

Effect of Naturally Fermented Wheat Straw Based Complete Feeds on the Growth of Buffalo Calves

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ABSTRACT : A 152 day trial was conducted to see the effect of feeding naturally fermented wheat straw (FWS) with either energy, protein or energy protein supplements on the growth of buffalo calves. Twenty four male buffalo calves (10-12 months old) divided in 6 equal groups were individually offered FWS as sole roughage along with either conventional concentrate mixture (conc), maize grains (M), solvent extracted mustard cake (DMC), M-DMC mixture (50:50), deoiled rice bran (DRB) or uromol bran mixture (UBM) in 70:30 ratio. The digestibility of nutrients, nitrogen retention and nutritive value was maximum in FWS:UBM followed by FWS:DMC and FWS:Conc groups. Almost, all the blood parameters were observed well within the normal range except that of blood urea (FWS:UBM) and creatinine (FWS:DMC and FWS:DRB). The dietary combination in which FWS was supplemented with only conventional protein supplement like DMC proved to be highly efficient as far as live weight gain was concerned. FWS supplemented with energy-protein combination i.e. M-DMC could also be used as complete feed for growing calves in comparison to conventional feeding system. (*Asian-Aust. J. Anim. Sci.* 2002, Vol 15, No. 11 : 1568-1572)

Key Words : Fermented Wheat Straw, Urea, Energy, Protein Supplements, Utilization of Nutrients, Buffalo Calves

INTRODUCTION

It has been reported that naturally fermented wheat straw with urea (96.5:3.5) when supplemented with Vit. A and minerals could meet the energy and protein requirements for maintenance of adult ruminants (Bakshi et al., 1986). This technology has universal application on all cereals straws, maize stovers and millet stalks (Bakshi and Langar, 1994). Keeping in view the queries raised at various forums that whether the nutrient requirements of different categories of ruminants could be met by supplementing FWS with either energy, protein or energy protein supplements in comparison to conventional concentrate mixture. Twenty-four dietary combinations using different feed ingredients supplemented to FWS in different roughage to concentrate ratio were evaluated (Pannu et al., 2002). The digestion kinetic studies revealed that FWS supplemented with N sources like uromol bran mixture (UBM), and deoiled mustard cake (DMC), energy source like maize (M) or energy protein supplement like M-DMC (50:50) in 70:30 ratio were considered quite promising. This study was undertaken to evaluate above combinations *in vivo* and to see their effect on the productive performance of buffalo calves.

MATERIALS AND METHODS

Processing of feedstuffs

Preparation of naturally fermented wheat straw (FWS) :

Urea and wheat straw (3.5:96.5) was moistened to 40 per cent and stacked for 9 d natural fermentation. In a batch, 14 kg urea was dissolved in 200 l water, uniformly sprinkled on 386 kg wheat straw, mixed and stacked for 9 days (Bakshi et al., 1987). After the completion of stipulated period, the stack was dismantled from one side for feeding to animals.

Preparation of uromol bran mixture (UBM) : Urea (1.0 kg) and molasses (3.0 kg) were cooked for 30 min. Once the boiling point was attained, the temperature was reduced and the mixture was allowed to simmer for 30 min. Thereafter, 4 kg deoiled rice bran was mixed while the uromol was still hot.

Feeding of animals

Twenty four male buffalo calves (10-12 months old) after deworming were conditioned for 30 days on FWS supplemented with conventional control concentrate mixture. Thereafter, the animals divided into 6 equal groups on live weight basis were individually offered FWS as a sole roughage with either conventional concentrate mixture (maize 20, wheat 10, deoiled mustard cake 18, deoiled rice bran 44, molasses 5, mineral mixture 2 and common salt 1 part each), only crushed maize (M), deoiled mustard cake (DMC), maize and deoiled mustard cake in 50:50 ratio (M-DMC), deoiled rice bran (DRB) or uromol bran mixture (UBM) in 70:30 ratio, supplemented with 2 kg available green fodder (to meet the Vit. A requirements) as complete feed. The experimental animals were offered 50 g each of mineral mixture and common salt in their ration. The experiment lasted for 152 days.

The feed was offered to each animal individually at 09:00 h as a single meal and water was offered twice-a-day at 10:00 and 15:00 h. The feeding schedule was changed every

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fortnight (NRC, 1989) after weighing the animals for 3 consecutive days. Daily record of feed intake and feed residue was also maintained throughout the experimental period. A fortnight prior to termination of 152 days growth trial, a 7 d digestion-cum-metabolism trial was conducted by keeping the animals in individual metabolic cages. The urine was collected in plastic canes (25 l capacity) kept underneath the metabolic cages, while faeces were collected manually round the clock. The volume of urine and weight of faeces voided by each animal was recorded at 24 h interval for 7 days. One per cent sample each of urine or faeces voided was pooled daily (animal wise) and preserved with 25 ml of 20 per cent H₂SO₄ (v/v) at 4°C till analysed for nitrogen. The dry matter voided in faeces was determined daily. The dried faecal samples were pooled (animal wise) and finely ground for chemical analysis. After the digestion-cum-metabolism trial, blood samples were also collected in heparinised tubes by puncturing jugular vein at 4 h post-feeding.

Chemical analysis

The finely ground samples of feed, feed residue and faeces were analysed for total ash, CP (AOAC, 1984), cellulose (Crampton and Maynard, 1938) and neutral detergent fibre (Robertson and VanSoest, 1981). The samples of urine were analysed for N only. Blood samples were analysed for glucose by glucose oxidase/peroxidase method (Trinder, 1969), urea by urease method (Weatherburn, 1967), protein by biuret method (Di Giorgio, 1974), albumin by bromocresol green method (Webster, 1977), creatinine by picrate method (Di Giorgio, 1974). The available metabolizable energy (ME) was calculated by using the equation of Broster and Oldham (1981).

$$\text{Available ME (MJ/kg DMI)} = \frac{\text{DOM} \times 18.5 \times 0.82}{\text{DMI}}$$

where DOM-Digestible organic matter (kg)
DMI-Dry matter intake (kg/day)

The data was analysed statistically by following completely randomized design (Snedecor and Cochran 1968).

RESULTS AND DISCUSSION

Chemical composition

The chemical composition of different dietary combinations varied with the ingredients used. The low total ash, CP and cellulose associated with high OM content in FWS:M combination was due to the corresponding composition of maize grains (Table 1). The UBM and DMC being protein supplements had high CP and low NDF content as reported earlier (Malik and Makkar, 1979; NRC, 1989). The dietary combinations containing either UBM or DMC

Table 1. Chemical composition of different feedstuffs/dietary combinations for buffalo calves (% DM basis).

	Total ash	CP	Cellulose	NDF
Feedstuff				
M	2.32	10.47	2.10	42.60
DMC	6.72	34.60	8.30	30.00
M-DMC (50:50)	4.92	24.57	5.75	36.60
DRB	10.67	19.00	9.80	63.90
UBM	11.30	47.25	6.00	31.50
Conc.	7.80	20.46	7.50	46.70
FWS	7.21	7.36	40.68	83.55
Diets				
FWS:Conc	7.39	11.29	30.73	72.49
FWS:M	5.75	8.29	29.11	71.26
FWS:DMC	7.07	15.53	30.97	67.48
FWS:M-DMC	6.53	12.52	30.21	71.56
FWS:DRB	8.25	10.85	31.42	77.65
FWS:UBM	8.44	19.50	30.28	67.93

M-Maize; DMC-Deoiled mustard cake; DRB-Deoiled rice bran; UBM-Uromol bran mixture; Conc-Concentrate mixture; FWS-Fermented wheat straw.

also had high CP content. The lowest NDF content was observed in FWS:DMC followed by that in FWS:UBM whereas the highest was in FWS:DRB. On the basis of chemical composition especially NDF which determines the digestibility of nutrients the FWS:DMC and FWS:UBM appeared to be quite promising dietary combinations.

Digestibility of nutrients

The daily dry matter intake (DMI) was maximum in conventional feeding regimen where FWS was supplemented with concentrate mixture (Table 2). The use of only energy supplement like maize with FWS decreased the DMI by 10.5 per cent. It was depressed further (19% as compared to conventional control) when only protein supplements like DMC or UBM were fed with FWS. But combination of energy and protein supplement (M-DMC) fed with FWS proved to be better choice as far as DMI was concerned. However, the daily DMI from all the dietary combinations was comparable statistically.

The digestibility of DM and that of OM was observed to be maximum in FWS:UBM combination which was statistically comparable with FWS:Conc., FWS:M and FWS:DMC combinations, but significantly higher ($p < 0.05$) than FWS:M-DMC and FWS:DRB combinations. The source of protein i.e. natural like DMC or non-conventional like UBM did not affect the CP digestibility of FWS:DMC and FWS:UBM dietary combination. The CP digestibility of these dietary combinations containing only protein supplements was significantly ($p < 0.05$) higher than all other combinations. The dietary combinations containing only maize exhibited lowest ($p < 0.05$) CP digestibility but supplementation with DMC improved it by 12 per cent. The maximum digestibility of nutrients in FWS:UBM group could be attributed to slow and consistent release of ammonia from uromol bran mixture

Table 2. Effect of different dietary combinations on the digestibility of nutrients and available ME in buffalo calves

Diet	DMI (kg/d)	Digestibility coefficient (%)					Available ME (MJ/kg DM)
		DM	OM	CP	Cellulose	NDF	
FWS:Conc	4.49	67.87 ^{bc}	70.08 ^{bc}	67.56 ^b	75.66 ^{ab}	70.15 ^b	11.63 ^{bc}
FWS:M	4.00	64.36 ^{abc}	67.32 ^{abc}	58.39 ^a	73.71 ^a	67.13 ^{ab}	11.37 ^{abc}
FWS:DMC	3.66	65.17 ^{abc}	67.65 ^{abc}	76.63 ^c	73.22 ^a	64.50 ^a	11.27 ^{abc}
FWS:M-DMC	4.22	61.93 ^a	64.96 ^a	65.58 ^b	72.01 ^a	64.70 ^a	10.89 ^{ab}
FWS:DRB	4.04	63.10 ^{ab}	65.80 ^{ab}	63.94 ^b	75.01 ^{ab}	67.77 ^{ab}	10.84 ^a
FWS:UBM	3.59	68.73 ^c	71.25 ^c	81.57 ^c	78.91 ^b	70.80 ^b	11.76 ^c
Pooled SE	0.36	1.33	1.50	1.63	1.55	1.61	0.25

M-Maize; DMC-Deoiled mustard cake; DRB-Deoiled rice bran; UBM-Uromol bran mixture; Conc-Concentrate mixture; FWS-Fermented wheat straw.

Mean values with different superscripts in the same column differ significantly ($p < 0.05$).

which could be used efficiently by rumen microbes. Chopra et al. (1974) and Mudgal and Puri (1977) have also reported slow and consistent release of ammonia from uromol as compared to that from unheated urea-molasses mixture, because of the maillard complex formed during heating of urea and molasses. Further, more than 80 per cent of the cellulolytic organisms in the rumen require ammonical nitrogen for their proliferation (Hungate, 1966) which resulted in significantly higher ($p < 0.05$) cell wall constituents digestibility in this group. The availability of ME was the highest ($p < 0.05$) in FWS:UBM group which was statistically comparable with that of FWS:Conc., FWS:M and FWS:DMC combinations. The availability of ME was minimum from FWS:DRB combination.

Blood profile

The constituents of blood remain within a normal range unless and until there is drastic change in their feeding schedule, environment or disease stress. But small variation within the normal range due to various dietary factors have been reported in the literature. The low serum protein concentration ($p < 0.05$) in animals fed FWS:DRB ration was due to low concentration of albumin and globulin fractions although the ratio of albumin to globulin was comparable with all other groups (Table 3). The highest concentration of blood urea in the FWS:UBM diet was obviously due to the presence of UBM. Turner and Boyer (1998) have reported that blood urea nitrogen concentration increased with the increase in per cent dietary nitrogen. Further, the higher blood urea level has been reported to be an index of inefficient protein utilization (Broderick and Clayton, 1998). Serum creatinine an indicator

of energy status of the animal was significantly higher ($p < 0.05$) in FWS:DRB fed animals. It indicated that the ration was not able to fulfil the energy requirements of growing animals. Similar trend was observed for diets containing only protein supplements like DMC. However, with the inclusion of energy rich ingredient like maize in the diet containing only DMC, the serum creatinine concentration decreased by 19 per cent. The high creatinine concentration in animals fed only DRB or DMC could be due to negligible fat content. Hovell et al. (1983) have also reported an apparent correlation between creatinine excretion and the amount of energy (VFA) infused in wether lambs. The regression coefficient was statistically significant.

Nitrogen retention

The daily N intake from the diets containing protein supplements (DMC or UBM) alone or in combination with energy rich feedstuffs (M-DMC) was significantly ($p < 0.05$) higher than diet containing only energy supplement like maize (Table 4). The FWS:UBM combination resulted in the lowest faecal-N excretion because of highest CP digestibility in this group. It was significantly lower ($p < 0.05$) than all other combinations except FWS:DMC combination. The N-excretion in the urine was maximum in FWS:UBM dietary combination. It may be because of higher N-intake resulting in higher blood urea nitrogen leading to higher urinary-N excretion in this group. Turner and Boyer (1998) have also reported increased urinary nitrogen excretion in lambs offered alfa alfa hay as compared to those offered timothy hay. The N retention was considerably high ($p < 0.05$) in dietary combinations containing conventional (DMC) or non-

Table 3. Effect of different dietary combinations on the blood profile of buffalo calves (mg %)

Diet	Protein*	Albumin*	Globulin*	Alb:Glb	Blood urea	Glucose	Creatinine
FWS:Conc	7.43 ^c	2.76 ^b	4.67 ^{ab}	0.60	26.84	49.53	1.37 ^a
FWS:M	7.30 ^{bc}	2.59 ^{ab}	4.71 ^b	0.55	22.77	50.77	1.77 ^{ab}
FWS:DMC	6.91 ^{bc}	2.60 ^{ab}	4.32 ^{ab}	0.61	22.95	52.50	2.96 ^c
FWS:M-DMC	6.78 ^{abc}	2.70 ^b	4.08 ^{ab}	0.67	21.30	48.65	2.40 ^{bc}
FWS:DRB	6.12 ^a	2.33 ^a	3.79 ^a	0.63	24.61	52.79	3.00 ^c
FWS:UBM	6.56 ^{ab}	2.46 ^{ab}	4.11 ^{ab}	0.61	34.77	50.88	1.73 ^{ab}
Pooled SE	0.24	0.12	0.29	0.06	6.04	2.07	0.26

M-Maize; DMC-Deoiled mustard cake; DRB-Deoiled rice bran; UBM-Uromol bran mixture; Conc-Concentrate mixture; FWS-Fermented wheat straw.

Mean values with different superscripts in a column differ significantly ($p < 0.05$). * (g/100 ml)

Table 4. Effect of different dietary combinations on nitrogen retention (g/day) in buffalo calves

Diet	Intake	Faeces	Urine	Retention	Apparent BV (%)	DCP (%)
FWS:Conc	83.53 ^{abc}	27.05 ^{bc}	25.03 ^{bc}	31.45 ^{ab}	55.29	7.86 ^{bc}
FWS:M	58.32 ^a	24.12 ^{bc}	12.40 ^a	21.80 ^a	63.97	5.29 ^a
FWS:DMC	90.78 ^{bc}	21.11 ^{ab}	24.54 ^{bc}	45.13 ^b	63.74	11.90 ^d
FWS:M-DMC	84.12 ^{abc}	28.81 ^c	27.05 ^{bc}	28.26 ^{ab}	49.37	8.20 ^c
FWS:DRB	68.98 ^{ab}	24.90 ^{bc}	19.42 ^{ab}	24.66 ^a	55.83	6.82 ^b
FWS:UBM	95.05 ^c	17.36 ^a	32.66 ^c	45.20 ^b	58.16	13.39 ^e
Pooled SE	8.44	2.09	3.70	6.32	6.20	0.44

M-Maize; DMC-Deoiled mustard cake; DRB-Deoiled rice bran; UBM-Uromol bran mixture; Conc-Concentrate mixture; FWS-Fermented wheat straw. Mean values with different superscripts in a column differ significantly ($p < 0.05$).

conventional (UBM) protein supplements but comparable with combination containing concentrate mixture or M-DMC. The efficiency of utilization of nitrogen i.e. apparent biological value of protein of various dietary combinations was comparable in all the groups. It clearly indicated that even though the nitrogen retained was low in the diet containing only maize but the efficiency of utilization of the retained nitrogen was equivalent to that of diet containing DMC whereas in case of diet containing UBM, the nitrogen retained was comparable to that of DMC but efficiency of utilization of nitrogen from UBM was approximately 10 per cent less than that of diets containing only maize or DMC. It can be concluded that the dietary level and source of nitrogen have direct impact on the efficiency of utilization. The nutritive value of diets (as indicated by per cent of DCP value) containing protein supplements alone or in combination with energy supplements was better than that of diets containing only energy sources like maize.

Live weight changes

Maximum daily live weight gain was noted in animals fed conventional protein supplement (DMC) with FWS (Table 5). The use of cereal grains only should not be advocated as they are unable to meet the protein requirements of growing animals. Supplementation of protein source in the ration containing only maize improved the daily live weight gain by 16.4 per cent. The daily live weight gain in the non-

conventional protein supplement (UBM) group was minimum because the diet was unable to provide protein for tissue growth may be due to inefficient protein utilization (as indicated by high blood urea and urinary-N excretion). The study conclusively revealed that conventional protein supplement alone or in combination with energy source with nutritionally improved poor quality crop residues like FWS could be used as complete feed for growing animals in comparison to conventional feeding system where roughage is supplemented with concentrate mixture.

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Table 5. Effect of different dietary combinations on the live weight changes in buffalo calves

Diet	Intial live wt. (kg)	Final live wt (kg)	Gain in wt. (kg)	Gain in wt. (g/day)
FWS:Conc	131.99	172.22	40.22 ^{bc}	264.63 ^{bc}
FWS:M	139.44	170.44	31.00 ^{abc}	203.97 ^{abc}
FWS:DMC	120.11	165.44	45.34 ^c	298.27 ^c
FWS:M-DMC	158.66	194.89	36.22 ^{abc}	238.31 ^{abc}
FWS:DRB	145.11	172.77	27.67 ^{ab}	182.02 ^{ab}
FWS:UBM	137.00	160.22	23.22 ^a	152.77 ^a
Pooled SE	17.25	19.14	5.22	34.34

M-Maize; DMC-Deoiled mustard cake; DRB-Deoiled rice bran; UBM-Uromol bran mixture; Conc-Concentrate mixture; FWS-Fermented wheat straw. Mean values with different superscripts in a column differ significantly ($p < 0.05$).

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