Effect of Partial Replacement of Green Grass by Urea Treated Rice Straw in Winter on Milk Production of Crossbred Lactating Cows

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ABSTRACT : Fresh elephant grass was replaced by urea treated rice straw (UTRS) to evaluate the effects on milk production of crossed lactating cows. A total of 16 crossbred F1 cows (Holstein Friesian × Vietnamese Local Yellow), with a body weight of about 400 kg and lactation number from three to five, were used in the experiment. The experimental cows were blocked according to the milk yield of the previous eight weeks and divided into 4 homogenous groups. The experiment was conducted with a Latin Square design with 4 treatments and 4 periods. Each period was 4 weeks, with 2 weeks of feed adaptation and 2 weeks for data collection. The ratio of concentrate to roughage in the ration was 50:50. All cows were given constant amounts of elephant grass dry matter (DM), with ratios of 100% grass without UTRS (control treatment 100G), and 75% grass (75G), 50% grass (50G) and 25% grass (25G) with *ad libitum* UTRS. Daily total DM intake on 100G, 75G, 50G and 25G was 12.04, 12.31, 12.32 and 11.85 kg, and the daily ME intake was 121.6, 121.5, 119.4 and 114.3 MJ, respectively. The daily CP intake was similar for all treatments (1.85-1.91 kg). There was a difference ($p<0.05$) in daily milk yield between the 25G and the 100G and 75G (11.7 vs. 12.6 and 12.5 kg, respectively). Milk protein concentration was similar for all treatments, while a tendency to increased milk fat concentration following the increase of UTRS ratio was observed. The cows gained 4-5 kg body weight per month and showed first oestrus 3-4 months after calving. The overall feed conversion for milk production was not affected by ratio of UTRS in the ration. It is concluded that replacement of green grass by UTRS with a ratio of 50:50 for crossbred lactating cows is as good as feeding 100% green grass in terms of milk yield, body weight gain and feed conversion. UTRS can preferably replace green grass in daily rations for crossbred dairy cows in winter to cope with the shortage of green grass, with the ratio 1:1. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 4 : 543-548)***

Key Words : Crossbred Cows, Green Grass, Urea Treated Rice Straw, Milk Production, Body Weight Change, Feed Conversion

INTRODUCTION

Dairy production in Vietnam has no long tradition, is still limited, and mainly based on crossbred cattle. However, it is developing in terms of the number of dairy cows, size of dairy farms and towards more intensive systems. In urban and peri-urban areas, dairy cows are often kept under roof and fed planted or natural grasses in cut and carry systems, by-products from industrial processing and compound feed. In rural areas, dairy cows are traditionally kept in semi-intensive systems and fed mainly natural grasses, crop residues and small amount of concentrates. Most of dairy farms are small scale, farm land for cultivation of grasses is often scarce and making silage as a way of feed preservation is not traditional. Feed resources and their efficient utilization are therefore considered the first limiting factor in improving animal productivity (Wanapat, 1999). Athough grasses can grow around the year, in winter, when the temperature and rainfall are low, the yield of grasses is reduced, which causes shortages of green forage for animals.

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Rice straw is the most important feed source to replace scarce green grass. It is readily available locally throughout the country, with a total amount of 25-30 million tons produced per year, in which a part is burnt or left in the field, some is used for fuels or mixed with animal manure for use as organic fertilizer etc. Only a small part has been used as feed for local cattle and buffalo which mainly are used for draught. Rice straw is low in available energy, protein and vitamins and has an imbalance of essential minerals, but it contains a large pool of structural carbohydrates which can potentially be degraded by rumen microbes into volatile fatty acids, and thus as energy sources for ruminants (Wanapat, 1999).

Urea treatment is the most applicable method for improving the quality of rice straw. Urea treatment of rice straw (UTRS) increases crude protein concentration and rumen degradability compared to untreated rice straw (Hai et al., 1994; Chowdhury et al., 1996). It gave higher NH_3-N concentration and total volatile fatty acids in the rumen than did untreated rice straw (Chanthai et al., 1987). A combined ration of green grass and UTRS increased degradability of organic matter (OM), crude protein (CP) and crude fibre (CF), and resulted in increased milk yield and milk fat concentration compared to a ration of untreated rice straw and green grass (Tuan, 2000). In comparision with untreated rice straw, cows fed UTRS increased dry matter

intake, milk yield and reduced feed cost (Bhaskar et al., 1992).

This study aimed to evaluate the effects of partial replacement of cultivated green grass by UTRS on milk production of crossbred lactating cows in zero grazing systems and to recommend the ratio of green grass, which can be replaced by UTRS for feeding dairy cows during the winter period.

MATERIALS AND METHODS

Experimental design and ratios of green grass to UTRS

A total of 16 crossbred F1 cows (Holstein Friesian × Vietnamese Local Yellow), with a body weight of about 400 kg and lactation number from three to five, were used in the experiment. The experimental cows were blocked according to the milk yield of the previous eight weeks and randomly divided into 4 homogenous groups. The experiment was conducted as a Latin square design with 4 treatments and 4 periods. Each period was 4 weeks, with 2 weeks of feed adaptation and 2 weeks for data collection.

The feeding standards were based on the National Research Council recommendations (NRC, 1988): for maintenance: 0.56 MJ ME and 3.5 g crude protein per 1 kg $BW^{0.75}$ and 16 g Ca, 11 g P for a 400 kg cow; for milk production: 5.19 MJ ME, 90 g crude protein, 3.21 g Ca and 1.98 g P per 1 kg fat corrected milk (FCM) produced; for weight gain: 35.77 MJ ME and 320 g crude protein per 1 kg weight gain, for weight loss: -34.52 MJ ME and -320 g crude protein per 1 kg weight loss.

The ration was formulated based on body weight and daily milk yield in the 8^{th} week of lactation and kept constant throughout the experimental period. The ratio of concentrate to roughage in the ration was 50:50 on a dry matter (DM) basis. All cows were given limited and constant amounts of elephant grass dry matter throughout the entire experiment at the ratios of 100% grass without UTRS as a control treatment (100G); and 75% grass (75G), 50% grass (50G) and 25% grass (25G) based on DM with *ad libitum* UTRS.

Feeds and feeding

The concentrates included compound feed and brewers' grains. The compound feed, which was mixed every two weeks, consisted of rice bran (50%), cassava meal (20%), maize bran (15%) and groundnut cake (15%). A mineral premix was added at a level of 1%. Wet brewers' grains was supplied daily by a local brewery factory.

Fresh elephant grass *(Pennisetum purpureum)* at 50-60 days re-growth was cut and supplied to the barn once in the morning. Dry rice straw was treated with 4% urea following the formula: 100 kg dry rice straw+4 kg Urea+80 kg water. The solid urea was diluted in the water and sprayed on to the dry rice straw slowly, and incubated in plastic bags for 3 weeks before feeding. The chemical composition and nutritive value of the feeds are shown in table 1.

Roughage was given 3 times daily at 09:00, 13:00 and 19:00 h, while the concentrate was given twice daily during milking. Fresh elephant grass was chopped and supplied in a constant amount according to each ratio, while UTRS was given *ad libitum* with the refusals never less than 10%. Water was available at all times in a water trough, which was cleaned every day.

Farm conditions and animal management

The research farm is situated outside Hanoi City, where monthly mean temperature is 15.7-29.5°C, relative humidity is 81-87% and rainfall 1,800-2,000 mm per year. The cows were kept in a concrete barn and separated from their calves. They were tied up and fed individually indoors with daily exercise in a small area for a few hours during cleaning time. They were hand milked twice daily at 04:00-06:00 and 16:00-18:00 h.

Data collection procedure

Milk yield was recorded at every milking and milk composition was analyzed every 2 weeks of data collection. Cow body weight was taken every 4 weeks at the end of each period in the morning before feeding. Postpartum oestrus was checked daily by visual observation and recorded. Data for individual animals on daily milk yield, daily feed intake, milk composition, body weight and

Table 1. Chemical composition and nutritive values of feeds used in the experiment, Mean values and standard deviation (n=8)

Item	Elephant grass	Urea treated rice straw	Brewers' grains	Compound feed	Rice straw
DM (%)	19.14 (±0.5)	48.51 (±2.4)	21.63 (±0.9)	89.3 (±0.4)	85.53 (±0.9)
CP (g/kg DM)	107.1 (±2.8)	102.4 (±3.9)	315.9 (±5.2)	145.6 (±1.4)	47.1 (±1.5)
EE (g/kg DM)	29.9 (±1.2)	19.1 (±0.9)	82.6 (±3.6)	29.4 (±2.1)	21.9 (±1.1)
CF (g/kg DM)	315.5 (±14.9)	377.2 (±13.8)	151.7 (±7.8)	82.3 (±5.9)	393.3 (±17.6)
NFE (g/kg DM)	455.2 (±21.3)	394.7 (±15.1)	373.3 (±18.8)	661.8 (±9.7)	428.6 (±18.4)
Ca (g/kg DM)	5.8 (±0.6)	3.3 (±0.4)	3.7 (±0.2)	11.9 (±1.4)	2.8 (±0.4)
P (g/kg DM)	3.4 (±0.6)	1.6 (±0.1)	7.2 (±0.4)	7.8 (±1.1)	1.4 (±0.2)

postpartum interval to first oestrus were collected. Feed conversion was calculated. The feeds were weighed at every feeding and feed refusals were weighed daily in the morning before the next feed was given. Grass, UTRS, rice straw, compound feed and brewers' grains were analyzed every 2 weeks.

Chemical analysis and calculation of nutritive value

Proximate parameters were analyzed by standard methods of the Association of Official Analytical Chemists (AOAC, 1990). Dry matter (DM) was determined by oven drying at 100-105°C for 6-8 h, total nitrogen (N) by the Kjeldahl method and crude protein (CP) calculated from N (CP=N×6.25 for feed and CP=N×6.38 for milk), ether extract (EE) by the Soxhlet system, crude fiber (CF) by the Weende method, and calcium (Ca) and phosphorous (P) by procedures of the AOAC. Milk fat was analyzed by the Gerber method.

The total digestible nutrients (TDN), digestible energy (DE) and metabolisable energy (ME) of the feeds were calculated by the models used and cited in the "Composition and Nutritive Value of Animal Feeds in Vietnam" (National Institute of Animal Husbandry, 1995):

TDN grass=-21.7656+1.4284 CP+1.0277 NFE+1.2321 EE +0.4867 CF

TDN UTRS=-17.2649+1.2120 CP+0.8352 NFE+2.4637 EE +0.4475 CF

TDN compound feed=40.2625+0.1969 CP+0.4228 NFE+ 1.1903 EE-0.1379 CF

TDN brewers' grains=40.3227+0.5398 CP+0.4448 NFE +1.4218 EE-0.7007 CF

Where CP is crude protein, NFE is nitrogen free extractives, EE is ether extract and CF is crude fiber of feed on a dry matter basis (calculated by %).

DE (Mcal/kg DM)=0.04409 TDN

ME (Mcal/kg DM)=0.82 DE

Statistical analysis

The data was analyzed by using the General Linear Model in MINITAB program release 12.21 (1998). Analysis of variance was done for all parameters.

The mathematical model used was: $Y_{ij}=\mu+b_i+f_j+\varepsilon_{ij}$, where μ is overall mean, b_i is effect of i_{th} block, f_j is effect of ratio of UTRS in total roughage and ε_{ij} are errors.

RESULTS

Changes in chemical composition and nutritive values of untreated and 4% urea treated rice straw

Table 1 presents the chemical composition and nutritive values of the feeds. With urea treatment, the CP content increased from 47.1 g in untreated rice straw to 102.4 g/kg DM in UTRS (2.2 fold).

Daily dry matter feed intake

Daily DM intake is shown in table 2. There was no significant difference in daily total DM intake between treatments. The DM intakes of UTRS were 28.0, 51.1 and 67.2% of total roughage DM for the 75G, 50G and 25G treatments, respectively. Due to the reduction of feed intake and increased ratio of UTRS in the ration, the daily ME intake of the 25G treatment was decreased to 114.3 MJ, while the 100G was 121.6 MJ. The daily CP intake was similar for all treatments (1.85-1.91 kg).

Milk yield and milk composition

There was no difference in daily milk yield between the

Table 2. Daily feed intake, Least square means and SEM

Item	Treatment				
	100G	75G	50G	25G	SEM
DM feed intake (kg)	12.04	12.31	12.32	11.85	0.23
DM elephant grass (kg)	6.00 [a]	4.51 [b]	3.06 [c]	1.90 [d]	0.13
DM UTRS (kg)	0	1.76 [a]	3.19 [b]	3.89 [c]	0.05
DM brewers' grains (kg)	2.16	2.16	2.16	2.16	0
DM compound feed (kg)	3.88	3.88	3.91	3.90	0.12
Ratio of concentrate (%)	50.2	49.1	49.3	51.1	0.01
Ratio of roughage (%)	49.8	50.9	50.7	48.9	0.01
ME (MJ)	121.6	121.6	119.4	114.3	2.3
CP (kg)	1.89	1.91	1.90	1.85	0.03
CF in diet (%)	20.8	21.8	22.5	22.7	0.5
Ca (g)	108	107	105	101	2.5
P (g)	70	68	65	63	1.4
ME/kg DM (MJ)	10.08	9.86	9.69	9.63	0.01
CP/kg DM (g)	157	155	154	156	0.6

100G, 75G, 50G and 25G are the ratios of grass in the roughage.

[a,b,c,d] Means in the same row with different superscripts differ at $p<0.05$.

100G, 75G and 50G treatments but there was a difference ($p<0.05$) between the 100G (12.6 kg) and 75G (12.5 kg) versus the 25G treatment (11.7 kg). The reduction in milk yield on the 25G treatment was 7.7%. There was a trend of increased milk fat concentration following the increase of UTRS ratio in the ration (table 3).

Body weight change and postpartum oestrus

Results of the recordings of body weight gain are shown in table 4. The cows gained on average 4-5 kg per month. Considering the whole period of 16 weeks, there was no significant difference in weight gain between the treatments. All the experimental cows showed the first oestrus 3-4 months after calving.

Feed conversion

Total feed DM, ME, and CP intake, total milk yield and body weight changes were not significantly different between treatments (table 4). The overall feed conversion for milk production was not significantly affected by ratio of UTRS in the ration.

DISCUSSION

The CP content in UTRS was increased due to the increase of non-protein nitrogen (NPN) by trapping NH_3 from urea. Treatment of rice straw by urea not only increases CP content, but also the degradability. The effects of urea treatment vary depending on the amount of added urea, moisture content of straw and the storage method of the treated straw. The results obtained in the present study, of doubling the CP content, are in good agreement with data from other similar studies on urea treatment of rice straw where CP content increased from 4.95 to 10.02% (Hai et al., 1994) and from 50 g to 95 g/kg DM (Chowdhury et al., 1996). From their studies of the effects of feeds and rations on rumen environment and feed digestibility in dairy cows, Vu et al. (1999) reported that degradability of UTRS vs. untreated RS at 48 h incubation was 54.6% vs. 49.5% for DM and 40.21% vs. 36.31% for CP, respectively, which was further confirmed by Tuan (2000). Urea treated rice straw resulted in higher NH_3-N concentration in the rumen than did untreated rice straw (Chanthai et al., 1987). It not only increased the potentially degradable fraction, but also its rate of degradation (Ibrahim et al., 1988) and thus allow higher DM intake.

According to the plan in the present study, all cows were given a constant amount of concentrates, and elephant grass at limited and constant levels depending on the grass:UTRS ratio of each treatment. UTRS was always

Table 3. Milk yield and milk composition, least square means and SEM

Item	Treatment				
	100G	75G	50G	25G	SEM
Daily milk yield (kg)	12.6 [a]	12.5 [a]	12.2 [ab]	11.7 [b]	0.2
Milk Protein (%)	3.41	3.38	3.36	3.39	0.07
Milk Fat (%)	4.16	4.20	4.22	4.27	0.09
Milk Protein yield (g/day)	430	421	408	399	22
Milk Fat yield (g/day)	523	525	509	499	10

100G, 75G, 50G and 25G are the ratios of grass in the roughage.
[a,b] Means in the same row with different superscripts differ at $p<0.05$.

Table 4. Total feed intake, milk yield, body weight gain and calculated feed conversion in the whole experimental period, least square means and SEM

Item	Treatment				
	100G	75G	50G	25G	SEM
Total DM intake (kg)	1,349	1,378	1,380	1,328	26
Total ME intake (MJ)	13,616	13,604	13,373	12,801	258
Total CP intake (kg)	211.9	214.1	213.7	207.7	3.2
Total milk produced (kg)	1,413	1,397	1,361	1,312	46
Body weight (BW)gain (kg)	19	20	18	15	2
ME for weight change (MJ)	671	706	652	528	83
CP for weight change (kg)	6.0	6.4	5.8	4.8	0.7
ME for milk prod. (MJ)	7,442	7,394	7,218	6,771	256
CP for milk production (kg)	171.5	173.5	173.3	168.6	3.2
ME/kg milk produced (MJ)	5.26	5.33	5.30	5.18	0.15
CP/kg milk produced (g)	122	125	127	129	3

100G, 75G, 50G and 25G are the ratios of grass in the roughage.

given *ad libitum*. The cows were able to consume slightly more of UTRS than the reduced amount of elephant grass DM on the 75G and 50G treatments. The total DM intake of around 12 kg/day (about 3 kg/100 kg body weight) for all treatments is reasonable for cows with about 400 kg body weight and a daily milk yield of around 12 kg/day.

The lower milk yield at 25G than at the higher grass levels can be explained by the lower daily DM and ME intake. This is in line with results from studies on the effects of different feeding and nutrient levels on milk production of dairy cows. A positive relationship between feeding level and milk yield has been confirmed by Malossini et al. (1990), Moran and Croke (1993), Lap (1996) and Sanh et al. (2001). In a study on the use of UTRS and whole sugar cane (WSC) crop as roughage sources for dairy cattle with ratios of UTRS and WSC of 100:0, 75:25, 50:50, 25:75 and 0:100 based on DM, Wanapat et al. (2000) found that the combination of UTRS and WSC at the ratio of 50:50 enhanced both DM intake ($p<0.05$) and especially milk yield, milk fat and protein percentages.

Milk composition in this study was not significantly affected by the treatment. However, the tendencies to increased fat concentration with increasing level of UTRS in the ration was probably due to the increasing level of available fibre in the ration and/or the reduced amount of milk produced at higher UTRS levels. This is supported by results from Man and Wiktorsson (2001) who treated fresh rice straw by urea and fed lactating cows with the same ratios as in this study; the milk protein was not different but milk fat increased following the increase of UTRS ratio. This is also in agreement with Ly (1975), who fed dairy cows rations with high proportion of dry grass.

A body weight gain of 4-5 kg/month is reasonable after peak production when cows have to regain what they generally have lost during the very first part of lactation. No difference between ratios of UTRS was observed in this study. All cows showed first oestrus 3-4 months after calving, which has been reported as a normal interval in other studies by Lap (1996), Dat (1998) and Sanh et al. (2001). With regard to the experimental design of altering the treatments every four weeks, it was not expected to find any differences in reproductive performance due to the partial replacement of grass by UTRS.

In this experiment, there were no differences in feed conversion between treatments in terms of ME and CP intake per kg of milk produced. The results showed that green grass can be replaced by UTRS without effects on feed conversion but the milk yield will be reduced when more than 50% of the grass is substituted by UTRS. There are reasons to believe that the relatively short period on each treatment does not allow the cows to fully express the long term treatment effects, but rather in the range of about 95% (Broster and Thomas, 1988). Therefore it is likely that the performance tendencies observed in the present study would have been still more pronounced in the long run.

CONCLUSIONS

Replacement of green grass by UTRS with the ratio 50:50 for lactating cows in winter is as good as feeding 100% green grass in terms of milk yield, body weight gain and feed conversion. It is concluded that UTRS can partially replace green grass in daily rations for crossbred dairy cows in winter to cope with the shortage of green grass, with the ratio 1:1.

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