Feeding Value of Urea Treated Corncobs Ensiled with or without Enzose (Corn Dextrose) for Lactating Crossbred Cows

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ABSTRACT : This study was aimed to establish the amount of enzose (corn dextrose) for optimum N fixation in urea treated corncobs (UTC) and their dietary effect on nutrient intake, digestibility and milk yield in crossbred cows. Corncobs were treated with 5% urea and ensiled in laboratory silos with 0, 2, 4 and 6% enzose for 15 days. Total nitrogen (N), neutral detergent fiber (NDF) and neutral detergent insoluble N contents were increased in UTC with the level of enzose. Five early lactating crossbred cows (Sahiwal×Holstein Frisian) were used in a 5×5 Latin Square Design to see the influence of UTC ensiled with 6% enzose on nutrient intake, digestibility, milk yield and its composition. Five iso-nitrogenous and iso-caloric diets were formulated. The UTC30 (control), UTC40, UTC50, UTC60 and UTC70 diets contained 30% UTC ensiled without enzose and 40, 50, 60, 70% UTC ensiled with 6% enzose, respectively. Dry matter, NDF and ADF intakes were increased with the increasing level of UTC ensiled with enzose in the diets of cows. Dry matter, NDF and ADF digestibilities were significantly higher with diets containing UTC ensiled with enzose. Milk yield was significantly higher in cows fed UTC70 compared to those fed on other diets. The milk crude protein percentage was significantly different across treatments. However, milk fat, total solids, solid not fat, true protein and non-protein nitrogen contents of milk remained similar across all diets. Ensilation of UTC with 6% enzose improved the nitrogen retention and thus enhanced the feeding value of UTC for lactating cows. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 8 : 1093-1097)***

Key Words : Urea, Corncobs, Enzose, Nitrogen Fixation, Digestibility, Milk Yield

INTRODUCTION

Dairy animals require maximum dry matter intake with optimum coupling of nutrients at digestive and cellular levels to support milk yield (Sarwar et al., 2003b). However, the basal feeds available to dairy animals in developing countries are largely the fibrous crop residues like straws, stovers, stubbles and corncobs, etc. (Man and Wiktorsson, 2001). Crop residues contain largely fibrous materials of low digestibility that consequently limit the intake in the ruminants. Protein and energy deficiency in combination with low digestibility of crop residues often restrict animal productivity (Klopfenstin et al., 1991; Islam et al., 2002). Feeding value of low quality fibrous feeds can be improved through various biological, physical or chemical treatments. Among various chemicals employed for upgrading fibrous feeds, ammonia, an alkali, proved to be better (Sarwar et al., 1994). However, ammoniation through urea treatment increases the pH of treated material and this increased pH does not only cause nitrogen (N) loss that escapes to the environment but also it causes asynchrony between available N and energy (Sarwar et al., 2004b).

Inorganic and organic acids were used with various degrees of success to capture NH_3 in the urea treated material (Yadave and Virk, 1994; Dass et al., 2001). However, fixing excess NH_3 with acid is costly and hazardous and thus, its use by farmers is impracticable. Ensiling urea treated material with fermentable sugars increased the production of lactic acid that reduced the pH and thus improved the N retention (Sarwar et al., 2003a). The enzose (dextrose derived from the enzymatic conversion of corn starch) could be used to enhance both the N fixation and fermentation process in urea treated corncobs (UTC). However the scientific evidence regarding the effect of dextrose on chemical composition and feeding value of UTC was limited. Thus the main objectives of the study were to establish the amount of enzose for optimum N fixation in corncobs and its dietary effect on nutrient intake, digestibility and milk yield in crossbred cows.

MATERIALS AND METHODS

Laboratory silos

Corncobs were ground through a Wiley mill (2 mm screen) and were treated with 5 kg urea and 50 kg water per 100 kg air-dry corncobs. The enzose was added to the urea treated corncobs at 0, 2, 4 and 6% on dry matter (DM) basis. The treated corncobs were ensiled in laboratory silos for 15 days at 40°C. Four laboratory silos were prepared for each level of enzose. The samples of fermented corncobs 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). NDF, acid detergent fiber (ADF) and acid detergent lignin (ADL) by methods described by Van Soest et al. (1991).

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Table 1. Ingredients and chemical composition of experimental diets

Ingredients	Diets[1]				
	UTC30	UTC40	UTC50	UTC60	UTC70
Corncobs (%)	30	40	50	60	70
Corn oil cake (%)	25	20	15	10	5
Corn gluten meal (%)	16	4	4	4	3
Corn bran (%)	29	34	28	22	17
Crude corn oil (%)	1	2	3	4	5
Chemical composition					
Crude protein (%)	16.00	16.60	16.30	16.20	16.07
NE_L (Mcal/kg)[2]	1.49	1.47	1.46	1.46	1.46
TDN (%)	70	70	67	65	63
NDF (%)	44	45	52	59	65
EE (%)	3.19	4.38	5.23	5.72	6.22

[1] UTC30 diet contained 30% urea treated corncobs ensiled without enzose, while UTC40, UTC50, UTC60 and UTC70 contained 40, 50, 60 and 70% urea treated corncobs ensiled with 6% enzose, respectively.
[2] NE_L was calculated from Conrad et al. (1984).

Table 2. Influence of varying levels of enzose on chemical composition of urea treated corncobs[1]

Items	Treatments[2]			
	E 0	E 2	E 4	E6
Total N	1.19	1.61	2.14	2.48
NH_3-N	0.81	0.83	0.85	0.87
NDIN[3]	0.41	0.69	0.84	0.99
ADIN[4]	0.39	0.42	0.43	0.46
Remainder-N	0.28	0.46	0.49	0.55
NDF	78.01	80.1	82.4	84.9
CP-free NDF	75.59	77.21	78.18	79.88
ADF	53.52	53.23	54.10	53.85
Hemicellulose	24.49	26.90	28.30	31.14
CP free Hemicellulose	19.23	20.02	20.19	21.01
Cellulose (%)	34.15	35.09	35.97	36.87

[1] Corncobs were treated with 5% urea.
[2] E 0, E 2, E 4, E 6 treatments were 5% urea treated corn cobs ensiled with 0, 2, 4 and 6% enzose, respectively.
[3] NDIN neutral detergent insoluble nitrogen.
[4] ADIN acid detergent insoluble nitrogen.
CP free NDF was calculated as (NDF-NDIN×6.25).
CP free Hemicellulose was calculated (NDF-NDIN×6.25)-ADF-(ADIN ×6.25).

Treatment of corncobs

The urea treatment method used for the performance trial was to add 5 kg urea and 50 kg water per 100 kg air-dried crushed corncobs. After the urea was dissolved in the water, the solution was uniformly sprayed on the corncobs. Then the corncobs were put into two different cemented pits and ensiled for a period of 5 days with air temperatures of 35-45°C. In the control pit, the corncobs were treated with 5% urea only. In the second pit, 6% enzose on DM basis was added to 5% urea treated corncobs. Each pit was covered with a 20 mm thick layer of rice straw, followed by a plastic film covering which was plastered with a blend of wheat straw and mud to avoid any cracking on drying. The material was allowed to react for 15 days. When the feed was used, the plastic film was removed and the feed was withdrawn starting from the upper layer to downward layers. An amount of the fermented corncobs 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 these fermented corncobs were analyzed for DM, OM, N and ash by the methods of AOAC (1990). NDF, ADF and ADL by methods described by Van Soest et al. (1991).

Animals and diets

Five early lactating crossbred cows (Sahiwal×Holstein Frisian) were used in a 5×5 Latin Square Design to evaluate the effect of varying levels of 5% urea treated corncobs ensiled with or without enzose on feed intake, digestibility and milk production and composition. Cows were housed on a concrete floor in separate pens. Crossbred cows were about 45±5 days in lactation. Five experimental diets were formulated to be iso-nitrogenous and iso-energetic using NRC (2001) values for energy and protein (Table 1). The control ration (UTC30) was balanced to contain 30% urea treated corncobs without enzose. The UTC40, UTC50, UTC60 and UTC70 diets were formulated to have 40, 50, 60 and 70% urea treated corncobs ensiled with 6% enzose, respectively. Diets were mixed daily and fed twice a day at *ad libitum* intakes. The cows were fed for 5 periods. The first 20 days of each period was allowed for dietary adaptation and last 10 days were given for sample collection. Daily feed intake and milk production were averaged over 150 days. 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 am and pm feedings (Sarwar et al., 1992). Feed offered and orts were sampled daily and composited by animal for analysis. The acid insoluble ash was used as digestibility marker (Van Keulen and Young, 1977). Diets, orts and fecal samples were analyzed for DM, OM and CP (AOAC, 1990) for NDF (Van Soest, 1991), ADF and ADL (AOAC, 1990) for estimation of NE_L (Conrad et al., 1984). Milk samples (a.m. and p.m.) were collected twice each day during sampling days of feeding trial and were analyzed for CP, fat, solid not fat, total solids by methods described by AOAC (1990).

Statistical analysis

Data were analysed as a 5×5 Latin Square Design using the GLM procedure of SAS (1988). The sums of squares of the model were separated into animal and treatment. In case of an interaction, means were separated by Duncan's multiple range test (Steel and Torrie, 1984).

RESULTS

Total N and NDIN content were higher in UTC ensiled with enzose compared to UTC ensiled without enzose (Table 2). About 31, 49, 72 and 87% of the added urea

Table 3. Nutrient intakes and digestibilities by crossbred cows fed diets containing urea treated corncobs ensiled with or without enzose

Items	Treatments[1]					
	UTC30	UTC40	UTC50	UTC60	UTC70	SE
Dry matter intake (kg/day)	10.9[a]	10.7[a]	11.9[b]	12.1[b]	12.2[b]	0.6
Apparent DM digestibility	66.0	65.6	65.7	66.7	66.0	0.4
CP intake (kg/day)	1.70	1.72	1.68	1.70	1.69	0.04
Apparent CP digestibility	65.2[a]	66.9[b]	67.67[b]	71.47[a]	71.53[a]	0.2
EE intake (kg/day)	0.34[a]	0.47[b]	0.57[c]	0.65[d]	0.69[d]	0.02
NDF intake (kg/day)	4.70[a]	4.80[a]	5.72[b]	6.56[bc]	7.28[c]	0.01
NDF digestibility	61.7	61.5	61.3	61.0	60.9	0.26
ADF intake (kg/day)	3.49[c]	3.60[c]	3.88[b]	4.07[a]	4.16[a]	0.09
ADF digestibility	55.3	55.2	54.9	55.6	55.0	0.3

[1] UTC30 diet contained 30% urea treated corncobs ensiled without enzose, while UTC40, UTC50, UTC60 and UTC70 contained 40, 50, 60 and 70% urea treated corncobs ensiled with 6% enzose, respectively.

Means in the same row followed by the same letter are not different at ($p<0.05$).

Table 4. Milk yield and composition by crossbred cows fed diets containing urea treated corncobs ensiled with or without enzose

Items	Treatments[1]					SE
	Control	UTC 40	UTC 50	UTC 60	UTC 70	
Milk yield (kg/day)	10.64[b]	13.20[a]	12.91[a]	13.49[a]	13.67[a]	1.42
Milk fat %	3.12	3.38	3.59	3.65	3.84	0.29
Solids not fat %	9.22	9.50	9.26	9.05	9.12	0.10
Total solids %	12.35	12.88	12.86	12.70	12.96	0.36
Crude protein %	3.55[b]	3.62[b]	3.93[a]	3.97[a]	3.96[a]	0.07
True protein %	3.07	3.15	3.08	3.24	3.24	0.05
Non-protein nitrogen %	0.55	0.50	0.85	0.74	0.72	0.09

[1] Control diet contained 30% urea treated corn cobs ensiled with 0% enzose and UTC 40, UTC 50, UTC 60 and UTC 70 diets contained 40, 50, 60 and 70% urea treated corncobs ensiled with 6% enzose, respectively.

Means in the same row followed by the same letter are not different at ($p<0.05$).

nitrogen was retained in 5% UTC ensiled with 0, 2, 4 and 6% enzose, respectively. The concentration of NDIN was approximately 0.41, 0.52 and 0.59 percentage units higher in UTC ensiled with 2, 4 and 6% enzose compared to UTC ensiled without enzose. However, ADIN fraction in UTC ensiled with or without enzose was remained similar across treatments. The NDF and hemicellulose contents of UTC ensiled with enzose were higher compared to UTC ensiled without enzose, however, the concentration of ADF, cellulose and lignin remained similar across all treatments (Table 2). The CP free NDF (NDF-NDIN×6.25) content remained similar across all treatments.

Dry matter, CP, NDF and ADF intakes by lactating crossbred cows fed diets containing varying levels of UTC ensiled with or without enzose were significantly ($p<0.05$) different across treatments (Table 3). Neutral detergent fiber and ADF intake was significantly ($p<0.05$) higher in cows fed on diets containing UTC ensiled with enzose compared with those fed control diet. The ether extract (EE) intake was significantly ($p<0.05$) differed across treatments (Table 3). Intake of EE was more in animals fed UTC70 diet when compared to all other diets. Apparent DM, NDF and ADF digestibilities were non-significant across experimental diets.

Milk yield (kg/day) and CP content in milk was significantly ($p<0.05$) higher in cows fed UTC ensiled with enzose compared to those fed on control diet (Table 4). However, fat, solid not fat, total solid and non-protein nitrogen content in milk were observed similar across all treatments.

DISCUSSION

The higher N retention in UTC ensiled with enzose may be because of the production of lactic acid that might have reduced the pH of the treated material. Higher lactic acid concentration reduced the N escape from urea treated wheat straw by lowering its pH (Nisa et al., 2004). Ensiling urea treated wheat straw with rapidly fermentable carbohydrates can stimulate the growth of lactic acid producing bacteria in urea treated wheat straw (Sarwar et al., 2003) by providing readily available nutrients for the proper fermentation milieu. The reduced pH probably has changed free ammonia (NH_3) into an ionic form of ammonia (NH^{+4}) that is very reactive and has the greater tendency to make bonds with fibrous materials. Mehra et al. (2001) used acetic acid to increase the nitrogen retention in urea treated wheat straw. They reported that about 50-60% of the added nitrogen was retained when 2.7% acetic acid was added in 4% urea treated wheat straw. They explained that it might be due to the formation of ammonium acetate. The increased NDF content in UTC treated with enzose was because of increased NDIN contents compared to UTC ensiled without enzose.

Significantly higher intake of DM, NDF and ADF in cows fed UTC70 and UTC60 was because of enhanced digestibility of fiber fractions of UTC ensiled with enzose. Supplementation of low quality fibrous feeds with non-protein N increased the digestibility of the feed (Leng et al., 1993) and thereby improved voluntary feed intake (Hogan, 1996). A faster digestion rate of the potentially digestible fiber promoted greater DMI (Sarwar et al., 1991). In present study, the percentage of UTC was different in each diet, which was expected to make major changes in the gut fill by altering lag time, rate of disappearance and extent of digestion of different feed fractions. However, Sarwar et al. (1994) demonstrated that increase in intake from feeding NH_3 treated wheat straw might be either associated with an increase in rumen volume, or rate of passage of digesta or both. The present results may be attributed to the specific treatment effect of enzose that brings physiochemical changes in cell wall of UTC. However, non-significant differences in digestibility were because of increased intake of DM, NDF and ADF in cows fed UTC ensiled with enzose. The rate at which fiber passes from the rumen affects ruminal digestibility (Sarwar et al., 1991). In present study, the UTC ensiled with enzose was expected to ferment rapidly in the rumen that might cause increased rate of passage of digesta and thus lowered the digestibility (Sarwar and Nisa, 1999; Sarwar et al., 2004a). Significantly higher CP digestibility may be because of increased levels of ruminal-escaped protein that might have improved apparent CP digestibilities in UTC70 and UTC60 diets when compared to other diets. The increased EE intake with UTC60 and UTC70 diets was because of higher inclusion rate of corn oil that was added into different diets to make them iso-caloric.

Higher milk yield by cows fed diets containing UTC ensiled with enzose as compared to control was because of increased digestible NDF and ADF intake. Cant et al. (1993) reported that cows performed better when fed highly digestible fiber by increasing DMI and milk production. The increased CP contents in the milk of cows fed UTC70 and UTC60 diets may be attributed to increased bypass protein supplied in these diets when compared to other diets. This increased bypass protein might have supplied amino acids in proper amount and proportion for milk protein synthesis. An increase in cellulolytic population might have resulted after feeding of diets containing UTC ensiled with enzose that might have resulted in proper synchronization and utilization of nutrients at ruminal level (Kanjanapruthipong and Leng, 1998).

CONCLUSION

The ensilation of UTC with 6% enzose has improved the N retention and its feeding value for lactating crossbred cows.

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