Feeding Value of Urea Treated Wheat Straw Ensiled with or without Acidified Molasses in *Nili-Ravi* Buffaloes

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ABSTRACT : Thirty early lactating *Nili-Ravi* buffaloes, six animals in each group, were used in a completely randomized design to examine the feeding value of 4% urea treated wheat straw (UTWS) ensiled with 6% or without acidified molasses. Five experimental diets were formulated. The control ration was balanced to contain 30% DM from UTWS ensiled without acidified molasses. The other four diets were formulated to have 30, 40, 50 and 60% DM from UTWS ensiled with 6% acidified molasses, respectively. Dry matter and neutral detergent fiber (NDF) intakes were higher in buffaloes fed diets containing UTWS ensiled with acidified molasses compared with those fed a diet containing UTWS ensiled without acidified molasses. Intake of DM was not significantly different in buffaloes fed diets containing varying levels of UTWS ensiled with acidified molasses. A similar trend was observed for crude protein (CP) intake. Apparent DM and NDF digestibilities were significantly higher in buffaloes fed diets containing UTWS ensiled with acidified molasses compared with those fed UTWS ensiled without acidified molasses. However, differences in DM and NDF digestibilities were non-significant across buffaloes fed diets containing varying levels of UTWS ensiled with acidified molasses. Milk yield (4% fat corrected) was significantly higher in buffaloes fed diets containing UTWS ensiled with acidified molasses than those fed a diet containing UTWS ensiled without acidified molasses. Milk yield was similar in buffaloes fed varying level of UTWS ensiled with acidified molasses. Milk CP, true protein, solid-not-fat and total solids were similar in buffaloes fed UTWS ensiled with or without acidified molasses. The UTWS ensiled with 6% acidified molasses can be included at up to 60% DM of lactating buffalo rations without any ill effect on productivity. ***(Asian-Aust. J. Anim. Sci. 2006. Vol 19, No. 5 : 645-650)***

Key Words : Fermentable Carbohydrates, Crop Residues, Intake Digestibility, Milk Yield, Lactating Buffaloes

INTRODUCTION

Fibrous crop residues (wheat straw, rice straw, stovers and corncobs) are important feedstuffs for ruminants in south Asian region. However, these feedstuffs are characterized by high content of indigestible fiber due to increased lignification of cellulose. Fermentable energy and protein deficiencies in crop residues coupled with their low digestibility impaired the ruminal functions, intake and ruminant productivity (Sarwar et al., 2004a).

Physical, chemical (Sarwar et al., 2004a, b), and biological (Sarwar et al., 1994) treatments have been used to weaken and break lingo-cellulosic bonds in crop residues, thereby increasing their feeding value for ruminants. Alkali, ammonia, and urea treatments have received much attention, however urea, which has high content of nitrogen (N), was more cost effective (Sarwar et al., 1994).

Ammoniation of crop residues through urea treatment is not a perfect method because only 30 to 35% of NH_3 released from urea is retained in the straw (Saadullah et al., 1981). Out of the retained N, much of it was held as water-soluble and thus rapidly liberated in the rumen and caused nutrient loss (Sarwar et al., 2004).

Efforts have been made to capture NH_3-N in urea treated fibrous crop residues using various organic and inorganic acids (Borhami et al., 1982; Yadav and Virk, 1994; Dass et al., 2001). However, fixing excess NH_3 with acid is costly and hazardous and thus, its use by the farmers is impracticable (Nisa et al., 2004a).

Sarwar et al. (2003) reported that ensilation of urea-treated wheat straw with corn steep liquor (CSL) or acidified molasses better fixed N and brought favorable physiochemical changes (Sarwar et al., 2004a) in wheat straw compared with urea- treated wheat straw ensiled with organic acids. Because CSL not only contains rapidly fermentable carbohydrates, which could improve fermentation, but it's acidic, pH (3.7) could also help to fix the NH_3 (Nisa et al., 2004a). Thus, the use of acidified molasses could enhance both the fermentation process and NH_3 fixation in the ensiled UTWS.

However, the scientific evidence regarding influence of UTWS ensiled with acidified molasses on performance of lactating buffaloes is limited. Therefore, the present study was planed to evaluate different levels of UTWS ensiled

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Table 1. Chemical composition of acidified cane molasses (on dry matter basis)

Composition	Cane molasses
Dry matter (%)	68
Protein (%)	4.7
Ash (%)	11
pH	3.7[1]

[1] Acetic acid was added in the cane molasses to attain the pH 3.7.

Table 2. Chemical composition (on dry matter basis) of urea treated wheat straw ensiled with and without acidified molasses

Chemical composition	Treatments [1]	
	US	MUS
Total nitrogen	0.99	1.98
NDIN [2]	0.28	0.60
ADIN [3]	0.25	0.25
NH_3-nitrogen	0.70	0.72
NDF	77.0	80.0
CP free NDF[4]	74.8	74.4
Hemicellulose	24.5	30.2
CP free hemicellulose[5]	23.4	24.1
Cellulose	42.5	41.5

[1] Wheat straw was treated with 4% urea and was ensiled without (US) and with 6% acidified molasses (MUS), respectively.
[2] Neutral detergent insoluble nitrogen.
[3] Acid detergent insoluble nitrogen.
[4] CP free NDF was calculated as (NDF-NDIN×6.25).
[5] CP free Hemicellulose was calculated (NDF-NDIN×6.25)-ADF-(ADIN×6.25).

with or without acidified molasses on feed intake, digestibility milk yield and its composition in *Nili-Ravi* buffaloes.

MATERIALS AND METHODS

Treatment of wheat straw

The urea treatment method used in this study was to add 4 kg urea and 50 kg water per 100 kg air-dry wheat straw. After the urea was dissolved in the water, the solution was uniformly sprayed on the wheat straw. In the control pit, the wheat straw was treated with 4% urea only. In the second pit, 6% acidified molasses (Table 1) on dry matter (DM) basis was added to 4% UTWS. Each pit was covered with 15mm thick layer of rice straw, followed by plastic film covering which was plastered with a blend of wheat straw and mud to avoid any cracking on drying. The treated material was allowed to react for 15 days, it was assumed that plastic film, and mud plastering provided anaerobic conditions for proper silage making. When feed was used, the plastic film was removed and the feed was withdrawn starting with the upper layer and working downwards to the lower layers. An amount of the fermented straw was taken out just sufficient for one day's feeding after being taken from the pit and the plastic film was put back to keep the pit sealed. The samples of this fermented wheat straw were analyzed for DM, organic matter (OM), neutral detergent insoluble nitrogen (NDIN), acid detergent insoluble nitrogen (ADIN), N and ash by the methods of AOAC (1990), neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) by methods described by Van Soest et al. (1991). Chemical composition of UTWS ensiled with or without 6% acidified molasses is given in Table 2.

Table 3. Ingredients and chemical composition of diets containing urea treated wheat straw ensiled with or without acidified molasses

Ingredients	Diets*				
	U30	MU30	MU40	MU50	MU60
Wheat straw	30	30	40	50	60
Corn grain	25	25	25	20	10
Wheat screening	15	20	10	5	5
Canola meal	15	7	13	12	12
Sun flower meal	10	10	6	6	5
Wheat bran	1	5	2	2	2
Vegetable oil	1	1	2	3	4
Di-calcium phosphate	2	2	2	2	2
Chemical composition					
NDF[1] (%)	42.6	45.6	48.6	53.9	59.5
CP[2] (%)	16	16	16	16	16
EE[3] (%)	3.9	3.8	4.5	5.1	5.8
NE_L[4] (kcal /kg)	1.4	1.4	1.4	1.4	1.4

* U30 diet contained 30% DM from UTWS ensiled without acidified molasses and MU30, MU40, MU50 and MU60 diets had 40, 50 and 60% DM from UTWS ensiled with 6% acidified molasses, respectively.
[1] Neutral detergent fiber.
[2] Crude protein.
[3] Ether extract (ruminally protected fat was added to make experimental diets iso-caloric).
[4] NE_L was calculated according to Conrad et al. (1984).

Animals and diets

Thirty early lactating *Nili-Ravi* buffaloes, six animals in each group, were used in a Completely Randomized Design to evaluate the effect of varying levels of 4% UTWS ensiled with 6% acidified molasses or without acidified molasses on feed intake, digestibility and milk production and its composition. Animals were housed on a concrete floor in separate pens. Buffaloes averaged 30±5 days in lactation. Five experimental diets were formulated (Table 3). The control ration was balanced to contain 30% DM from UTWS ensiled without acidified molasses (U30). Other four experimental diets were formulated to have 30 (MU30), 40 (MU40), 50 (MU50) and 60% (MU60) DM from UTWS ensiled with 6% acidified molasses, respectively. All diets were formulated to be iso-nitrogenous and iso-caloric (Table 3) using NRC (2001). Diets were mixed daily and fed twice a day at *ad libitum* intakes.

The buffaloes were fed for 120 days. The first 20 days were allowed for dietary adaptation and 100 days were for sample collection. Daily feed intake and milk production

Table 4. Nutrient intake and digestibility by buffaloes fed diets containing urea treated wheat straw ensiled with or without acidified molasses

Items	Treatments [1]					
	U30	MU30	MU40	MU50	MU60	SE
Dry matter intake (kg/day)	13.00[b]	15.49[a]	16.45[a]	16.108[a]	15.68[a]	0.54
Apparent DM digestibility (%)	64.84[b]	69.96[a]	68.77[a]	68.67[a]	68.99[a]	0.40
CP[2] Intake (kg/day)	2.08[b]	2.51[a]	2.63[a]	2.58[a]	2.50[a]	0.06
Apparent CP digestibility (%)	66.10[b]	68.90[a]	69.45[a]	69.61[a]	69.50[a]	0.20
EE[3] intake (kg/day)	0.58[b]	0.58[b]	0.74[a]	0.82[a]	0.86[a]	0.04
Apparent EE digestibility (%)	80.99	81.8	80.90	82.10	81.43	0.50
NDF[4] intake (kg/day)	5.98[c]	7.06[b]	7.99[b]	8.67[a]	9.32[a]	0.18
NDF digestibility (%)	52.90[b]	58.40[a]	57.70[a]	57.10[a]	56.87[a]	0.32
ADF[5] intake (kg/day)	3.16	3.45	4.06	4.47	4.84	0.17
ADF digestibility (%)	47.33	49.40	50.04	50.72	49.85	0.80

[1] U30 diet contained 30% DM from UTWS ensiled without acidified molasses and MU30, MU40, MU50 and MU60 diets had 40, 50 and 60% DM from UTWS ensiled with 6% acidified molasses, respectively.

[2] Crude protein, [3] Ether extract, [4] Neutral detergent fiber, [5] Acid detergent fiber.

Means in the same row having different superscripts differ significantly ($p<0.05$).

were averaged over 100 days. Milk samples (a.m. and p.m.) were collected twice weekly during the last 100 days of feeding trial and were analyzed for crude protein (CP), true protein (TP), fat, solid not fat (SNF), total solids (TS) and ash by the methods described by AOAC (1990). During the last week of the trial, a digestion trial was conducted. The acid insoluble ash was used as digestibility marker (Van Keulen and Young, 1977). Fecal grab samples were taken twice daily such that a sample was obtained for every 3 h interval of 24 h period (8 samples) between a.m. and p.m. feedings (Sarwar et al., 1991). Feed offered and orts were sampled daily and composited by animal for analysis. Diets, orts and fecal samples were analyzed for DM, OM and CP by the methods of AOAC (1990) NDF ADF, ADL by the methods of (Van Soest, 1991) and NE_L was estimated by the equation of Conrad et al. (1984).

Statistical analysis

The data collected on different parameters (feed intake, milk production, milk composition and digestibility) were analyzed according to Completely Randomized Design. The difference in means was tested using Duncan's Multiple Range test (Steel and Torrie, 1984). Significance at $p<0.05$ were used throughout unless otherwise noted.

RESULTS

Chemical composition

Chemical composition of 4% UTWS ensiled with or without acidified molasses is given in Table 2. Total N contents of UTWS ensiled with acidified molasses were higher than UTWS ensiled without acidified molasses. The UTWS ensiled with 6% acidified molasses had approximately double N contents compared with UTWS ensiled without acidified molasses. The acidified molasses not only increased total N concentration in UTWS, it also improved the NDIN content in UTWS.

Neutral detergent fibre contents of UTWS ensiled with acidified molasses were higher than UTWS ensiled without acidified molasses. Neutral detergent fibre contents on CP-free basis (NDF-NDIN×6.25) were similar for UTWS ensiled with or without acidified molasses. Hemicellulose content was higher in UTWS ensiled with acidified molasses than that ensiled without acidified molasses. However, hemicellulose contents were similar when calculated on a CP-free basis [(NDF-NDIN×6.25)-(ADF-ADIN×6.25)] across treatments.

Intake

Dry matter (% body weight) and NDF intakes (kg/day) were higher in buffaloes fed diets containing UTWS ensiled with acidified molasses compared with those fed diet containing UTWS ensiled without acidified molasses (Table 4). Intake of DM was non-significant in buffaloes fed diets containing varying levels of UTWS ensiled with acidified molasses. Similar trend was observed for CP intake. The ether extract (EE) intake was increased with increasing level of UTWS ensiled with acidified molasses. However, ADF intake was non-significant in buffaloes fed UTWS ensiled with or without acidified molasses.

Digestibility

Apparent DM and NDF digestibilities were significantly higher in buffaloes fed diets containing UTWS ensiled with acidified molasses than those fed UTWS ensiled without acidified molasses (Table 4). However, DM and NDF digestibilities were non-significant across buffaloes fed diets containing varying levels of UTWS ensiled with acidified molasses. Similar trend was observed for CP digestibility. The apparent EE and ADF digestibilities were non-significant across all experimental diets.

Table 5. Milk yield and its composition in buffaloes fed diets containing urea treated wheat straw with or without acidified molasses

	Treatments[1]					SE
	U30	MU30	MU40	MU50	MU60	
Milk yield[2] (kg/day)	11.67[b]	15.64[a]	15.49[a]	15.98[a]	15.31[a]	1.36
Milk fat (%)	5.77[b]	6.93[a]	6.90[a]	7.00[a]	6.95[a]	0.34
Solids not fat (%)	9.44	9.22	9.50	9.26	9.05	0.14
Total solids (%)	15.21	16.15	16.40	16.26	16.00	0.44
Crude protein (%)	3.78	3.76	3.70	3.99	3.97	0.10
True protein (%)	3.14	3.27	3.24	3.30	3.26	0.11
Non-protein nitrogen (%)	0.64[a]	0.49[b]	0.46[b]	0.69[a]	0.71[a]	0.06

[1] U30 diet contained 30% DM from UTWS ensiled without acidified molasses and MU30, MU40, MU50 and MU60 diets had contained 30, 40, 50 and 60% DM from UTWS ensiled with 6% acidified molasses, respectively.
[2] 4% fat corrected milk yield.
Means in the same row having different superscripts differ significantly at ($p<0.05$).

Milk yield and its composition

Milk yield (4% fat corrected) was significantly higher in buffaloes fed diets containing UTWS ensiled with acidified molasses than those fed diet containing UTWS ensiled without acidified molasses (Table 5). Milk yield was similar in buffaloes fed varying level of UTWS ensiled with acidified molasses. The percent milk fat contents were significantly higher in buffaloes fed diets containing UTWS ensiled with acidified molasses than those fed diet containing UTWS ensiled without acidified molasses. However, milk fat (%) was non-significant across all diets containing varying levels of UTWS ensiled with acidified molasses. Milk CP, TP, SNF and TS were similar in buffaloes fed UTWS ensiled with or without acidified molasses. Milk non-protein N contents were lower in buffaloes fed MU30 and MU40 diets than those fed MU50, MU60 and U30 diets.

DISCUSSION

Chemical composition

Higher N content of UTWS ensiled with acidified molasses was likely due to low pH of acidified molasses (Table 1). The provision of readily available nutrients (carbohydrates and minerals) for proper fermentation by acidified molasses might have caused a further drop in pH of UTWS. Decreased pH has probably changed free NH_3 into an ionic form of ammonia (NH^{4+}) that is very reactive and has a greater tendency to make bonds with fibrous materials.

Similar higher N values in ammoniated straw were reported when excess free NH_3 was trapped by using fermentable carbohydrates (Sarwar et al., 2004a). Increase in NDF content of UTWS ensiled with acidified molasses was due to increased NDIN, as NDF contents on a CP-free basis (NDF-NDIN×6.25) were similar for UTWS ensiled with or without acidified molasses. Sarwar et al. (2004a) reported that NDF content was higher in UTWS ensiled with fermentable carbohydrates compared with UTWS ensiled with organic acids. The entire increase in NDF content was because of fiber-bound N. Concentrations of ADIN, ADF, cellulose and lignin were similar in UTWS ensiled with different levels of acidified molasses.

Intake

Higher DM and NDF intakes with UTWS in this study can be ascribed to both the enhanced fiber digestibility of wheat straw because of ammoniation and addition of ruminally inert fat that not only remained largely unavailable in the rumen because of its low solubility and high melting point (Khan et al., 2004) but it could not also impair ruminal fiber digestibility that possibly affects the distension of rumen that can limit the intake. Higher DM and NDF intakes with diets containing UTWS ensiled with acidified molasses would be because of higher degradability (Sarwar et al., 2004a) and digestibility (Nisa et al., 2004) of UTWS ensiled with acidified molasses. The low DM intake with UTWS ensiled without acidified molasses may be due to higher fluxes of ruminal NH_3 and plasma urea N (Sarwar et al., 2004a). These results were contrary to those reported by Dass et al. (2001), who observed no difference in DM intake in buffaloes fed ammoniated straw ensiled with or without Hydrochloric acid. However, urea plus CSL treatment to wheat straw has improved digestibility and thus it increased feed intake by lactating buffaloes (Nisa et al., 2004a). Higher EE intake was because of higher contents of ruminally-protected fat that was added in these diets to make them iso-caloric.

Digestibility

Higher digestibility in buffaloes fed UTWS ensiled with acidified molasses may be because of physico-chemical changes that occurred in the cell wall structure (Nisa et al., 2004), making more structural carbohydrates available for microbial fermentation in the rumen (Mehra et al., 2001). Higher NDF digestibility in buffaloes fed UTWS ensiled with acidified molasses was because of its increased rate of degradation (Sarwar et al., 2004a) and shorter lag time

(Mehra et al., 2001) and increased fragility of UTWS ensiled with acidified molasses (Sarwar et al., 2004a). In present study, increased NH_3 retention in UTWS ensiled with acidified molasses might have broken the linkages between lignin and cellulose or hemicellulose (Nisa et al., 2004a) thus resulted in better digestibility.

Milk yield and its composition

Higher milk yield in buffaloes fed UTWS ensiled with acidified molasses was because of increased digestible DM and NDF intake and higher ruminally inert fat concentration. The results of this study were consistent with the findings of Osteigaard et al. (1981) who reported that increased milk production by feeding ruminally inert fat to lactating cows at different stages of lactation. Cant et al. (1993) reported that cows performed better when fed highly digestible fiber, which increased DM intake and milk production. Khan et al. (2004) reported that milk production was increased when fat was added in the dairy diets containing urea treated corncobs ensiled with enzose (corn dextrose). They attributed this increase in milk production to higher amount of both ruminally un-degradable protein and inert fat which might have provided a better nutrient synchronization at cellular level and thus helped synthesize more milk (Kanjanapruthipong and Leng, 1998; Sarwar et al., 2004b).

Higher non-protein N content of milk in buffaloes was because of higher level of dietary non-protein N that might have exceeds the fixation capacity of ruminal microbes and thus might have caused higher blood urea N and milk non-protein N. Results of metabolic trials (Nisa et al., 2003; Sarwar et al., 2004b) revealed that total, viable and cellulolytic bacterial count per ml was higher in buffaloes fed diets containing UTWS ensiled with CSL when compared to those fed diets containing UTWS ensiled without CSL.

CONCLUSIONS

Urea treated wheat straw ensiled with 6% acidified molasses can be included up to 60% DM of lactating buffalo rations without any ill effect on productivity. This inclusion may reduce the concentrate requirements in the diets of lactating buffaloes. However, extensive feeding trials involving more number of buffaloes are warranted before any practical recommendation.

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