THE USE OF MULTINUTRIENT BLOCK SUPPLEMENTED TO UREA TREATED RICE STRAW BASE DIET FOR DAIRY HEIFERS

B. Cheva-Isarakul[1] and S. Promma[2]

Department of Animal Science, Faculty of Agriculture
Chiang Mai University 50200, Thailand

Summary

Eighteen Holstein Friesian × Native heifers with an average live weight of 175.4 ± 27.8 kg were allotted to 3 dietary groups. All animals were kept individually in a stanchion barn with free access to water and urea-treated rice straw (UTS). The supplemented feeds were as follows: Group (Gr) 1 − concentrate mixture (15% CP) at 1% body weight (BW), Gr 2 − concentrate mixture at 0.7% BW + free licking of multinutrient block (MNB), Gr 3 − as Gr 2 + 0.3% BW ground corn. Multinutrient block composed of 20% mineral mixture, 10% urea, 18% molasses, 20% soybean meal, 22% sesame meal, 10% cement, 0.15 million IU and 50 IU/kg MNB of vitamin A and E. The experimental period lasted 12 weeks. The result revealed that MNB enhanced intake of UTS and total dry matter intake. Animals in Gr 3 consumed a higher amount of feed than the other 2 groups, thus resulting in the highest live weight gain and tended to possess the best feed conversion ratio. Heifers in Gr 2 also performed better than Gr 1 although the difference was not significant. Average MNB intake found to be 0.65 kg/day. Feed cost per kg gain was not significantly different among groups. However if the cost of MNB could be lower, it would benefit the production cost of animals. The advantage of MNB is the safety of using a high level of urea. Although it was supplemented to UTS which also contained non-protein nitrogen (NPN), no toxic sign was shown. The results indicated that MNB could be partially substituted to concentrate mixture and it was even better when used incombination with soluble carbohydrate feed.

(**Key Words** : Urea-molasses Block, Multinutrient Block, Mineral Block, Urea Treated Rice Straw, Dairy Heifers, Urea)

Introduction

The shortage of good quality roughages in dry season has forced researchers to develop methods to improve the feeding value of rice straw which is the major feed in many areas of the world during this period. The most convincing method to increase the nutritive value, intake and digestibility of rice straw is the treatment with urea (Promma et al., 1982; Wanapat et al., 1984; Promma, 1988). However supplementation with a higher nutrient content feed, e.g. spraying with urea-molasses solution, leguminous leaves such as leucaena, peanut, pigeonpea, or even concentrate mixture are also effective and could be an alternative (Cheva-Isarakul and Potikanond, 1985; Cheva-Isarakul and Kanjanapruthipong, 1987; Saengdee, 1986).

Recently mineral blocks (Promma et al., 1988) and urea-molasses blocks have gained attention (Arts and Sansoucy, 1987; Soetanto et al., 1988; Schiere et al., 1988; Hamada, 1989). Multinutrient block (Cheva-Isarakul and Cheva-Isarakul, 1990, 1991; Wanapat et al., 1992) composed of urea, molasses, minerals, natural protein and vitamins have also been developed. Urea and molasses are cheap sources of nitrogen and soluble carbohydrate for the synthesis of microbial protein. Mineral mixture provides minerals not only for microbes but also for the host animal itself. Much of the natural protein is expected to by-pass the rumen and supply amino acids to the animals in the small intestine, particularly necessary to those animals which require high nitrogen : energy ratio (N : E) such as growing, pregnant, and high performance animals. The supplement of vitamin A and E is to mitigate vitamin deficiency which is common in dry period due to the lack of green forages.

An advantage of lick blocks is that they provide nutrients slowly but at a constant rate which is suitable for

[1] Address reprint requests to Dr. B. Cheva-Isarakul, Department of Animal Science, Faculty of Agriculture Chiang Mai University 50200, Thailand.

[2] National Dairy Training and Applied Research Institute, Chiang Mai 50200, Thailand.

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microbial activities and could also avoid urea toxicity due to the slow release of ammonia. Lick blocks are convenient to used to supplement local carbohydrate sources in areas including rural and/or highland districts where protein, minerals and vitamins are usually deficit.

Materials and Methods

The experiment was conducted at the National Dairy Training and Applied Research Institute, Chiang Mai, Thailand. Eighteen crossbred Holstein Friesian × Native heifers with live weight 175.4 ± 27.8 kg, were allotted to 3 dietary treatments. All animals were fed with 6% urea treated rice straw (UTS) *ad libitum* and were supplemented with concentrate mixture without or with multinutrient block (MNB) as follows;

Group	Concentrate mixture	Ground corn	MNB
1	1% BW	–	–
2	0.7% BW	–	*ad libitum*
3*	0.7% BW	0.3% BW	*ad libitum*

All animals were kept individually in a stanchion barn where water is available for free access. Concentrate mixture was fed half an hour prior to UTS which was offered *ad libitum* at 8.30 and 15.30 h daily. A multinutrient block was provided in a wooden box to avoid biting or chewing of the block.

Urea treated rice straw (UTS) was prepared in trench silos in which 3 tons of straw was treated each time. The ratio of straw : urea : water = 100 : 6 : 100. It was covered with a plastic sheet for 21 days prior to use. Concentrate mixture (table 1) containing 15% crude protein (CP) was the formula commonly use for heifers of the Institute.

TABLE 1. COMPOSITION OF CONCENTRATE MIXTURE (%)

Corn	40.0	Limestone	1.2
Rice bran	29.7	Biophos	0.3
Kapok seed meal	18.1	Sodium sulfate	0.2
Sesame meal	9.1	MgO	0.2
Salt	0.8	Vitamin mix	0.009
Mineral mix*	0.5		
		Total	100.109

* Mineral mix. composed of (%): 83 Dicalcium phosphate, 13 Sulphur powder, 1.5 Zinc oxide, 0.6 Copper sulphate, 1.5 Manganese dioxide, 0.015 Cobalt sulphate, 0.013 Sodium selenite, 0.065 Potassium iodide.

The MNB was composed of urea, molasses, macro and trace minerals, natural protein and vitamin A and E (table 2). All dry ingredients were mixed together before adding molasses, cement and phosphoric acid. The mixture was pressed in the rectangular mold by an equipment constructed locally. After 2 days of sun drying, the final product became hard and dry.

TABLE 2. COMPOSITION OF MULTINUTRIENT BLOCK (MNB)

	kg /100 kg MNB		Min-mix E	100 g composed of: -
Molasses	18		Salt	64 g
Urea	10		MgO	18 g
Soybean meal	20		S	14 g
Sesame meal	22		ZnO	2,200 mg
Cement	10		$CuSO_4 \cdot 5H_2O$	1,480 mg
Mineral mixture	20		MnO	280 mg
composed of:-			$CoCl_2 \cdot 6H_2O$	16 mg
Min-mix E		5	KI	8 mg
Bone meal		7	Na_2SeO_3	16 mg
Ca $(OH)_2$		3		
H_3PO_4		5		
Vit A (500,000 IU/g)	30 g			
Vit E (500 IU/g)	10 g			
Total	100.04			

Calculated mineral content supplied by mineral mixture

	g/100g MNB		mg/100g MNB
Ca	3.78	Zn	66.0
P	2.09	Cu	18.5
Na	1.25	Mn	8.0
Mg	0.51	Co	0.2
S	0.35	I	0.3
		Se	0.4

All heifers were weighed for 3 consecutive days at the beginning and the end of the experimental period of 12 weeks and at 2 weekly intervals. Feeds were sampled once a week for the chemical determination (Proximate analysis; A.O.A.C., 1980). To avoid nitrogen loss during oven drying, crude protein of UTS was determined from fresh samples. The data was subjected to analysis of variance and Duncan's new multiple range test (Steel and Torrie, 1980)

Results and Discussion

Chemical composition and animal performances

Chemical compositions of the experimental feed are shown in table 3. Dry matter and crude protein content of UTS were similar to those reported by Cheva-Isarakul and Potikanond (1985) and Saengdee (1986). Multinutrient block possessed a high level of CP (49% of DM) because it was composed of both NPN (10% urea) and natural protein (20% soybean meal and 22% sesame meal). The estimated contents of Ca and P in the block are 3.8 and 2.1% respectively. The major source of S was sulfur powder (0.35%). The ratio of N : S in the block was 13 : 1 which was in the range suggested by NRC (1988) for optimum microbial protein synthesis in the rumen (Ensminger and Olentine, 1980)

Heifers in Gr 3 and 2 consumed significantly higher dry matter (DMI) than Gr 1 (3.8 and 3.5% vs 3.1% BW, table 4). This might be due to the supplement of MNB which provided more nutrients for microbial growth and activities, thus enhanced digestibility, rate of passage and feed intake (Cheva-Isarakul and Cheva-Isarakul, 1991; Wanapat and Sommart, 1992).

TABLE 3. CHEMICAL COMPOSITION OF FEED (DM BASIS)

Feed	DM	CP	EE	CF	NFE	ASH	ADF
Urea-treated rice straw	57.4	7.9	1.2	38.5	35.1	17.4	45.3
Ground corn	91.1	8.1	4.8	3.6	81.7	1.7	4.2
Concentrate	94.3	15.1	8.7	9.8	58.1	8.3	8.2
Multinutrient block	89.0	49.2	3.9	3.0	9.2	34.7	4.8

TABLE 4. PERFORMANCES OF HEIFERS FED UREA-TREATED RICE STRAW (UTS) SUPPLEMENTED WITH CONCENTRATE (CONC) WITHOUT OR WITH MULTINUTRIENT BLOCK (MNB) (N=6)

	Conc (1% BW)	Conc (0.7% BW) + MNB (*ad lib*)	Conc (0.7% BW) Corn (0.3% BW) + MNB (*ad lib*)	SEM
Initial weight (kg)	173.7	174.5	181.7	2.4
Average daily gain (kg/head. day)	0.6[a]	0.7[a]	0.8[b]	0.1
Dry matter intake (DMI)				
UTS (kg/head. day)	4.5	5.2	5.4	0.2
Concentrates (kg/head. day)	1.8[b]	1.3[a]	1.3[a]	0.0
Corn (kg/head. day)	–	–	0.5	–
MNB (kg/head. day)	–	0.6	0.7	–
Total DMI (kg/head. day)	6.3[a]	7.1[a]	8.0[b]	0.3
% of BW	3.1[a]	3.5[b]	3.8[b]	0.1
g/kg $BW^{0.75}$	117.4[a]	132.4[b]	143.6[b]	4.4
Feed conversion ratio (kg feed/kg gain)	11.1	10.7	10.2	0.8
Feed cost ($ US/kg gain)	1.12	1.15	1.11	–

Cost of feed ($ US/ton DM) : 56.8 for UTS, 212.4 for Conc, 199.6 for corn, 314.4 for MNB.

The higher CP level of diets consumed by Gr 2 and 3 than Gr 1 (12.8 and 12.7% vs 10.0%) was in agreement with Journet et al. (1983; cited by NRC, 1988) and Oldham (1984) who found that dry matter intake and digestibility increased with the increasing CP level from 6 to 21 and 8 to 17% of the diet, respectively. Heifers in Gr 3 had the highest weight gain, followed by Gr 2 and 1, respectively. The superior performance of heifers in Gr 3 and Gr 2 might be due to the better balance of nutrient supply because MNB contained high protein, minerals and vitamins while corn served as a good source of energy. Feed conversion ratio of Gr 3 was also better than Gr 2 and 1, attributing to the higher nutrient concentration of MNB.

Intake of NPN and minerals

Average consumption of MNB by Gr 2 and 3 was 0.62 and 0.71 kg/h/d (table 4) which was equal to 0.30-0.33% BW. Urea intake from MNB equalled 62 and 71 g/h/d or 30.6 and 32.9 g/100 kg BW. In addition the animals also received NPN from UTS. The assuming concentration of NPN in UTS was (7.9-3)/6.25 = 0.78% which was equal to 0.78 × 100/46 = 1.7% urea. Therefore urea intake from UTS was calculated as 89 and 92 g/d or 44 and 42.6 g/100 kg BW for Gr 2 and 3, respectively (table 5). Although the total urea intake 74.7 and 75.5 g/100 kg BW which was equal to 2.1 and 2.0% of the ration was higher than the safety level which is generally recommended, no toxic signs were observed.

The consumption of MNB was highly variable between individual heifers from 0.1-1.5 kg/h/d, thus causing the intake of urea to be as high as 115 g/100 kg BW/d which was nearly 4 times higher than the recommended level (30 g/100 kg BW/d; Jeroch, 1976). However no animals suffered from urea toxicity. This might be due to the variation of a lethal dose of urea which is affected by a number of factors. With poorly fed or starved animals, the ingestion of 0.4-0.5 g/kg BW with a time span of approximately 30 min has lethal effects while in better fed cattle levels of urea 0.65-0.75 g/kg BW are required to show sign of toxicity. Blood levels of ca 4 mg% are nearly always fatal. Sudden and rapid consumption of urea is one of the most critical factors, leading to toxicity. High ruminal pH also promotes the absorption of ammonia (cited by Church, 1975). On the other hand, animals fed readily digestible carbohydrate, and/or high vitamin A were less susceptible to urea toxicity (cited by Church, 1975). Copper, Cr and Oxytetracycline are known to inhibit urease activity, thus could partially protect animals given lethal doses of urea (cited by Church, 1975). In this experiment, the animals were fed good quality feed including readily available carbohydrate in concentrate mixture and ground corn (Gr 3). In addition MNB contained high level of vitamin A and Cu, possibly enhancing the toleration of urea toxicity.

Animals in the last 2 groups consumed an average of 0.65 g/h/d of lick block. The intake of minerals as calculated only from those supplied by mineral mixture in the block was shown in table 6. The daily requirement for minerals of 6-12 months old heifers (column 4, table 6) was calculated from the value suggested by NRC (1988), assuming that DMI was 3% of BW. It seems that minerals supplied by the block was 22-200% of the requirement. Although the consumption of some minerals was too high (>100% of the required amount), they were still much less than the maximum tolerable level (NRC, 1988). Those minerals which were lower than the requirement are expected to be obtained from other feed. Thus the consumption of the block provided mineral supply and had no harmful effects to the animals.

Production cost

No significant difference among groups was found on feed cost/kg BW gain. However, if the price of MNB could be lowered by using the cheaper ingredients, the production cost should be diminished. Although the price of MNB was rather high, it was however, cheaper and contained higher nutrient than commercial mineral blocks

TABLE 5. CRUDE PROTEIN (CP) INTAKE OF HEIFERS FED UREA-TREATED RICE STRAW (UTS) PLUS CONCENTRATE MIXTURE (CONC) SUPPLEMENTED WITHOUT OR WITH MULTINUTRIENT BLOCK (MNB)

	Conc (1% BW)	Conc (0.7% BW) + MNB (*ad lib*)	Conc (0.7% BW) + MNB (*ad lib*) Corn (0.3% BW)
Total CP intake (kg/head. day)	0.628	0.912	1.016
− Urea-treated rice straw	0.356	0.411	0.427
− Concentrate mixture	0.272	0.196	0.196
− Corn	−	−	0.044
− Multinutrient block	−	0.305	0.349
CP (% of diet)	10.0	12.8	12.7
NPN intake (g urea/100 kg BW/day)	38.6	74.7	75.5
− UTS[1)]	38.6	44.0	42.6
− MNB	−	30.7	32.9
NPN intake (g urea/head. day)	76.5	150.9	163.1
Dry matter intake (kg/head. day)	6.3	7.1	8.0
Urea (% of total ration)	1.2	2.1	2.0

[1)] NPN was calculated as urea equivalent although it was already degraded.

TABLE 6. MINERAL SUPPLIED BY MULTINUTRIENT BLOCK (MNB) AS PERCENTAGE OF THE REQUIREMENT RECOMMENDED BY NRC (1988) AND THE MAXIMUM TOLERABLE LEVEL

	Concentration in MNB[1]	Daily intake from MNB[2]	Concentration in diet[3]	Daily requirement[4]	Supplied by MNB (% of requirement)	Max tolerable level: Concentration in diet[3]	Max tolerable level: Daily intake[4]
	(g/100 g)	(g)	(%)	(g)	(%)	(%)	(g)
Ca	3.78	24.6	0.41	24.6	100	2.0	120
P	2.09	13.6	0.30	18.0	75	1.0	60
Na	1.25	8.1	0.10	6.0	135	–	–
Mg	0.51	3.3	0.16	9.6	34	0.5	30
S	0.35	2.3	0.16	9.6	24	0.4	24
	(mg/100 g)	(mg)	(mg/kg)	(mg)	(%)	(mg/kg)	(mg)
Zn	66.0	429.0	40	240.0	179	500	3,000
Cu	18.5	120.3	10	60.0	200	100	600
Mn	8.0	52.0	40	240.0	22	1,000	6,000
Co	0.2	1.3	0.10	0.6	217	10	60
I	0.3	2.0	0.25	1.5	133	50	300
Se	0.4	2.6	0.30	1.8	144	2	12

[1] Calculated from the ingredients in mineral mixture only.
[2] Average daily licking amount of MNB = 650 g.
[3] Recommended by NRC (1988) for growing heifers at 6-12 months old.
[4] Calculated from [3]; assuming that DMI = 3% BW, average BW = 200 kg.

which are generally used in farms. Therefore, if the processing method of MNB could be improved, it should be well accepted.

The block has been extended to many parts of the country and many feeding situations including small farms in lowland, highland, medium and commercial farms. The animal raisers admitted that MNB could be supplemented to low quality roughages without or with concentrates with satisfactory results (data are not available).

Conclusion

Multinutrient block which was composed of 10% urea, 20% mineral mixture, 42% natural protein, 18% molasses and vitamin A and E at 0.15 million IU and 50 IU/kg MNB, respectively, contained 49% CP. The supplement of MNB to urea-treated rice straw based diet enhanced feed intake, growth rate and feed conversion ratio of cattle. Feeding MNB in combination with high soluble carbohydrate feed, e.g. corn or cassava chip could be partially substituted for a concentrate mixture. Feed cost per kg weight gain of the animals supplemented with MNB was similar to the group fed higher concentrated feed without MNB. The advantage of MNB is the safety of consuming high amount of urea. No toxic sign was observed although the estimated urea intake was 3.5 times of the amount generally recommended.

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