J. Dairy Sci. 88:4434–4440

Milk Urea Nitrogen Concentration: Heritability and Genetic Correlations with Reproductive Performance and Disease

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ABSTRACT

The objectives of this study were to estimate the heritability of milk urea nitrogen (MUN) concentration and describe the genetic relationship between MUN and reproductive performance and between MUN and diseases in Holsteins. Dairy Records Management Systems (Raleigh, NC) provided lactation data. The Danish Agricultural Advisory Center provided breeding value estimates for diseases. Infrared (IR) and wet chemistry (WC) data were analyzed separately. Heritabilities and genetic correlations for 2 different measures of MUN and reproductive performance were estimated with an animal model using ASREML. Heritabilities for MUN were estimated using all lactations combined (lactations 1 through 5) and separately for first lactation and second lactation. Genetic correlations with reproduction and health were estimated separately for parities 1 and 2. Herd-test-day or herd-year-season along with age at calving and days in milk were included as fixed effects in all models. Heritability estimates for all lactations combined were 0.15 for WC MUN and 0.22 for IR MUN. Genetic correlations between WC MUN and 2 measures of reproductive performance, days to first service, and first service conception were not different from zero. In contrast, the genetic correlation between WC MUN and days open of 0.21 in first lactation and 0.41 in second lactation indicated that higher WC MUN values were associated with increased days open. Correlations among estimated breeding values for MUN and estimated breeding values for Danish diseases identified no significant relationships. Although the results of this study indicate that heritable variation for MUN exists, the inability to identify significant genetic relationships with several measures of disease or reproductive performance appears to limit the value of MUN in selection for disease resistance and improved reproduction.
(**Key words:** milk urea nitrogen, reproductive performance, disease, genetic correlation)

Abbreviation key: DO = days open, **IR** = infrared, **WC** = wet chemistry.

Received September 22, 2004.
Accepted August 23, 2005.
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INTRODUCTION

Traditional selection programs used by dairy cattle breeders have been extremely successful in improving yield traits (USDA Animal Improvement Programs Laboratory, 2003). An undesirable correlated response to this selection strategy has been a decline in overall cow health and reproductive performance (Van Dorp et al., 1998; Rogers et al., 1999). This has resulted in increased efforts to develop selection criteria to improve cow health and reproductive performance.

Although evidence exists for considerable genetic variation in fertility measures (Pryce et al., 2001; Veerkamp et al., 2001; Berry et al., 2003) and disease resistance (Lin et al., 1989; Simianer et al., 1991; Van Dorp et al., 1998), heritability estimates for these traits are generally low. Daughter pregnancy rate, which is calculated from days open (**DO**) data, has an estimated heritability of 0.04 (VanRaden et al., 2004). Currently, no uniform method for collection of health data exists in the United States. Denmark employs a mandatory, centralized recording system for all health traits and publishes national genetic evaluations for numerous health and reproductive traits. Published heritability estimates for all health and reproductive traits are 0.05 or less (Danish Cattle Federation, 2003).

Milk urea nitrogen is considered a normal nonprotein nitrogen component in milk. Urea concentration in milk results as a by-product of protein metabolism (Moore and Varga, 1996). Digestion of dietary protein results in the production of ammonia. Ammonia is converted to urea primarily in the liver (Ferguson, 2003). Urea is then excreted from the body primarily through urine, but is also found in blood and milk (Moore and Varga, 1996). Milk urea nitrogen levels have been used to evaluate herd nutritional status, as well as assess nitrogen excretion to the environment (Jonker et al., 1998).

Many DHI programs routinely offer MUN analysis to participating herds. Elevated MUN concentrations have been documented to adversely affect fertility (Melendez et al., 2000; Rajala-Schultz et al., 2001; Vallimont et al., 2003; Guo et al., 2004). Evidence of a phenotypic relationship between MUN concentrations and reproductive performance suggest the possibility that genetic evaluations for MUN could be useful in selection programs to improve reproductive performance and cow health.

The objectives of this study were 3-fold. The first objective was to estimate the heritability of MUN concentration. The second objective was to describe the genetic and phenotypic relationships between MUN and reproductive performance. Finally, the third objective was to estimate correlations among EBV for MUN generated from US lactation records and EBV for diseases from Denmark.

MATERIALS AND METHODS

MUN Data

Lactation records including MUN data obtained from Dairy Records Management Systems in Raleigh, North Carolina, were used in this study. Milk urea nitrogen concentrations were measured by either infrared (**IR**) or wet chemistry (**WC**) methods on test-day samples routinely collected through the DHI system. Infrared measures of MUN are indirect measures of MUN. Infrared MUN values are calculated from prediction equations that use spectrum analyses. Wet chemistry methods directly measure urea nitrogen in milk samples.

The initial data set included 625,000 lactations with 1 or more test-day MUN before July 2001. Records were edited to include only Holstein cows with valid identification from herds with more than 10 cows per test-day and greater than 75% of the cows within the herd having valid MUN data for each test-day. Further edits eliminated records with missing or illogical birth or calving dates, DIM greater than 305, parities greater than 5, and MUN values greater than 40 mg/dL. Preliminary analyses indicated that MUN values greater than 40 mg/dL were indicative of improper milk sampling. A minimum of 5 contemporaries was required, with contemporaries for heritability analysis defined as cows of the same parity that had MUN recorded for the same herd-test-day. Data were excluded unless 5 contemporaries were available, even for parities 3 to 5 when they were analyzed. Cows entering a herd in midlactation and records with indications of abnormal samples were eliminated. Records with test-days before October 1998 were eliminated to ensure uniform calibration standards across all DHIA milk testing laboratories. Therefore, data were from test-days between October 1998 and March 2001. First-lactation records were edited to include cows that calved after 20 mo of age and before 36 mo of age. Second-lactation records were edited to include cows that calved after 30 mo of age and before 60 mo of age. Numbers of records and cows used to estimate heritabilities from the various data sets are in Table 1. An additional data set including records from cows with a minimum of 4 MUN observations per lactation was created to compare with Wood et al. (2003) who imposed this same edit on their data.

Reproductive Performance Data

Cows used to estimate heritabilities for MUN were also used to estimate correlations between MUN and reproductive performance. However, many cows with MUN had little information on reproductive performance. Additionally, only 25% of first-lactation cows with MUN and reproductive data had both MUN and reproductive data in second lactation. Several edits for reproductive information were applied to records on cows with MUN data. This reduced the number of records available to estimate correlations between MUN and reproductive performance. Each cow used in the analyses of the 3 reproductive traits (DO, first-service conception rate, days to first service) was required to have a MUN value within ± 30 d of first service and a verified reproductive status for a lactation as reported to DHIA (producer-designated code for open or pregnant determined by palpation). Days open was not calculated for first-lactation cows having a subsequent lactation but missing a first-lactation reproductive status code due to the possible bias of excluding some of the poorest first-lactation reproductive records that were missing a calving date in addition to missing a reproductive status code. The analysis of DO may have also been affected by our decision to use MUN within ± 30 d of first service because DO was not just a result of the first service. Use of MUN during periods late in lactation along with DO might produce results that are difficult to interpret as well. Edits were made to exclude records with days to first service <25 or >200 and DO <25 or >365. Due to limited observations of IR MUN and reproductive performance measures, correlations among IR MUN and reproductive measures were not calculated. Only the WC MUN data were used to estimate correlations between MUN and reproductive performance measures. The number of cows used to estimate the parameters for reproductive performance measures are in Table 2.