friesian × Jersey) male calves with initial live weight of 87 ± 5 kg were randomly allocated into 3 treatment groups of 6 animals each for this experiment in a randomized block design. The feeding trial was carried out for a period of 90 days with an initial adjustment period of one week and collection period of five days. The calves were offered weighed quantities of feed with fresh, clean drinking water twice daily at about 8:00 AM and 3:00 PM. The animals were fed with three different rations A standard concentrate mixture-

C (CP- 20% and TDN-75%) using rice polish, de-oiled rice bran, groundnut cake (GNC), soyabean meal, molasses, mineral mixture and common salt (Table 1) was prepared maintaining CP level as per ICAR (2013) specification for growing calf for feeding of the control group. Two iso-nitrogenous (CP -14.63% each) complete rations – T_1 and T_2 were prepared using untreated and urea (3%) treated paddy straw with banana stem and the same concentrate ingredients used in the standard concentrate mixture- C maintaining 50:50 roughage and concentrate ratio as shown in Table 1.

Table 1: Percent ingredient composition of experimental rations

Ingredients (in Kg)	Rations		
	Conventional Ration	Complete Ration	
	C	T_1	T_2
Banana stem	—	20	20
Untreated paddy straw	—	30	—
Urea treated paddy straw	—	—	30
Rice polish	30	6	9
De-oiled rice bran	30	7	9
Ground nut cake	20	15	13
Soyabean meal	12	14	11
Molasses	5	5	5
Mineral mixture	2	2	2
Common salt	1	1	1
Total	**100**	**100**	**100**
Feed offering (kg/animal/day)			
Mixed grass	3-4.5	—	—
Paddy straw	1.0-1.8	—	—
Concentrate mixture	0.6-1.3	—	—
Complete ration	—	2.5-3.8	2.5-3.8

For preparation of complete ration, banana stem, treated and untreated paddy straw was first manually chopped into small pieces of 2-3 cm long. Daily requirement of banana stem was chopped into 2-3 cm pieces and cooked with required volume of water for 15 minutes. After cooling, the banana stem, paddy straw and concentrate ingredients were mixed thoroughly maintaining the roughage and concentrate ratio at 50:50. For urea treatment of paddy straw, one hundred (100) kg of paddy straw was treated with 3% solution of urea (3 kg urea in 40 litres of water) spraying with the help of a gardener's sprayer in 4 layers to a thickness of 4 inches each giving turning every time. Treated straw was preserved in anaerobic condition by putting it into ten (10) polythene bags (10 kg in each) for a period of 21 days. After the treatment period the straws were opened for elimination of free ammonia gas and chopped into 3-4 cm pieces before preparing the complete rations.

The feeding trial was conducted for a period of 90 days during which the calves of the control group (C) were fed individually in conventional feeding system with concentrate mixture, mixed green fodder and paddy straw as per the Thumb Rule to meet the DM and other nutrients requirement requirements as per ICAR (2013) standard for growing calf. Concentrate was offered at 8:00 A.M. followed by mixed grass and paddy straw. A metabolic trial was conducted after 90 days feeding period with five days collection period where collection of a representative sample of feed offered, residue left, faeces and urine were analysed as per AOAC (2007) to determine the utilization of nutrients and balance of nitrogen (N), calcium (Ca) and phosphorous (P).

Feed and biological samples were analyzed as per standard procedures (AOAC 2007), Van Soest *et al*. (1991), Talapatra *et al.* (1940). Data obtained were analyzed statistically as per procedure suggested by Scnedecor and Cochran, (1994) and significance of difference by Duncan's Multiple Range Test (Duncan, 1995) using SPSS 20.0 version.

RESULTS AND DISCUSSION

The evaluated chemical composition of different feed ingredients and the experimental rations has been given in Table 2. It has been observed that the CP content of the mixed green fodder, paddy straw, urea treated paddy straw and banana stem were 13.28, 3.68, 9.2 and 7.2 percent respectively. It was observed that there was increased in the CP percent from 3.68 to 9.2 for urea treated paddy straw. However the CF, NDF, ADF and NFE contents were decreased from 32.2 to 29.76; 67.34 to 64.18; 48.92 to 45.93 and 49.73 to 45.93 percent respectively. OM and EE content of paddy straw were 86.18 and 1.28 percent respectively, but these values were increased in urea treated paddy straw. Similar findings on the nutrient composition of treated and untreated paddy straw was reported by Sinha *et al.*

Table 2: Chemical composition and NV (percent on dm basis) of mixed green fodder, urea treated and untreated paddy straw, banana stem and composite control (C) and complete ration (T_1 and T_2)

Particulars	Paddy straw	Urea treated paddy straw	Banana stem	Mixed green fodder	Control (C) Concentrate mixture	Complete rations	
						T_1	T_2
DM	89.58	81.86	26.64	33.23	90.43	76.96	76.83
OM	86.18	86.41	83.5	86.83	86.74	85.95	85.89
CP	3.78	9.20	7.20	13.28	20.26	14.63	14.63
EE	1.28	1.52	2.49	1.90	2.28	2.10	2.30
CF	32.2	29.76	25.76	21.83	7.85	22.57	22.48
NFE	48.92	45.93	48.05	49.82	56.35	46.65	46.48
NDF	67.34	64.18	59.6	43.78	34.00	53.4	51.00
ADF	45.21	44.37	32.87	27.93	12.70	32.14	31.68
TA	13.82	13.59	16.5	13.17	13.26	14.05	14.11
Ca	0.55	0.58	1.22	1.30	1.78	1.27	1.26
P	0.35	0.35	0.12	0.53	0.67	0.57	0.52
Estimated nutritive value (percent on DM basis) of composite control (C) and complete ration (T_1 and T_2)							
CP(%)					14.02	14.63	14.63
DCP (%)					9.75	11.65	11.73
TDN (%)					54.83	57.53	57.98
DE MCal/kg					2.42	2.54	2.56
ME MCal/kg					1.98	2.08	2.10

‡C : Control conventional ration; T_1: Complete ration of 50:50 concentrate and roughage (banana stem and paddy straw); T_2: Complete ration of 50:50 concentrate and roughage (banana stem and urea treated paddy straw).

(2011) and Rahman *et al*. (2009). However, Gunun *et al*. (2013) and Wanapat *et al*. (2013) reported lower CP in urea (3%) treated straw. Saikia and Goswami (2003) reported variation from the present study in the nutrient composition of banana stem, this could be due to variety of banana stem and the soil type. The crude protein content of the control concentrate mixture was 20.26 percent on DM basis. The complete feed was made isonitrogenous by controlling the concentrate ingredients level in the ration. The nutritive value of the composite rations in term of CP, DCP, TDN, DE and ME has been estimated and is presented in Table 2. It was found that the DCP content of T_1 and T_2 group was comparable. The DCP content in C group was lower as compared to T_1 and T_2 which might be due to separate feeding of concentrate and roughage in C group which result in lesser utilization of nutrients as compared to complete feed. Sheikh *et al*. (2017) reported higher DCP and TDN contents in lamb fed paddy straw based complete feed and the improvement in DCP content might be due to better utilization of fibre and higher microbial protein synthesis. The evaluated chemical composition of different feed ingredients and the experimental rations has been given in Table 2.

The DMI expressed in terms of Kg/100 Kg body weight and as g/Kg $W^{0.75}$ by the experimental calves of different treatment groups, depicted in Table 3, was found to be not significant (P>0.05) among groups. Similarly, comparable DMI between complete feeding and conventional feeding was also observed by many workers in cattle (Hundal *et al*. 2004 and Gupta *et al*. 2010), buffalo (Singh *et al*. 2000; Wadhwa and Bakshi, 2006; Kumar *et al*. 2010; Kishore *et al*. 2013 and Kishore *et al*. 2016) and sheep (Vaghamashi and Pandya 2016). However, Kovler *et al*. (1998), Bargo *et al.* (2002), Khan *et al.* (2010) and Waje *et al*. (2010) reported increased DMI in complete ration fed cattle and buffalo because of their higher palatability and reduced particle size. Mayulu *et al.* (2013) reported similar DMI in complete diets and control diet which showed that the different treatment have similar palatability. The DMI was 2.39 percent live weight which was within the range of cattle's DMI needs. Beauchemin *et al*. (1997) reported that reducing particle size of poor quality high fibre diets significantly increased

the DM intake. However in the present study, the particle size reduction in complete ration fed group (T_1 and T_2) did not affect the total DM intake which was similar to the finding as reported by Gunun *et al*. (2013). The DMI in the present experiment was within normal range and can be compared with the above worker. The similar DMI between groups in the present experiment might be due to similar palatability in the different rations and that the mixing of roughages (Paddy straw treated or untreated and banana stem) and concentrates in the form of complete rations has not affected the palatability.

Non significant difference were observed among the groups in respect of digestibility coefficient of DM, OM and NFE but there was significant difference in CP, EE, CF, NDF and ADF among the groups and the values were higher in T_1 and T_2 group as compared to control group (C) Table 3. The better CP digestibility in the present study in T_2 group might be due to addition of urea treated paddy straw which result in better digestibility by hydrolizing the urea (Ahmed *et al.* 2002). The similar CP digestibility in T_1 might be due to different percentage composition of feed ingredients in complete feed formulation which affect the CP digestibility as reported by Mayulu *et al*. (2013). The results obtained in the present study of better CP digestibility in complete diet feeding (T_1 and T_2) as compared to conventional feeding (C) support the hypothesis that complete feed provide uniform supply of nutrients at regular interval which helps to maintain steady rumen environment resulting in better digestibility of nutrients (Talpada *et al*. 2002). In the present study the CF digestibility was higher in complete ration based diets (T_1 and T_2) which might be due to crude fibre content, particle size of fibre resources as reported by Mayulu *et al*. (2013). The chopping treatment enlarges the surface area of the feed and makes it easier for rumen microbes to digest the feed and there by increases digestibility of crude fibre. In the present experiment, the NDF

Table 3: Effect of banana stem and with or without urea treated paddy straw based complete rations on nutrient utilization and balances of nutrients in growing crossbred calves

Attributes	Group			SEM	P Value
	C	T_1	T_2		
Digestibility of nutrients					
DM	55.10±0.24	56.74 ±0.49	57.10±0.73	0.40	0.075
OM	63.65±0.11	64.33±0.42	64.60±0.61	0.26	0.348
CP	73.74^{a}±0.38	76.11^{b}±0.21	76.61^{b}±0.56	0.49	0.005
EE	74.52^{a}±1.33	76.18^{b}±0.44	76.91^{b}±0.21	0.39	0.007
CF	57.56^{a}±0.86	65.55^{b}±0.49	66.17^{b}±0.45	1.42	<0.001
NFE	59.03±1.48	58.92±0.41	58.93±0.56	0.47	0.996
NDF	53.02^{a}±0.49	57.99^{b}±0.29	59.45^{b}±1.00	1.00	<0.001
ADF	50.68^{a}±0.58	55.85^{b}±0.58	56.60^{b}±0.31	0.96	<0.001
Balance of nitrogen					
N-Intake (g/d)	57.89a±0.44	62.10b±0.09	62.08b±0.40	0.72	0.001
N- voided in faeces (g/d)	15.20±0.29	14.83±0.15	14.52±0.43	0.18	0.372
N-voided in urine (g/d)	8.16c±0.05	6.74b±0.05	6.28a±0.05	0.28	<0.001
Total N-voided (g/d)	23.36a±0.27	21.57a±0.19	20.81b±0.48	0.41	0.004
N- balance (g/d)	34.53a±0.35	40.52b±0.12	41.27b±0.19	1.07	<0.001
N-retention (%)	59.65a±0.37	65.26b±0.27	66.49b±0.57	1.07	<0.001
Balance of calcium (Ca)					
Balance (g/d)	17.24^{a}±0.32	20.98^{b}±0.34	20.96^{b}±0.19	0.64	<0.001
Retention (%)	51.91±0.13	54.14±0.90	54.34±0.66	0.51	0.069
Balance of phosphorus (P)					
Balance (g/d)	6.85^{a}±0.08	9.20^{c}±0.14	8.45^{b}±0.15	0.35	<0.001
Retention (%)	47.95^{a}±0.66	52.32^{b}±0.78	52.56^{c}±1.14	0.87	0.017

^{tab} *Mean values with different superscripts within row differed significantly.*

digestibility was significantly (P<0.001) higher in T_1 and T_2 group than control group. This might be due to the urea ammoniation of paddy straw, which might have resulted in weakening of the intermolecular hydrogen bonds and swelling of cellulose fibrils (Han and Garrett 1986). Similarly, the better digestibility of ADF in the complete rations (T_1 and T_2) might be due to better proportion of roughage and concentrate providing favourable environment for microbial metabolism.

Calves of different groups were in positive balance of N, Ca and P, however significant different were observed among the group in respect of balance and retention of N, Ca and P. It was observed that all the animals were in positive N balance (Table 3). Positive nitrogen balance was recorded in all the groups which indicated that the complete rations fed to calves met the nitrogen requirements. The percent retention of N in C, T_1 and T_2 was 59.65, 65.26 and 66.49, respectively. On statistical analysis it was found that N balance was significantly (P<0.001) higher in T_1 and T_2 group than group C. The better N balance and retention in complete ration group (T_1 and T_2) might be due to higher N intake by the calves of these groups compared to group C and more losses through urine in group C. Similarly, Wadhwa and Bakshi (2006) reported higher N retention in animals fed TMR based diet as compared to conventional ration though not significantly different. The N retained ranged from 31.2 to 41.6 g/d. The higher N retention might be due to higher N intake and lower total N voided in animal fed TMR based diet as compared to conventional control diet.

Balances of Ca was higher (P<0.001) significantly in T_1 and T_2 group than group C. It was observed that total Ca intake and loss (g/d) were higher (P<0.01) in animals fed complete rations than those fed conventional ration whereas Ca retention percent was comparable in the animals fed different rations and were in positive balance. Higher P retention was found in T_2 followed by T_1 and group C respectively.

The ADG were 242.09±32.84, 256.13±17.55 and 280.89±20.63 g in C, T_1 and T_2 group, respectively. No significant difference was observed among the groups in respect of ADG (Table 4). However values were in increase trend from group C to group T_2. The FCE were 10.48±0.36, 9.63±0.15 and 8.97±0.16 in C, T_1 and T_2 group, respectively. The FCE was significantly lower in T_1 and T_2 groups as compared to the control group C.In the present experiment the feed conversion efficiency was found to be better in T_2 followed by T_1 and group C, respectively. The better FCE in complete ration fed group might

Table 4: Effect of banana stem and with or without urea treated paddy straw based complete rations on DMI, ADG and FCR in growing crossbred calves

Particulars	Group			SEM	P value
	C	T_1	T_2		
Dry Matter Intake (kg/day)					
Concentrate mixture	1.15±0.03	—	—	—	—
Green roughage	0.79±0.02	—	—	—	—
Dry roughage	0.65±0.07	—	—	—	—
Complete ration	—	2.58±0.00	2.60±0.04	—	—
Total (kg)	2.58±0.07	2.58±0.00	2.60±0.04	0.02	0.915
DMI per 100 kg body weight	2.15±0.10	2.16±0.06	2.27±0.05	0.04	0.491
DMI per kg $W^{0.75}$ (g)	71.20±2.05	71.35±1.59	74.34±1.20	0.97	0.378
Body weight (kg)					
Average initial body weight (Kg)	87.80±7.21	87.90±5.99	87.50±5.56	3.36	0.999
Average final body weight (Kg)	109.59±9.79	110.95±5.67	112.78±7.31	4.17	0.959
Total body weight gain (Kg)	21.79±2.96	23.05±1.58	25.28±1.86	1.24	0.545
Average daily gain in body weight (g)	242.09±32.84	256.13±17.55	280.89±20.63	13.82	0.545
Total feed consumed (kg DMI/ animal/90 days)	226.05±1.30	224.67±0.81	226.04±1.25	0.63	0.628
Feed efficiency (kg DMI/kg gain)	10.48b±0.36	9.63a±0.15	8.97a±0.16	0.20	0.002

be due to better utilization by the animal as both roughage and concentrate are fed together at the same time. Improved feed conversion efficiency might be due to high digestibility of nutrient (Ryan *et al*. 2007).

The feed cost per kg gain in body weight was ₹ 155.86, ₹ 173.99 and ₹ 153.44, respectively for C, T_1 and T_2 group, respectively (Table 5). The total cost of feeding in C was lowest among the three groups. The lowest cost of production in terms of growth per kg live weight gain was found in T_2 group which might be due to higher body weight gain as compared to the other two groups. This indicated that feeding of urea treated paddy straw and banana stem based complete ration was found to be beneficial in improving growth with lower feed cost per kg gain.

Table 5: Relative cost of feed on growth in crossbred calves on various treatments

Particulars	Treatment		
	T_0	T_1	T_2
Total feed intake (kg)/animal (DMI)			
i. Concentrate	98.7		
ii. Dry roughage	71.85		
iii. Green roughage	55.5		
iii. Complete feed	—	224.67	226.04
Total	**226.05**	**224.67**	**226.04**
Feed Cost (₹) (DM basis)			
i. Concentrate (₹/kg)	23.58	—	—
ii. Dry roughage (₹/kg)	5.58	—	—
iii. Green roughage (₹/kg)	12.04	—	—
iv. Complete feed (₹/kg)	—	17.85	17.16
Total feed cost in ₹/animal/90 days	3396.10	4010.36	3878.85
Total feed cost per day per animal (₹)	37.74	44.56	43.10
Total gain in body weight (kg)	21.79	23.05	25.28
Feed cost per Kg gain (₹)	155.86	173.99	153.44
Relative (%)	89.57	100	88.19

CONCLUSION

From the present study, it was observed that the performance of calves feeding on banana stem and paddy straw based complete ration in terms of growth, feed intake and nutrient utilization were comparable with that of calves feeding on conventional system. So, inclusion of banana stem (*Musa paradisiaca*) up to 20% in paddy straw based complete ration of growing calf had no adverse effect on the performance and health of calves. However, more elaborate work with large number of animals is appreciated for exploration of available banana stem for growth and production of the livestock.

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