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Predicting colostrum quality from performance in the previous lactation and environmental changes

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ABSTRACT

Nine New Hampshire Holstein dairies contributed to a study to investigate if colostrum quality could be predicted by cow performance in the previous lactation and by environmental factors during the 21-d prepartum period. The numbers of days below 5°C (D<), days above 23°C (D>), and days between 5 and 23°C (D) were used in the development of the regression equation. Between 2011 and 2014, 111 colostrum samples were obtained and analyzed for IgG. Producers recorded cow identification number, calf date of birth, sex of the calf, colostrum yield, hours from parturition to colostrum harvest, and weeks on pasture during the dry period (if any). Dairy Herd Improvement data from each cow and weather data were compiled for analysis. Information accessed was predicted transmitting abilities for milk, fat (PTAF), protein (PTAP), and dollars; previous lactation: milk yield, fat yield, fat percent, protein percent, protein yield, somatic cell score, days open, days dry, days in milk, and previous parity (PAR). Colostrum yield was negatively correlated with IgG concentration (r = −0.42) and D (r = −0.2). It was positively correlated with D> (r = 0.30), predicted transmitting ability for milk (r = 0.26), PTAF (r = 0.21), and PTAP (r = 0.22). Immunoglobulin G concentration (g/L) was positively correlated with days in milk (r = 0.21), milk yield (r = 0.30), fat yield (r = 0.34), protein yield (r = 0.26), days open (r = 0.21), PAR (r = 0.22), and tended to be positively correlated with DD (r = 0.17). Immunoglobulin G concentration (g/L) was negatively correlated with D> (r = −0.24) and PTAF (r = −0.21) and tended to be negatively correlated with PTAP (r = −0.18). To determine the best fit, values >0 were transformed to natural logarithm. All nontransformed variables were also used to develop the model. A variance inflation factor analysis was conducted, followed by a backward elimination procedure. The resulting regression model indicated that changes in Ln fat yield (β = 2.29), Ln fat percent (β = 2.15), Ln protein yield (β = −2.25), and Ln protein percent (β = 2.1) had largest effect on LnIgG. This model was validated using 27 colostrum samples from 9 different farms not used in the model. The difference between means for actual and predicted colostrum quality (IgG, g/L) was 13.6 g/L. Previous lactation DHI data and weather data can be used to predict the IgG concentration of colostrum.
Key words: colostrum, immunoglobulin G, prediction equation

INTRODUCTION

Colostrum is designed to be a concentrated source of nutrients, which includes fats, proteins, including immunoglobulins such as IgG, carbohydrates, vitamins, and minerals. It is key in supporting the health of the young dairy animal. Inadequate feeding of quality colostrum to the neonatal calf can result in reduced growth rates, increased risk of disease and death, increased risk of being culled, and decreased milk production in her first lactation (Smith and Foster, 2007). The long-term effects determine the success of the cow and therefore special care should be taken to ensure colostrum of the highest quality is provided to the newborn calf.

Currently, colostrum can be tested on farm by either colostrometer (Fleenor and Stott, 1980) or refractometer (Quigley et al., 2013). These methods are effective in estimating IgG concentration (Bartier et al., 2015). Many producers do not have access to these tools or do not take the time to test their colostrum before feeding. Only 5.7% of US dairy producers evaluated colostrum quality using a colostrometer (NAHMS, 2007). Providing a method of predicting colostrum quality would provide a means of evaluating colostrum quality before the calf is born and colostrum is collected. Colostrum quality has been previously investigated with factors such as parity and quantity being the main contributors to quality variations. Several parties have observed enhanced colostrum quality with increasing numbers of lactations (Devery-Pocius and Larson, 1983; Tyler et al., 1999; Moore et al., 2005; Gulliksen et al., 2008).

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Quantity of colostrum produced at the first milking has been negatively correlated with IgG concentration, which is most likely caused by a dilution effect (Pritchett et al., 1991).

Approximately 22% of the US dairy herd is enrolled in DHI; the goal of this study was to evaluate DHI data and environmental data to provide producers with a means of predicting colostrum quality on the date the cow calves. The objective of this study was to evaluate the possible correlations between previous lactation, predicted transmitting abilities, and environmental conditions on the subsequent colostrum produced and develop a regression equation that could be incorporated into management software programs as an aid in predicting IgG concentration in colostrum.

MATERIALS AND METHODS

On-Farm Information

Colostrum samples from 9 dairy farms from across New Hampshire were sampled over the years of 2011 through 2014. In total, 108 samples were obtained. Number of samples collected per farm ranged from 2 to 46. Two farms comprising the majority of the samples provided 77 samples. Of the other 6 farms, 2 farms provided 3 samples, 1 farm provided 4 samples, 1 farm provided 5 samples, and 2 farms provided 8 samples. For farms to participate, they had to be enrolled in DHI. Only Holstein cows with >1 lactation were used. Producers were asked to record calf birth date, time (h) of colostrum harvest after parturition, cow identification, yield of colostrum (**COL**), and sex of the calf (1 for heifer; 2 for bull). Producers were asked if cows grazed during the dry period and to provide the number of weeks (**PASWK**). From calf birth date, ordinal day was determined.

Weather Data

Utilizing the website www.wunderground.com and entering the location of the farm and date of parturition, the number of days during the 21 d before parturition with temperatures <5°C (**D<**), temperature between 5°C and 23°C (**D**) or with temperature >23°C (**D>**) were recorded.

Dairy Herd Improvement Data

PC Dart (Dairy Records Management Systems, Raleigh, NC) was used to access information for predicted transmitting ability for milk (**PTAM**), fat (**PTAF**), protein (**PTAP**), dollars (**PTAD**), previous lactation milk yield (**PROD**), previous lactation fat yield (**FY**), previous lactation fat percent (**FP**), previous lactation protein percent (**PP**), previous lactation protein yield (**PY**), previous lactation SCS, previous lactation days open (**DO**), previous lactation days dry (**DD**), previous lactation DIM, and previous parity (**PAR**). Individual farm was added to the model.

Colostrum Analysis

Samples of colostrum were analyzed for IgG using radial immunoassay (Triple J Farms, Bellingham, WA).

Statistical Analyses

Based upon observation of these data it was determined that conversion of the model components into a natural logarithm to estimate IgG was appropriate. To determine the best-fit values >0 were transformed to natural logarithm. All nontransformed variables were also used to develop the model.

Means, standard deviations, and Pearson correlation coefficients for all variables were calculated. (SAS Version 9.4, SAS Institute Inc., Cary, NC). The variance inflation factor procedure (**VIF**) of SAS was used to determine any relation between the model parameters. This procedure calculates a VIF for each variable. For each iteration, the highest valued parameter is removed from the model until all VIF values are $\leq$10.

As a final step, the backward elimination procedure of SAS was conducted, Ln IgG was used as a dependent variable, and farm PASWK, time, SCS, sex, PTAM, PTAF, D>, Ln FY, Ln FP, Ln PY, Ln PP, Ln DD, Ln OD, Ln DO, Ln PAR were used as independent variables. Variables that were least significant, the ones with the largest *P*-value, were removed and the model refitted until all remaining variables had individual *P*-values $\leq$0.10.

Model Validation

Colostrum samples (n = 27) from 9 other New Hampshire farms (3 samples/farm) were used to validate the model. Samples were harvested during early fall of 2014. Any sample that was 2.5 SD from the mean was removed from the validation data set.

RESULTS

Descriptive characteristics of each farm are in Table 1. Means and standard deviations of variables used in the development of the model are in Table 2. Results indicate relatively large variability for COL, IgG, and DO. The range in IgG concentration was 21.4 (poor) to 141.4 (excellent) g/L. The wide range of ordinal day