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The Effects of Treated Corn Silage Using Urea and Formaldehyde on Rumen Ecosystem and Blood Metabolites in Sheep

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Abstract: The effects of chemical treated corn silage (using urea and formaldehyde) on rumen ecosystem (pH, sedimentation and floatation, methylene blue reduction, total VFA, rumen ammonia) and blood metabolites (urea and glucose) in sheep were investigated. Sixteen sheep (41.85±4.6 kg) were used in a 4-treatment completely randomly design. The treatment contented: Corn Silage (CS), Corn Silage treated Urea(10 g Kg^{-1})(CSU), Corn Silage treated Formaldehyde(4 g Kg^{-1}) (CSF), Corn silage treated urea (10 g kg^{-1}) and formaldehyde (4 g Kg^{-1}) (CSFU). The ruminal pH had significant differences between treatments ($p<0.05$). The sedimentation andfloatation time, methylene blue reduction, total VFA showed no significant differences between treatments. The ruminal ammonia nitrogen in CUS was significantly more than the other treatments. The blood urea nitrogen in CSU and CSFU was more than the other treatments ($p<0.05$). There was no significant differences for blood glucose concentration among treatments. This study indicated that formaldehyde decreased ruminal ammonia nitrogen, resulting high escaped protein and offer users flexibility in formulating rations according to the productive performance of target animals.

Key words: Corn silage, urea, formaldehyde, rumen, sheep, ruminal ammonia

INTRODUCTION

Performance of ruminants given corn silage diets is low due to low quality of protein contents resulting of high fermentation protein in silage processing.

There is growing interest in the use of chemical stuffs for improving of poor-quality forage diets (Taghizadeh *et al*., 2006). Formaldehyde and urea are the additives that used in treating the corn silage.Formaldehyde can prevent protein degradation in the rumen (Taghizadeh *et al*., 2003 a,b) and decreased ruminal the ammonia nitrogen resulting manipulation on ruminal ecosystem (Rodrigues *et al*., 2005).

Reza and Rowlinso (1995) reported low digestibility of NDF and ADF when corn silage treated with formaldehyde due to low availability of nitrogen for rumen microorganism. The using of urea in corn silage increased digestibility of dry matter and crude protein , whereas did not affect on ruminal microbial synthesis (Molony and Kiely, 1997).Treating of corn silage with urea increased ruminal pH due to producing of ammonia resulting of high buffering capacity (Van Soest, 1994). The objective of this study was to investigate the effect of corn silage treated using urea and formaldehyde on rumen fermentation of sheep.

MATERIALS AND METHODS

Silage preparation: Corn Silage was treated Using 1% urea (CSU), 0.4% Formaldehyde (CSF) and treated both of 1% urea and 0.4% formaldehyde. Samples were chopped to a 2cm Length using the paper cutter, wilted to approximately 30% DM and padded to a bulk density of between 0.63 and 0.80 Kg L^{-1}, then the individual silos closed completely. After 60 day, the silage was removed from the silos. A sample was taken for DM, pH.

Chemical analysis: All samples were ground through a 1mm screen in a Wiley mill (model 4, Arthur H. Thomas Co, Philadelphia, PA). Neutral detergent fiber and ADF were measured according to the method of Van Soest *et al*. (1991). Determinations of N were conducted using the Kjeldahl method in an automated Kjelfoss apparatus (Foss Electeric, Copenhagen, Denmark). Dry matter was determined by drying the whole sample in an oven at 55°C until a constant weight was achieved (AOAC, 1990).

Sheep and feeding: 16 sheep (41.85±4.6 kg) are randomly received one of 4 diets in a completely

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randomized design. The composing of diet based on NRC (1985), consisting of 430 g Kg^{-1} DM of alfalfa, 350 g Kg^{-1} DM of corn silage, 100 g Kg^{-1} DM of barley grain and 120 g Kg^{-1} DM wheat bran containing predicted metabolizable energy 2.98 Mcal Kg^{-1} DM and containing crude protein 140 g Kg^{-1} DM. The difference in the rations was only related to type of used corn silage. The treatments contain CS: treatment untreated corn silage, CSF: CS + 4 g Kg^{-1} DM formaldehyde, CSU: CS + 10 g Kg^{-1} DM urea and CSFU: CS + 4 g Kg^{-1} DM Formaldehyde + 10 g Kg^{-1} DM urea.

Sample collection and statistical analyses: The period of present study was 21 days. The rumen fluid of each treatment was obtained by stomach tube. The effect of treatments was determined on rumen pH, ammonia-N, total Volatile Fatty Acids (VFA) (Stuchbury and Sake, 2001), methylene blue reduction time, the sedimentation and flotation period, glucose and urea of blood. The sedimentation and flotation time was determined using filtration of collected rumen liquor from cheese cloth and then collected in experimental tubes, as the small partial precipitated, while large partial was suspended in surface of liquor and the spending time was recorded (Dirksen and Smith, 1987). The methylene blue reduction time was measured using combining of 20 mL rumen liquor and 0.3 % methylene blue and recording of reduction time (Dirksen and Smith, 1987). The data was analyzed using the GLM procedure of SAS according to completely randomized design (SAS Institute, 1990).

RESULTS AND DISCUSSION

Chemical composition: The chemical composition of the treatments in this experiment is presented in the Table 1. The DM content of the CSU and CSF was lower than expected (Table 1). However the silages in this experiment were well presented, with an expected pH = 4. As expected as corn silage treated with urea the CP contents increased (CSU, CSFU).

The chemical treating of corn silage with urea and formaldehyde decreased the concentration of ADF resulting of high hemicellulose concentrations.

These results certified the reports of Liu *et al.* (2002). As urea treated rice straw increased hemicellulose concentrations.

Ruminal parameters: The results are indicated shown in Table 2. The ruminal pH had significant differences between treatments. The high ruminal pH in CSU can be expected due to high ruminal ammonia. The sedimentation and floatation time and methylene blue reduction time hadn't significant differences between treatments. The results showed no significant differences for total VFA. The ruminal ammonia nitrogen indicated significant differences between treatments. The treatments containing of urea (CSU and CSFU) had higher ruminal ammonia nitrogen due to releasing of ammonia in the rumen. This results are consistent with reporting of Obaray and Dellow (1993).

Table1: Chemical composition of the experimental treatments

Item	CS	CSU	CSF	CSFU
DM	33.21	29.45	29.12	34.28
CP	8.06	12.02	7.89	10.8
N	1.29	1.92	1.26	1.73
NDF	58.35	57.6	57.5	58.5
ADF	38.85	35.85	32.7	37.2
Hemicelluloses*	19.5	21.75	24.8	21.3
pH	3.94	4.07	3.92	4.07

* Hemicelluloses = NDF - ADF

Table 2: The effect of treatments on ruminal parameters

	Treatment				
Factors	CS	CSF	CSU	CSFU	SEM
pH	6.19^{a}	6.4^{ab}	6.51^{a}	6.185^{b}	0.16
Sedimentation and floatation (Second)	361.25	387.5	309.0	370.0	21.81
Methylene blue reduction (Second)	188.75	101.25	175.0	186.25	18.49
Total VFA (mMol L^{-1})	101.0	100.75	111.5	107.0	11.2
Rumen ammonia nitrogen (mg L^{-})	127.75^{ab}	91.0^{b}	136.5^{a}	136.5^{a}	24.3

Table 3: The effects of treatments on blood metabolites

Treatments	Blood urea nitrogen	Blood glucose
CS	17.5^{ab}	58.5
CSU	19.5^{a}	61.25
CSF	14.0^{b}	59.0
CSFU	19.5^{a}	64.75
SEM	2.7	3.16

Blood metabolites: The blood metabolites are showed in Table 3. There was significant differences in Blood Urea Nitrogen (BUN) among treatments. The BUN in CSU and CSFU was more than the other treatments ($p<0.05$) and that is agreement with the results of Obaray and Dellow (1998) and Sowell *et al.* (2003). The high BUN is these treatments could be due to high releasing of ammonia in the rumen resulting of high absorption of ammonia from the rumen to blood. However addition to ruminal ammonia concentration, the other factors containing ruminal available energy can be affect in the BUN. There was no significant differences in blood glucose concentration among treatments. The blood glucose concentration in the our experiment observed in the normal range (51 to 57 mg dL^{-1}) that is consistent with the results of Jean *et al.* (1994) and Schlumbohma and Harmeyer (2003).

CONCLUSION

The low ruminal ammonia nitrogen in CSF showed high escaped protein and offer users flexibility in formulating rations according to the productive performance of target animals.

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