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Section 10 : Milk Processing (PP2)

PP2-1

The use of near infrared spectra of urine for monitoring milk urea nitrogen in dairy cattle

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Introduction

Milk should be an ideal medium for evaluating the health and efficiency of production of dairy cattle, because the concentration of urea in milk can be used as an indicator of nutritional status of dairy cows due to the relationship between the balance and energy to protein intake (Pehrson, 1996). However, the previous study on measurement of milk urea nitrogen (MUN) by near infrared (NIR) spectroscopy of milk was failed because of the interference by dominant fat components and the fact that MUN is a trace component (Purnomoadi *et al.*, 1998). An ideal medium for assessing the nutritional status may be provided by urine. It is known that there is a significant relationship between milk urea and urinary nitrogen (Gonda and Lindberg, 1994), hence it may be worth trying to use urine for detecting nutritional status of dairy cows.

This study was done to investigate the most available wavelength of urine spectra for monitoring nutritional status in animals as shown by MUN. This study is a part of the work for developing a continuous system measurement for a live animal system using NIR spectra.

Materials and Methods

Four lactating Holstein cows were housed in a controlled climatic room over four weeks and were exposed to a temperature of 18C for the first two weeks, and then to 28C for the next two weeks. This elevation was performed so as to obtain the significant trend of MUN because if temperature is raised to over comfort zone, the cow will be energetically underfeeding due to the decreasing dry matter intake. Feed was given four times a day at 08:00, 10:00, 16:30 and 19:00 to meet the requirements of maintenance and milk production (MAFF, 1994). Milking was done twice a day in the morning and evening at 09:00 and 18:00, respectively. Milk yield was recorded from week-2 to week-4. The concentration of MUN was determined by Urease-Indophenol method (Wako pure chemical, Ltd., Japan). Urine samples were collected daily after morning milking. Samples were filtered to separate the solid contaminants.

NIR spectra of the urine samples were measured with a Pacific Scientific (Neotec) model 6500 instrument (Perstorp Analytical, MD) using a transmittance cell sample (thickness : 1 mm). Spectra were read over a range of wavelengths between 1100 and 2500 nm at 2 nm intervals. The spectra were then calculated on second derivative of log 1/T, where T is transmittance. The spectra from daily urine samples (n=76) were averaged and analyzed to find the wavelength that had the strongest relationship with MUN. Analysis was done using linear regression from the 700 points of wavelength recorded.

Results and Discussion

The average of daily milk production, MUN and spectra of urine at 1550 nm during elevation of temperature from 18C to 28C are shown in figure 1. Milk production started to decrease at day-1 after elevating the room temperature. The decrease continued, stopped around day-6 and then steadied. The phenomenon of MUN level was contradictory to that of milk production. Though milk production steadied at day-6, MUN kept decreasing to the original level (before the temperature was elevated). If

MUN expresses the balance of energy and protein, it can be assumed that the recovery process to balance the protein to energy ratio still continues until day-12.

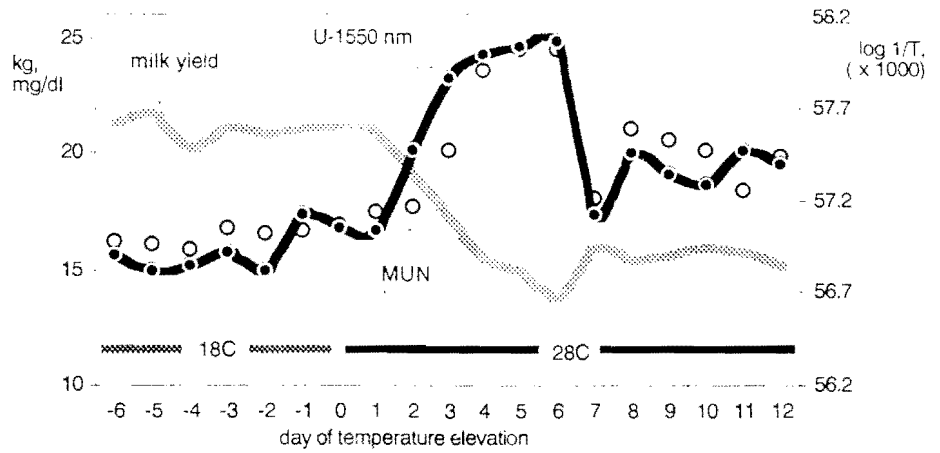

Figure 1. The trend of daily morning yield, MUN (○) and the NIR spectra of urine (●) at 1550 nm

Detection of daily increase in MUN using NIR spectra of urine using the wavelength of urine spectra at 1550 nm (U-1550) was highly correlated (r = 0.92). Both trends of MUN and U-1550 are also shown in figure 1. The trend of U-1550 is very similar to the trend of MUN level and seems to be more sensitive rather than that of MUN. The MUN level elevation from day-2 to day-6 seems to be one-day later compared to the U-1550. This is because the milk collected in the morning is the accumulation of milk secreted in the udder after evening milking until the next morning milking. The wavelength at 1550 nm in urine is considered to be the absorbance of N-H bond component (Murray and Williams, 1990).

This result not only confirms a significant relationship between milk urea and urinary nitrogen, but also strongly shows that the spectra of urine can be used to monitor the variation of MUN in order to manage the energy-protein balance status in dairy cattle.

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