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Effects of supplementation of urea-molasses multinutrient block (UMMB) on the performance of dairy cows fed good quality forage based diets with rice straw as a night feeding

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Abstract : An experiment was conducted to evaluate the effects of nitrogen supplementation through urea-molasses multinutrient block (UMMB) on the performance of dairy cows fed good quality forage based diets with rice straw as a night feeding. A total of 10 multiparous crossbred dairy cows in their early lactation were grouped into two categories based on their breed, parity, body weight, milk yield, milk fat and protein contents and daily fed a chopped CO-3 grass (*Pennisetum purpureum* × *Pennisetum americanum*; hybrid Napier) *ad-libitum*, 1 kg of dairy cow concentrate feed during the day time and 5 kg of rice straw (dry matter basis) at night as the basal diet (control) for 5 wk. In addition to the basal diet, the treatment group received 300 g of crushed UMMB daily throughout the experimental period. Cows were milked twice daily and the milk yields were recorded. Milk and feed samples were collected weekly for chemical analysis. Supplementation of UMMB had no significant effects ($p>0.05$) on straw intake, daily milk yield, contents and yields of milk constituents such as milk fat, protein, lactose and solids-non-fat. In addition, milk urea nitrogen content were not affected ($p>0.05$) by UMMB supplementation. However, numerical increments in all the parameters measured were observed during the study in cows fed diets supplemented with UMMB. It can be concluded that nitrogen supplied through UMMB had no effects on production performances of dairy cows in this study.

Key words **:** Dairy cows, Urea-molasses multinutrient block, Supplementation, Performance

I. Introduction

The present status of the dairy industry in Sri Lanka is far below expectations, though it has a huge potential for the development. The virtual stagnation of the dairy industry in the country may be attributed to many political, technical and socio-economic factors (Perera and Jayasuriya, 2008). Among the constraints faced by the dairy industry, poor nutritional status of dairy cattle has been identified as one of the major obstacles (Perera et al., 2007). According to Perera et al. (2007), dairy cattle in the country are malnourished not because of unavailability of feed resources, but due to underutilization. About 95 percent of the dairy farms in the country are still being kept under smallholder conditions where feeding has become an important and critical factor because it has a tremendous effect on productivity of the animals. About 98 percent of the smallholder dairy farmers mainly depend on naturally available forage for animal feeding which is abundant during the wet season (Perera et al., 2007). However, the quantity and quality of these forages decline during the dry season which leads the smallholder farmers to utilize agricultural crop residues to keep the animals alive. Rice straw is low in nutritional quality, palatability and digestibility as opposed to other straws (Perera et al., 2007; Perera and Jayasuriya, 2008). Feeding of poor quality roughages having only very little amounts of energy and protein and limited amounts

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of concentrates, eventually lead to lower milk production. Hence, the genetic potential of dairy cattle for the maximum milk production has not been achieved over the years.

Several solutions have been suggested by researchers to improve the nutritional quality and palatability of low quality roughages. In this regards, combined feeding of low quality roughages with UMMB is considered to be one of the easiest and effective practices (Perera et al., 2007; Perera and Jayasuriya, 2008). Hard solid blocks of UMMB provide readily available sources of energy and protein in the forms of molasses and urea together with fiber and minerals (Saddul and Boodoo, 2001). Urea-molasses mineral block (UMMB) licks can improve the utilization of low quality roughages because it satisfies the requirements of the rumen microorganisms and creates a better environment for the fermentation of fibrous material which eventually increases the production of microbial protein and volatile fatty acids (Wongnen, 2007). Urea, after hydrolyzing into ammonia in the rumen, provides a nitrogen source for the rumen microflora for their microbial protein synthesis. Molasses is a major source of readily fermentable energy, which assists the growth of rumen microorganisms. In addition, it is considered to be a good carrier for urea and a source of micro minerals (Perera et al., 2007; Wongnen, 2007). It has been reported by Perera et al. (2007) that the incorporation of UMMB under field conditions has tremendously improved the animal performance which may be associated with the "supplementary" and "catalytic" effects of UMMB promoting an optimal ammonia level for efficient microbial activity in the rumen (Kunju, 1986).

Several researchers have previously reported the use of UMMB licks for supplementing the crop residue-based diets of large and small ruminants (Leng, 1983; Sansoucy, 1995), but only very few studies have been conducted on the use of UMMB with good quality forage-based diets. Results of one such study by Weerasinghe et al. (2010) to evaluate the effects of supplementation of nitrogen through UMMB on the performance of dairy cows fed good quality forage based diets, highlighted that UMMB supplementation significantly increased milk yield and yields of milk fat, protein, and solids-non-fat (SNF). Further, UMMB supplemented animals in that study had a significantly higher body weight compared with those fed control diet and the authors suggested that the improvements of production and performance could be due to improved digestibility of UMMB supplemented diet. However, no information is available on the use of rice straw only as a night feeding supplemented with UMMB. Thus, the objective of this study was to evaluate the effects of supplementation of UMMB to dairy cows fed good quality forage based diets while supplying rice straw as a night feeding on their production performances.

II. Materials and Methods

1. Experimental Animals and Treatments

A total of 10 multiparous cross-bred dairy cows in their early lactation were randomly allocated to two experimental groups based on their breed, parity, body weight, milk yield, milk fat and protein contents measured three days prior to the beginning of the experiment. The cows were penned individually and had free access to water throughout the experiment period. Control group animals were daily fed a basal diet consisted of chopped CO-3 grass (*Pennisetum purpureum* × *Pennisetum americanum*; hybrid Napier) *ad-libitum,* 1 kg of dairy cow concentrate feed during the day time and 5 kg of rice straw (dry matter basis) at night during the experimental period of five weeks. High crude protein content is considered to be one of the characteristic features of CO-3 grass. Under average management conditions, CO-3 grass contains 15-16% crude protein, 34-37% crude fiber, 42-47% acid detergent

Table 1. Ingredient composition (%) of UMMB blocks and concentrate fed to dairy cows.

Ingredient	UMMB blocks	Concentrate
Rice bran	23.0	-
Rice polish	-	33.5
Coconut poonac	-	30.0
Molasses	40.0	-
Urea	10.0	1.0
Mineral mixture	2.0	2.5
Maize	-	33.0
Salt	10.0	-
Lime	15.0	-

fiber, 74-78% neutral detergent fiber, 6.2-6.9% crude fat and 9.5-12.8% ash contents on dry matter basis (Premaratne and Premalal, 2006). In addition to the above basal diet, the treatment group animals received 300 g of crushed UMMB daily in three equal meals (100 g at a time) at 0700, 0100 and 1800 h. The ingredient composition of UMMB produced using the method described by Weerasinghe et al. (2004) and dairy cow concentrate feed are shown in Table 1.

2. Sampling and Data Collection

Cows were milked twice daily at 0700 and 1600 h using a mobile milking machine and the milk yields were recorded separately. Throughout the experimental period, milk samples were obtained in each week separately from cows in control and treatment groups for the chemical analysis. In addition, samples of UMMB were collected weekly, stored at −20°C and finally composited prior to analysis. Daily intake of rice straw was also recorded.

3. Chemical Analysis

The proximate composition of feed samples were analyzed according to the methods described in Association of official Analytical Chemists (AOAC; 2000) for dry matter (method 934.01), crude protein (method 988.05), ether extracts (method 920.39), and ash (method 978.10) contents. In detail, ground samples (2 g) were dried in a dry oven (80°C; OV-9023A, Jiangsu Zhengji Instruments Co., Ltd., China) until constant weights were obtained. After being cooled in a desiccator, the dry weights were measured. The dry matter content was expressed as a percentage of the initial weight of the sample. Crude ash content was measured by igniting 2 g of ground samples in a muffle furnace (Gallenkamp, Loughborough, UK) at 550℃ overnight and expressed as a percentage of the initial weight of the sample. Ether extract and crude protein contents of feed samples were measured via the Soxhlet extraction system (TT 12/A, Gerhardt Ltd., Idar-Oberstein, Germany) and the Kjeldahl method (VAPO45, Gerhardt Ltd., Idar-Oberstein, Germany), respectively.

Milk fat, solids-non-fat (SNF), protein, and lactose contents were measured using a portable ultrasonic milk analyzer (Lactoscan MCC, Milkotronic Ltd., Bulgaria). The urea content in milk was estimated according to the method described by Malik and Sirohi (1998). In detail, 10 mL of well mixed milk sample was treated with 10 mL of trichloroacetic acid and subsequently filtered through a filter paper (No. 42, Whatman Ltd., Kent, UK). Then, 5 mL of the filtrate was mixed with 5 mL of 1.6% dimethylamino benzaldehyde (DMAB) reagent. Absorbance of the sample was measured using a spectrophotometer (Jenway 6105, Staffordshire, UK) at 425 nm against a blank. The concentration of urea was estimated by comparison with a standard curve.

4. Statistical Analysis

All the data were analyzed using the ProcGLM procedure (SAS Inst. Inc, Cary, NC) in a completely randomized design. The statistical significance was considered at $p<0.05$.

III. Results and Discussion

The ingredient composition of UMMB block used in this study is shown in Table 1. It was previously recommended that 100 g of urea per kilogram of block was sufficient to maintain an optimum rumen ammonia levels for efficient microbial activity (Perera et al., 2007). In addition, Perera and Perera (1996) explained that the level of external urea intake depended on the nitrogen content of the diet. For instance, 10% of urea was sufficient for UMMB blocks when the animals were fed on medium quality forages with 10–12% crude protein. Hence, the ingredient composition of UMMB block used in this study was comparable to the above recommendations (Table 1). Further, Table 2 shows the chemical compositions of UMMB blocks and rice straw used in the current study, which clearly indicate the higher quality of UMMB as opposed to rice straw.

The effects of dietary supplementation of UMMB on the production performances of dairy cows are shown in Table 3. The straw intake was not significantly

Table 2. Proximate composition (%) of UMMB blocks and rice straw fed to dairy cows.

Item	UMMB	Rice straw
Dry matter	84.70	91.90
Crude protein	27.79	4.40
Ether extracts	2.51	0.95
Ash	3.95	31.62

Table 3. Performance of dairy cows fed control diet and diets supplemented with UMMB.

Item	Control	Treatment	SEM	p-Value
Straw intake (kg/d)	3.53	3.44	0.44	0.800
Milk yield (l/d)	5.34	5.66	0.38	0.205
Milk fat				
Fat (%)	4.14	4.35	0.44	0.657
Fat yield (g/d)	225.6	234.2	18.74	0.670
Milk protein				
Protein (%)	2.85	2.89	0.04	0.359
Protein yield (g/d)	152.4	163.6	13.54	0.455
Milk lactose				
Lactose (%)	4.02	4.11	0.06	0.228
Lactose yield (g/d)	215.3	233.0	19.12	0.407
Milk SNF[1)]				
SNF (%)	7.64	7.78	0.13	0.333
SNF yield (g/d)	409	440	36.1	0.434
MUN[2)] (mg/ml)	0.17	0.20	0.02	0.119

[1)]Milk SNF = milk solid-non-fat.
[2)]MUN = milk urea nitrogen.

affected ($p > 0.05$) by the dietary supplementation of UMMB. Generally, the intake and beneficial effects of UMMB were affected by the type and the quality of the basal feed and other supplements (Soetanto et al., 1987). Confirming this, it was observed that an increase in dry matter intake was significant when the basal diet consisted mainly of poor quality roughages such as hay or straw (Badurdeen et al., 1989; Singh and Singh, 2003). Further, Kunju (1986) reported that when the quality of the basal diet improved with the inclusion of concentrate, the dry matter intake reduced. The basal diet of the current study included the chopped CO-3 grass (*ad-libitum*), dairy cow concentrate feed (1 kg/day) during the day time and rice straw (5 kg) at night. The CO-3, a hybrid Napier variety, is considered as a good quality fodder grass (Premaratne and Premalal, 2006) while the concentrate feed used in the current study includes 30% of coconut poonac which is a good protein source (Table 2). Further, treatment group were supplemented with UMMB which was a good nitrogen source. Therefore, lower straw intake in treatment group might be attributed to the high quality basal diet supplemented with UMMB. As the rice straw intake had not been increased ($p > 0.05$) through the supplementation of UMMB in the current study, it can be further suggested that the basal feed containing the CO-3 and concentrate was adequate in providing optimum nutrition to the dairy cows, thus maintaining optimal nitrogen concentration in the rumen. Therefore, the cows were not in the need of increased ingestion of rice straw. Schiere et al. (1989) reported that the effect of UMMB on dry matter intake was not significant and this is comparable to the findings of the present study.

In addition, there were no significant differences ($p > 0.05$) in the daily milk yields, proportions and yields of milk constituents including milk fat, protein, lactose and SNF contents between the control and treatment groups (Table 3). These low responses in dairy cows used in this study could be due to comparatively lower nutrient demand due to smaller body size and lower milk yield, which may have been satisfied by the basal diet (Perera and Perera, 2000). Nevertheless, the mean daily milk yield and other milk quality parameters were numerically higher in the treatment group than in the control group. According to Table 3, approximately 6% numerical increase was observed in daily milk yield of cows fed the experimental diet in addition to higher milk fat and milk Solid-Non-Fat contents which are very important factors in determining the price of milk in Sri Lanka. In contrast, a recent study conducted by Weerasinghe et al. (2010) to evaluate the effects of supplementation of nitrogen through UMMB on the performance of dairy cows fed good quality forage based diets, highlighted that UMMB supplementation significantly ($p < 0.05$) increased the milk yield and the yields of milk fat, protein, and SNF. Further, it was stated that Sahiwal crossbred cows and Nilli-Ravi buffaloes gave 12% and 11% more milk daily, respectively when their diets were supplemented with UMMB (Perera et al., 1997; Perera and Perera, 2000). Similar to this study, Uthayathas et al. (1998) and Sivayoganathan et al. (2001) reported that milk quality of Sahiwal and cross-bred cattle was improved due to higher milk fat content when the basal diets were supplemented with UMMB, respectively. As suggested by Weerasinghe et al. (2010) in the previous study, the numerically higher improvements in production performances of dairy cows fed treatment diet in this study might be associated with the improved digestibility of the basal diet supplemented with UMMB and the optimum rumen environment maintained thereby (Perera and Perera, 2000). Higher milk fat content of treatment group compared with that of control group may be associated with the higher cellulolytic fibre utilization by the microbes in the presence of the optimum urea ammonia provided by UMMB (Perera et al., 2007). Therefore, it can be suggested that animals were in positive energy and protein balance; hence they had no requirement for additional nutrients through straw intake. However, numerical increases in all the milk production parameters indicated that if basal diet was deficient in major nutrients, part of it can be fulfilled through UMMB supplementation.

Milk Urea Nitrogen, the concentration of urea nitrogen in milk, generally expresses how cows utilize the crude protein that they consume. In the current study, supplementation of basal diet with UMMB had no significant effect ($p>0.05$) on milk urea nitrogen (MUN) content. A well-balanced diet resulted in MUN in the range of 10 to 12 mg/ dL, but values increased when (a) excess Rumen Degradable Protein (RDP) was fed, or (b) excess Rumen Undegradable Protein (RUP) was fed, or (c) RDP was not balanced with dietary Non-fiber Carbohydrates (NFC; Miller, 2001). In these cases, the unutilized portion of dietary crude protein was converted to urea by the liver, which ended up in the blood, urine, and milk (Miller, 2001). However, the mean MUN content had numerically increased in the treatment group compared with the control group. Higher average contents indicated excess nitrogen supply or it could be due to insufficient fermentable carbohydrates content in the diet.

IV. Conclusions

The supplementation of UMMB with the basal diet had no effect ($p>0.05$) on production performances of dairy cows in this study. As the basal diet consisted of a good quality roughage source and sufficient amount of concentrate feed, nutrients provided through UMMB would not be required by the animals for their milk production. The numerical increments observed in milk production and quality parameters as the dairy cows were fed diet supplemented with UMMB suggested that creating low nutrient contents in the basal diet through reducing concentrate feed and good quality roughages could be paid off through the provision of UMMB.

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