Growth and Nutrient Utilization in Buffalo Calves Fed Urea-ammoniated Wheat Straw and Hydrochloric Acid plus Urea Treated Wheat Straw

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ABSTRACT : Ten growing male buffalo calves (aged 6-8 months, average body weight 88.2±0.57 kg were divided randomly into two groups. Animals in group I were fed on concentrate mixture A (CP 20.2%, TDN 77.4%) and urea- ammoniated wheat straw (UAWS) while the animals in group II were fed on concentrate mixture B (CP 17.9%, TDN 77.6%) and HCl plus urea treated wheat straw (HCl UAWS) to meet their nutrient requirement for 500 g gain/d as per Kearl (1982). This feeding practice lasted for 120 days, during which fortnightly body weight were recorded to assess their growth rate. A metabolism trial was conducted after 90 days of experimental feeding to compare the digestibility of nutrients, their balance, plane of nutrition and relative cost of feeding in two groups of animals. Results revealed a significant increase in the CP content of ammoniated wheat straw due to addition of HCl viz 12.1% from 7.5%. There was a decrease in the intake of DM ($p<0.05$), OM ($p<0.05$), EE ($p<0.05$), NDF ($p<0.01$), ADF ($p<0.01$), cellulose ($p<0.01$) and hemicellulose ($p<0.01$) in group II as compared to group I. The digestibility (%) of DM, OM and CP was significantly ($p<0.01$) more in group II, whereas the digestibility (%) was significantly more for NDF ($p<0.05$) and hemicellulose ($p<0.01$) in group I than group II. There was no significant difference in the N, Ca and P balance in two groups. Intake of total DM (g/d) or (g/kg $W^{0.75}$) was significantly ($p<0.01$) more in group I as compared to group II, whereas the intake of DCP and TDN (g/d or g/kg $W^{0.75}$) was alike in two groups. The total body weight gain (kg), average daily gain (g/d) and feed conversion efficiency were significantly ($p<0.01$) more in UAWS fed group as compared to HCl UAWS fed group. Feeding cost (Rs./kg. weight gain) was significantly ($p<0.05$) more in group II as compared to group I. It is concluded that HCl UAWS is not suitable for the feeding of growing buffalo calves as it reduced the growth rate in comparison to UAWS fed buffalo calves. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 5 : 682-686)***

Key Words : Buffalo Calves, Urea-Ammoniation, Hydrochloric Acid, Urea Ammoniated Wheat Straw, Growth

INTRODUCTION

Feeding of animals in the third world countries is totally dependent upon agricultural crop residues, which are low in essential nutrients like protein, minerals and vitamins, as well as poor in palatability and digestibility. The cause of poor digestibility of crop residues has been earmarked to the presence of lignin as ligno-cellulose complex, which is resistant to the enzymes secreted by the mammalian tissues as well as rumen microbes. Out of the various chemicals used to break this complex, urea-ammoniation of the crop residues has been found beneficial as it improves the palatability, digestibility and also adds a significant amount of nitrogen, a deficient nutrient in the crop residues (Mehra et al., 1989; Dass et al., 1993 a,b; Khan et al., 1999; Rath et al., 2001). The process of urea ammoniation of crop residues is simple and can easily be adopted by the farmers/livestock owners. The only drawback of the method is extensive loss of urea-ammonia, which may be as high as 60-70% (Dass et al., 2000,2001) which is not a significant loss of the valuable nutrient but ammonia escaped to the atmosphere also pollute the environment. Various workers have used some organic (acetic acid, phosphoric acid and formic acid) and inorganic acids (boric acid, hydrochloric acid and sulphuric acid) to fix this excess ammonia (Borhami et al., 1982; Cloette and Kritzinger, 1984; Yadav and Virk, 1993a,b; Dass et al., 2000) with different degree of ammonia fixation. Recently Dass et al. (2001) treated the wheat straw with urea and hydrochloric acid simultaneously to trap 30% of the ammonia evolved from 4% urea and got significant increase in CP content of the wheat straw.

The objective of this study was to compare the effect of feeding urea treated and hydrochloric acid plus urea treated wheat straw on the growth and nutrient utilization in growing male buffalo calves.

MATERIAL AND METHODS

Urea-ammoniation of wheat straw

Wheat straw was treated on large scale in two batches with 4% urea at 50% moisture level. Commercial grade hydrochloric acid was added simultaneously in batch two to trap 30% of the ammonia released from 4% urea during urea-ammoniation of wheat straw. The straw was covered with a polythene sheet as described earlier (Dass et al., 1984). After 4 weeks the polythene sheet was removed and straw was aerated for 24 h before feeding to the animals.

Animal feeding and management

Ten buffalo calves (6-8 months old, 88.2±0.57 kg average body weight) purchased from the local market were

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assigned to two equal groups in a completely randomized design, after deworming, vaccination and acclimatization to the new environment for a period of one month. The buffalo calves were housed individually in well ventilated cement floored shed having individual feeding facilities and reared under proper hygienic and uniform managemental conditions. Buffalo calves in group I were offered urea-ammoniated wheat straw (UAWS) plus concentrate mixture A, while the animals in group II were offered HCl treated ammoniated wheat straw (HCl UAWS) plus concentrate mixture B to meet their nutrient requirement for 500 g gain/day as per Kearl (1982). Concentrate to roughage ratio was kept as 50:50 in both the groups and animals were fed at 9:30 AM throughout the experimental feeding of 120 days. All the animals were weighed at fortnightly interval to assess their growth rate and for readjusting the feeding schedule. Clean and fresh water was provided *ad libitum* daily.

Metabolism trial

In order to determine the digestibility and balance of nutrients , a metabolism trial of six days durartion involving daily collection of faeces and urine and recording of feed and residue was carried out after 90 days of experimental feeding on all the animals by harnessing them in the metallic cages. Faeces voided and urine excreted by each individual animal were recorded at 10 AM daily. Faeces pooled in preweighed plastic buckets in 24 h were mixed thoroughly in a large plastic trough and a representative sample was taken to the laboratory for aliquoting and analysis. Urine collected through a tray kept under each metabolic cage was stored in a plastic bottle. To avoid loss of ammonia-N, 10 ml of 1:4 HCl was sprinkled on the tray daily. Representative sample of feed offered and residues left were taken daily for dry matter estimation and proximate analysis.

Analysis of samples

The feed and faecal samples were analysed for proximate composition (AOAC, 1980), neutral detergent fiber (NDF) and acid detergent fiber (ADF) (Van Soest et al., 1991). Hemicellulose and cellulose were calculated as NDF-ADF and ADF-ADL respectively.

Nitrogen in urine was determined by the Kjeldahl N method (AOAC, 1980). Calcium in feed, faeces and urine was estimated as per the method of Talapatra et al. (1940), while phosphorous was determined colorimetrically using molybdovanadate reagent as per AOAC (1990).The data were analysed statistically using standard t test as discussed by Snedecor and Cochran (1967)

RESULTS AND DISCUSSION

The physical and chemical composition of ration ingredients is presented in table 1. Urea ammoniation of wheat straw increased the crude protein (CP) content to 7.5 percent, which further increased to 12.10 percent in HCl plus urea treated wheat straw. This may be due to the formation of ammonium chloride. Earlier workers have also reported similar increase in CP content after the addition of acids to the ammoniated straw (Borhami et al., 1982; Cloette and Kritzinger, 1984; Yadav and Virk, 1994 a,b; Taiwo et al., 1995; Dass et al., 2000, 2001 and Mehra et al., 2001). Total intake, and digestibility of dry matter and various other nutrients are presented in table 2. Intake (g/d) of dry matter (DMI) and organic matter (OMI) were significantly ($p<0.05$) more in group I as compared to group II. Similarly, the intake (g/d) of ether extract (EEI), neutral detergent fiber (NDFI), acid detergent fiber (ADFI), cellulose and hemicellulose (HCI) were significantly ($p<0.01$) more in group I as compared to group II, whereas the intake of crude protein (CP) was statistically alike in 2 groups. The lower intake of DM vis-a-vis other nutrients may be due to the acidic pH of the straw as reported by Cloettle and Kritzinger (1984), who also observed an adverse effect of the higher (50%) acid fixation level on the voluntary dry matter intake. Contrary to this Borhami et al., (1982) did not find any significant difference in dry matter intake in sheep fed with ammoniated straw or ammoniated straw sprayed with formic or acetic acid. Similarly Yadav and Virk (1994 a,b) observed no difference in dry matter intake in buffalo calves fed on ammoniated straw and

Table 1. Physical and chemical composition of feeds offered to experimental buffalo calves

Attributes	Conc. Mix. A	Conc. Mix. B.	UAWS	HCl UAWS
Formular composition (percent as fed basis)				
Ingredients				
Wheat bran	7	12		
Crushed maize	62	66		
Soyabean cake	28	19		
Mineral mixture	2	2		
Common salt	1	1		
*Vitablend (AD_3)g/ 100 kg	25	25		
Chemical composition (percent DM basis)				
Organic matter	92.0	94.5	6.9	91.1
Crude protein	20.3	17.9	7.5	12.1
Ether extract	5.6	4.8	0.9	0.8
Neutral detergent fiber	28.0	22.2	85.0	78.0
Acid detergent fiber	5.8	5.6	63.7	60.1
Cellulose	3.8	3.9	44.6	46.6
Hemicellulose	22.2	16.5	21.2	17.9
Calcium	1.6	1.2	0.57	0.54
Phosphorus	0.7	0.6	0.13	0.14

* Vitablend contained Vitamin A (50,000 I.U./g) and D3 (5,000 I.U./g).

Table 2. Intake and digestibility of various nutrients in buffalo calves fed UAWS and HCl UAWS

Attribute	Group	
	I	II
Dry matter intake through		
Concentrate mixture A/B	1,693.1±154.5	1,622.4±105.4
UAWS/HCL UAWS	1,941.8±97.8	909.5±37.8
Total intake (g/d)	3,634.9±341.7	2,531.9±104.7
Digestibility (%)**	57.2±10.5	64.4±0.9
Organic matter		
Intake (g/d)*	3,253.1±302.7	2,365.2±178.7
Digestibility (%)**	61.8±1.42	67.7±0.74
Crude protein		
Intake (g/d)	491.5±44.7	403.6±28.2
Digestibility (%)**	51.6±2.26	66.1±1.24
Ether extract		
Intake (g/d)*	113.3±10.15	86.9±5.37
Digestibility (%)	64.9±7.68	71.7±1.80
Neutral detergent fiber		
Intake (g/d)**	2,086.7±213.8	1,067.5±107.0
Digestibility (%)*	56.3±2.5	50.2±1.7
Acid detergent fiber		
Intake (g/d)**	1,331.7±134.1	618.5±77.2
Digestibility (%)	45.0±3.7	40.0±2.9
Cellulose		
Intake (g/d)**	926.1±93.6	484.9±58.1
Digestibility (%)	66.3±2.67	61.4±1.85
Hemicellulose		
Intake (g/d)**	790.9±73.7	440.6±23.7
Digestibility (%)**	77.4±3.79	63.1±2.38

* p<0.05, ** p<0.01.

ammoniated straw treated with sulphuric acid. The digestibility (%) was significantly more of DM (p<0.05), OM (p<0.01) in group II as compared to group I, whereas the digestibility of hemicellulose was significantly (p<0.05) more in group I as compared to group II. Similar higher digestibility of DM, OM and CP was reported earlier by Dass et al. (2001) in adult buffaloes fed HCl-UAWS and HCl-UAWS+barley grain fed buffaloes. Similarly, Fahmy and Orskov (1989), Toroitich (1992) and Yadav and Virk (1994a,b) reported significant effect of urea and acid treatment on dry matter digestibility. A significant increase in CP digestibility was reported by Yadav and Virk (1994a, b) in buffalo calves fed on urea ammoniated straw treated with acids. Borhami et al. (1982) reported that the apparent digestibility of nitrogen of the straw increased significantly (p<0.01) by urea ammonia treatment and even further by spraying with acetic or formic acid.

Data on intake, excretion and balance of nitrogen (N), calcium (Ca) and phosphorus (P) is presented in table 3. Nitrogen intake (g/d) was alike statistically in 2 groups.

Table 3. Intake, excretion and balance of nitrogen, calcium and phosphorus in group I and II

Attribute	Group	
	I	II
Nitrogen intake (g/d)	78.45±7.15	64.58±4.51
N out go through		
Feces (g/d) **	37.36±1.59	22.05±2.28
Urine (g/d)	20.93±2.72	19.74±1.01
N balance (g/d)	20.16±4.22	22.79±2.97
Calcium intake (g/d)**	41.05±3.83	25.63±1.84
Ca outgo through		
Feces (g/d)**	31.29±2.25	18.68±1.91
Urine (g/d)	6.00±0.76	4.80±0.80
Ca balance (g/d)	3.76±1.80	2.15±0.47
Phosphorus intake (g/d)*	14.81±1.34	10.53±0.67
P out go through		
Feces (g/d)	7.36±0.85	4.64±0.83
Urine (g/d)	4.20±0.70	4.04±0.35
P balance (g/d)	3.25±0.90	1.88±0.52

* p<0.05, ** p<0.01.

Though the excretion of N through feces was significantly (p<0.01) more in group I, but animals in both the groups were in positive N balance having no statistical significant difference. These results are contrary to the results reported by Dass et al. (2001) in adult buffaloes fed ammoniated straw sprayed with HCl, where a negative N balance was recorded, but similar to the results reported by the same authors in adult buffaloes fed on HCl UAWS plus barley grain. The intake and excretion of Ca through feces were significantly (p<0.01) more in group I as compared to group II, where the excretion of calcium through urine (g/d) and its positive balance in both the groups were statistically alike. Like the calcium, intake of P was significantly (p<0.05) more in group I as compared to group II. The excretion of P through feces and urine and its balance were statistically similar in two groups. These results of mineral balance are similar to the observation of Dass et al., 2001 and Mehra et al., 2001 in adult buffaloes fed HCl treated and acetic acid treated UAWS respectively. Contrary to these L'Estrange and Murphy (1972) reported higher excretion of Ca and P in sheep fed pelleted food supplemented with HCl or H_2SO_4 or mixture of HCl and H_2SO_4 (1:1). They observed negative Ca and P balance in sheep, where the diet was treated with acid.

Body weight gain and plane of nutrition in two groups of animals is presented in table 4. The total body weight gain in two groups was 76.2 and 55.6 kg respectively in 120 days of experimental feeding, indicating a significantly (p<0.05) more weight gain in group I as compared to group II. Similarly the average daily gain (g/d) was significantly (p<0.05) more in group I (635.0 g/d) as compared to group II (463.20 g/d). This may be due to the significantly

Table 4. Body weight change and plane of nutrition in group I and II

Attribute	Group	
	I	II
Initial body weight (kg)	88.30±7.55	88.10±7.52
Final body weight (kg)	164.5±14.42	143.7±9.34
Total weight gain (kg)	76.20±7.32	55.60±6.40
Average daily gain (g)	635.00±60.91	463.20±53.3
Average body weight (kg) at the time of metabolism trial	132.2±10.9	115.90±6.7
Metabolic body size ($W^{0.75}$ kg)	38.89±2.38	35.28±1.52
Dry matter		
Intake (g/d)*	3,724.4±341.6	2,531.9±193.2
Intake (g/100 kg body weight)*	2,763.8±165.5	2,183.0±88.5
Intake (g/kg $W^{0.75}$)**	95.66±5.34	71.54±3.15
Crude protein		
Intake (g/d)	491.5±44.7	403.6±28.2
Intake (g/100 kg body weight)	373.8±21.8	348.0±10.6
Intake (g/kg $W^{0.75}$)	12.62±0.70	11.41±0.39
DCP		
Intake (g/d)	256.7±36.0	265.9±14.7
Intake (g/100 kg body weight)*	193.3±16.5	229.7±4.7
Intake (g/kg $W^{0.75}$)	6.55±0.60	7.53±0.16
TDN		
Intake (g/d)	2,115.0±244.0	1,673.9±108.4
Intake (g/100 kg body weight)	1,663.5±276.2	1,446.0±51.5
Intake (g/kg $W^{0.75}$)	54.12±3.9	47.40±1.71
DCP	6.8	10.6
TDN	56.6	66.3

* p<0.05, ** p<0.01.

(p<0.01) lower DM intake vis-a-vis other nutrients in this group. A growth rate of 635.0 g/d in group I was equivalent to growth rate of 640 g/d reported by Yadav and Virk (1994a) in buffalo calves fed on urea-ammoniated wheat straw having 24% germinated barley, but growth rate was less in group II as compared to the values obtained by the same workers in buffalo calves fed on H_2SO4 treated urea ammoniated wheat straw. This may be due to the higher level of urea (7.5%) and low level of acid used (to trap 20% ammonia) by these workers.

There was no significant difference in intake of DCP and TDN in two groups when calculated as such or on the basis of per kg $W^{0.75}$. The DCP and TDN values of the two diets were 6.8, 56.6 and 10.6, 66.3 percent respectively. The poor growth rate in group II may be due to the low intake of nutrients i.e. DM and TDN, than the requirements as specified by Kearl (1982). Feed cost of live weight gain is presented in table 5. The feed cost of live weight gain is largely dependent on cost of feed and efficiency of feed utilization. Results revealed no significant difference in the feed cost of concentrate in two groups, indicating the similar nutrient utilization and their metabolism, but the cost of roughage in group II was significantly (p<0.05) lower than group I. This may be due to the poor palatability of HCl UAWS as compared to UAWS (Dass et al., 2001).

Table 5. Feed cost of live weight gain in group I and II

Attribute	Group	
	I	II
Dry matter intake (kg)		
Through concentrate mixture	197.9±15.6	180.0±10.9
UAWS/HCl UAWS*	260.9±20.2	186.8±12.5
Total (kg)*	458.8±35.0	366.8±20.1
Cost of feed (Rs)		
Concentrate mixture	1,405.3±110.8	1,242.6±74.8
UAWS/HCl UAWS*	328.7±25.4	265.3±15.4
Total cost (Rs.)	1,734.0±134.5	1,563.9±89.6
Total live wt. gain (kg)*	76.2±7.3	55.6±6.4
Cost/kg gain (Rs)*	23.12±0.66	28.20±2.65

* p<0.01.

Cost of feeds in the year 2000-2001 in India were (Rs/kg): maize-6.22 wheat bran-5.38, soyabean-9.28, mineral mixture-12.98, common salt-0.95, wheat straw-1.00, urea-4.00.

CONCLUSION

Feeding of hydrochloric acid treated urea ammoniated wheat straw is not suitable for the feeding of growing buffalo calves as it reduced the growth rate in comparison to urea-ammoniated wheat straw fed buffalo calves.

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