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Milk Urea Nitrogen: A Tool to Evaluate Dairy Cow Rations

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Abstract **– Frequent evaluation of milking cow feed rations will be beneficial for optimum production in a dairy farm. Milk Urea Nitrogen (MUN) is a tool that measures the efficiency of protein and carbohydrate feeding to milking cows. It is extensively used in many European and developed countries with many research studies on the baselines of MUN values for particular region or country. However, in many tropical countries (i.e. Sri Lanka), dairy herds had not been evaluated for the mean MUN values. This study had taken an initial step to evaluate the MUN values in one of the commercial dairy farm in Sri Lanka. According to the study, the MUN values of the farm had a range of between 12 mg dL^{-1} to 20 mg dL^{-1}, which are higher than the recommended range (i.e. 8 mg dL^{-1} to 12mg dL^{-1}). According to the proximate evaluation of the feed of the farm, only slight deviations from the standard NRC recommendations were found. The highest producing group of cows had the highest MUN mean values. The MUN values showed strong relationship with crude protein levels of the feed ($p<0.05$) and a weak relationship with dry matter intake ($p<0.1$). There was less evidence to find out any significant relationship between other feed compositional matters with MUN. Also the milk fat, protein, solid nonfat (SNF) and total solids (TS) did not show any significant relationships with MUN. The higher MUN values of the dairy herd could be due to higher protein content of the feed or energy imbalances in the feed. However, to confirm this argument, an extensive study including the metabolic energy of the feed will be needed. Further research is needed to confirm the baseline MUN values and how they relate to animal factors and environmental factors in Sri Lanka.**

Keywords **– Milk Urea Nitrogen, TMR, Feed composition, Milk composition.**

I. INTRODUCTION

Milk production of a cow will depend on; the ability of mammary gland to produce milk, the ability of the cow to provide mammary gland with nutrients and the ability of the farmer to manage and care of the cow. Animals fed properly will have less metabolic diseases and better immune function. Excess feeding of nutrients will again lead to environmental pollutions and losses [1].

When adequate energy is in the diets of dairy cows, both Milk Urea Nitrogen (MUN) and blood urea Nitrogen has long been known to be indicators of their protein status [2]. Considerable interest has developed in using MUN as an indicator of the efficiency of nitrogen utilization by dairy cows [3]. Using MUN as a management tool has obtained increased interest in Europe, USA and Japan like regions [4]. Implementing routine use of MUN on dairy farms could reduce nutrient loading to natural environments and improve farm profitability [5]. Analysis of urea in milk is available as a normal part of herd recording in parts of Europe, South Africa and the USA. In these countries, MUN was developed as a tool for ration formulation and for diagnosis of nutritionally related fertility disorders. The benefits of using MUN as a monitoring tool to help optimize the efficiency of dietary protein utilization include improved efficiency and reduced cost of production, reduced nitrogen excretion in to the environment and improved fertility [3]. Furthermore, measurement of MUN is convenient and noninvasive and will be useful as a management tool to improve the efficiency of production [6].

The majority of the studies on MUN were performed on individual animals under experimental conditions using chemical tests to measure MUN. The association between MUN and both nutritional management and performance should be determined under field conditions using commercial testing procedures [3]. Even though findings on MUN have been based on sound physiological principles, the relationships derived may not be universally applicable due to variations in nutrient intake and between animal differences. Furthermore, previous evaluations of MUN fail to account for random study effects, which can lead to biased estimates of regression coefficients and have been based on data from a limited number of studies [7]. Due to these reasons it will be beneficial to study about the patterns of MUN in different regions rather than highly depending on the values and recommendations of the previous studies.

II. MATERIALS AND METHODS

A. *Animal Experimentation*

The study was carried out for three months period in Ambewela farm, located in up country of Sri Lanka (6°53'23.28"N and 80°48'2.87"E at an altitude of 1860.0 m above MSL). Lactating dairy cows in the farm were grouped in to four groups according to their milk production (Table I). 15 Healthy multiparous cows (average body weight of 450 kg) from each group were randomly selected for the study. Animals were fed with four different total mixed rations adjusted according to their milk production (Feed formulation was done by the farm management). Lactating cows were managed under free-stall system. Feed intake of the animals was measured by deducting the weight of leftovers from the amount provided at the morning.

B. *Milk and Feed Samples Collection*

Cows were machine milked and milk samples were collected once in every fortnight. Milk samples were

Table I. Grouping of lactating dairy cows at Ambewela Farm

Group	Milk yield (L/milking)
S	27.5-33
A	23.5-27
P1	19.5-23
P2	15.5-19

collected in to 50 mL sterile specimen containers (Specimen container, Softa Care, Sri Lanka) and 0.1 mL of formalin (40%) was added as a preservative to each container. Milk samples were stored at 4 °C until further analysis for fat, solid non-fat, protein and milk urea nitrogen (MUN). For each group, separate TMR samples were collected day before the milk sampling and stored at -20 °C until further analysis for proximate composition.

C. *Analysis of Milk and Feed Samples*

Prior to analysis, milk samples were thawed under room temperature. Three milk samples were prepared for each group by pooling five milk samples of cows in each group. Milk was analyzed for milk fat%, SNF%, protein%, lactose% and pH using a calibrated ultrasonic milk analyzer (Lactoscan MCC, Milkotronic Ltd., Bulgaria). The urea content in milk was estimated according to the method described by [8].

Proximate composition of the feed samples was determined according to AOAC methods. Dry matter content (AOAC 934.01), total ash content (AOAC 942.05), crude protein content (AOAC 984.13) and crude fat content (AOAC 920.59) were determined for each feed sample.

D. *Statistical Analysis*

The data were analyzed for normality using Anderson-Darling test. Then, since some variables do not follow the normal distribution, relationships among those variables were statistically analyzed using non-parametric statistical methods (i.e. Spearman Rank Correlation Coefficient). If the variables follow a normal distribution, regression analysis was conducted. STATA® S/E 11.2 and Minitab® 17 software packages were used in statistical analysis of the data.

III. Results and Discussion

A. *MUN Levels in Different Groups*

The MUN values of the four groups (i.e. S, A, P1, P2), during experimental period, are shown in fig.1. During the study period, except on week 3, all the groups had reported MUN concentrations higher than 12 mg/dL. Under typical production conditions, most dairy herds should have MUN concentrations between 8 to 12 mgdL^{-1} [9]. Moreover, the mean MUN values of the four groups (Table II) also indicated higher MUN concentrations than the upper critical limit. Higher MUN values could be an indication of higher protein content of feed or an imbalance in energy: protein ratio in the feed [4]-[10]. Further, high levels of MUN are generally interpreted as an indication of inefficient utilization of protein, which is economically unfavorable [4]-[11]. Furthermore, [13] had found that BUN, body weight, fat corrected milk yield, dietary crude protein content, excess nitrogen intake, dry matter intake and days in milk were positively related to MUN, and milk and fat yield and dietary crude protein per mega calorie of net energy for lactation content were negatively related to MUN. Hence, the differences among MUN content of different groups could be due to the physiological and production differences of these groups.

B. *Evaluation of Proximate Composition of the TMRs*

The proximate composition of the four TMRs provided to each respective group is shown in Table III. According to the proximate analysis, the TMRs provided to each group align with the NRC (2001) recommendations [12]. However, the crude protein content of TMRs provided to P1 and P2 groups were higher than the NRC (2001) recommendations.

C. *Relationship of MUN with Milk Composition*

Milk fat%, SNF%, protein% and lactose% did not indicate any significant relationship with MUN concentrations. Other studies also suggested that there is no significant association between MUN and either milk fat or true protein percentage [3]. Also in another study, it confirms that there is no significant relationship between SNF% in milk and MUN values [13]. With the previous studies and with the results of this study, a conclusion could be made that MUN values are not related with fat%, SNF% and protein% in dairy cow milk.

D. *Relationship of MUN with TMR Composition*

Only the CP% of TMR showed a positive linear relationship with MUN ($p<0.05$). All other components of feed analysis did not show any significant relationship with MUN. Many studies have proved that the dietary crude protein content is a better predictor of MUN [3]-[14]. However, the dietary ratio of CP to energy is considered as the most important nutritional factor affecting MUN [7]. Hence, the higher levels of MUN cannot be interpreted only through feed CP%. A comprehensive study on the utilizable energy content of the feed should also be conducted along with the MUN values. The dry matter intake (DMI) had positive linear relationship with MUN concentration ($p<0.1$). However, the relationship is weaker than the relationship with CP%.

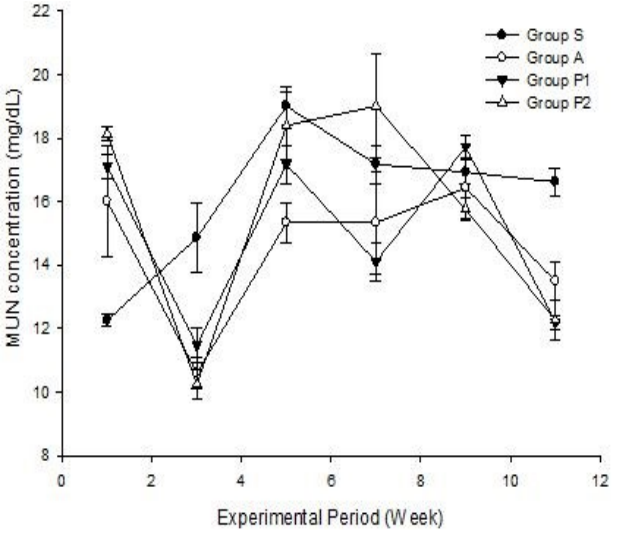

Fig. 1. MUN concentration of four groups during the study period

Table II. Mean MUN concentrations of four groups

Group	Mean MUN (mg dL^{-1})	Max (mg dL^{-1})	Min (mg dL^{-1})
S	16.75 ± 2.87	20.24	12.25
A	14.53 ± 2.17	16.43	10.59
P1	14.77 ± 3.01	17.72	11.04
P2	15.46 ± 3.64	19.02	10.24

Table III. Proximate composition of TMRs

Group	CP %	CF%	EE%	Ash%	Sand%
S	16.73 ± 1.02	14.89 ± 1.09	3.17 ± 0.33	5.72 ± 0.35	0.04 ± 0.03
A	16.66 ± 1.86	14.30 ± 2.73	3.43 ± 1.19	5.62 ± 0.58	0.03 ± 0.05
P1	18.20 ± 2.99	14.59 ± 2.56	3.06 ± 1.14	5.51 ± 0.35	0.01 ± 0.02
P2	17.08 ± 2.82	16.56 ± 1.89	3.63 ± 1.60	6.24 ± 1.75	0.14 ± 0.19

An earlier study also suggested that the relationship between MUN and DMI is less significant than the other factors [13]. The reason behind the positive relationship of DMI with MUN could be the higher protein intake simultaneously associated with high DMI.

E. *Interpretation of Higher MUN Values*

The higher MUN values of the four groups of lactating dairy cows could be interpreted in relation to CP% and energy balance of the TMR provided to each group. Hence the MUN values indicated a strong relationship with CP% of feed, it could be concluded that the higher MUN values of the groups P1 and P2 are due to higher CP% in the respective TMRs provided to those groups. However, the higher MUN values of groups S and A could be due to imbalance of energy: protein ratio of the respective TMRs. Reference [15] also indicate that dairy cows in early lactation at Ambewela farm were identified with poor energy status. Hence, it could be postulated that the animals with highest production in the farm are lacking with energy balance in their feed. Therefore, a detailed study including metabolic energy values of the feed provided to these animals will be beneficial.

IV. Conclusion

MUN could be used as a valuable tool to evaluate the balance between energy content and CP% of feed given to lactating dairy cows. However, establishing of baseline values for MUN content in different regions will be beneficial for more accurate results interpretations. More studies are recommended to establish reference values of MUN to different regions of Sri Lanka.

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