Rumination Time in the Transition Period and its Relationship to Lactation Success in the first 30 days in milk for Holstein Dairy Cows.

BIOL806 Final Project

Kayla Young

Introduction:

Dairy cows have a natural behavior to ruminate, which occurs in all ruminant animal species since they are foregut fermenters. Rumination is the process of regurgitating undigested food, chewing for further mechanical digestion and swallowed again to increase surface area for feed particles, as well as aid in saliva production to buffer the acidic rumen pH to ensure a stable environment for the microbes that are responsible for the fermentation process (Paudyal et al. 2018; Kaufman et al. 2018; Schirmann et al. 2013). Rumination is also known to be an indicator on well-being and is widely used in research for the transition period, the three weeks before and three weeks after calving, which is the critically most important stage in a dairy cow's life and its success determines how well they will perform in lactation (Calamari et al. 2014; Drackley 1999). Technology has been increasing in the dairy industry that has helped researchers learn more how to utilize rumination to predict dairy cattle health. There are many forms of technology that can measure different metrics like rumination time, activity time, body temperature, water intake, and so much more. These technologies essentially act like an apple watch, fit bit or aura ring for humans but instead, for cows. They come in many different wearable forms from collars, ear tags, wristbands and more increasingly popular, bolus's that reside inside the cow's reticulum (Schirmann et al. 2013; Kaufman et al. 2018; Soriani et al. 2012).

In recent decades, there has been an increase in the utilization of this advanced technology to help improve dairy cow health and well-being. Not only does it combat efficiency for farmers, but it also has the capabilities to aid in disease detection that is still currently being explored. As stated previously, the transition period is such a critical time, as there are many metabolic changes happening, and if detrimental enough, it can negatively impact dairy cow health (Drackley 1999). Which in turn, has a negative effect on farmers by losing product, increase in vet care and if worse enough, loss of the cow. Once a cow undergoes parturition, or gives birth, there is an increased demand for nutrients since most of the cow's energy is used to produce mass amounts of milk, this is called a negative energy balance (NEB). Dairy cows must eat to meet their energy requirements and if failure to adapt to NEB puts them at a higher risk for heath disorders or metabolic diseases in the first few weeks of lactation (McArt et al. 2012; Tufarelli et al. 2024). Some of these health disorders include hypocalcemia (milk fever), ketosis, rumen acidosis, displaced abomasum, retained placenta, etc. When dairy cows get sick or feel unwell, that will have a negative effect on their rumination and dry matter intake (DMI), causing them to eat less. In addition, most metabolic diseases, some cows can show no symptoms and be considered subclinical, which makes it harder to detect just from visual observation. However, with advanced dairy technology, rumination can be measured, and farmers and researchers can now utilize this to monitor dairy health data to help detect diseases/disorders earlier (Soriani et al. 2012).

Objective:

The objective of this study is to explore rumination time data collected from SmaXtec rumen bolus's from (n=34) cows at Fairchild Teaching and Research Center and see how it impacts milk production in the first 30 days into lactation (days in milk, DIM).

Methods:

This data used in this study was collected from Fairchild Dairy Teaching and Research Center and from the automated cow monitoring system, SmaXtec for (n=34) Holstein dairy cows. Bolus's have been installed for majority lactating cows and have been collecting rumination time (min/24hr), water intake (l/24hr), body temperature (°C), activity, calving indicator, and heat index. The metrics of interest for this study involved milk yield data from 0-30 DIM and rumination time every 10 mins from -14d – 30 post-partum. Also included is a confirmed diagnosis of metabolic diseases that occurred in the first 30 DIM.

Data Cleaning and Organizing:

Cow ID was gathered from the farm manager on a list of cows have calved since April 1st, 2025, and stored in an excel spreadsheet which consisted of Cow ID, lactation number, date of calving, 14d before calving date, as well as the date of when the cow reached 30 DIM. From there, individual cow data (rumination time (min/24hr)) from the SmaXtec online database was exported from -14d pre-partum to 30d post-partum and scanned to ensure it consisted appropriate days needed. Cows that did not meet the date requirements, i.e. bolus was administered at a later time and not calibrated for the individual cow, was not included in the study (n=13). In a new sheet, consisted of all SmaXtec imported data, and new columns was created to gather 2 hour, 6 hour, and 24 hours mean rumination time (RT) for each individual cow, on each day, from -14d to 30d post-partum. Each cow's spreadsheet was then copied and pasted to create one long running spreadsheet for all cows in this study (n=34) to then be imported to R studio for further analysis.

As for milk yield, data was exported from the milk system at the UNH dairy computer, for each individual cow (n=34). Each excel spreadsheet consisted of Cow ID, date, days since last calving (DIM), and total daily yield (lbs.). New columns of lactation number, weekly milk yield (MY) and Week (1-5) was added. Similar to the RT data, each cow's spreadsheet was then copied and pasted to create one long running spreadsheet to then be imported to R studio for further analysis.

Exploring Rumination Time (RT) in Last Week of Pregnancy:

The idea is to place cow's in either one of two groups, above or below, the mean rumination time (RT) in the last week of pregnancy. With cows that associate with metabolic disorders, tend to have decreased RT in the week before calving. To start, each individual cows 24 hour RT was selected from -7d to -1d, the "distinct" function was used from the dyplr package to clear out identical rows and then using the function "group by" for Cow ID, then "summarize" to obtain the mean RT for each cow in the last week of pregnancy. Now that each cow has an average RT for the last week of pregnancy, a new column was added using the "mutate" function to take the group mean RT, as well as another column was added to compare the individual RT to the group RT mean to identify if each cow falls above or below of the mean group RT. New data frames were created using the "filter" function to separate and organize each cow into either the above RT dataset or below RT dataset.

- (2 tables here, one of the above group, and one for below group)
- box plot comparing above and below grp

Exploring Mean RT in the Week Before and Week After Calving (-7d to 7d):

From the above RT dataset, Cow ID, Day and 24 hour RT was selected and filtered from days -7 to 7, and identical rows were removed. The "group by" function was used to find the above group mean RT for each day, -7 to 7. These steps were copied and used to do the same for the below RT dataset. These two data sets were combined into one using the "left join" function from dplyr, by day, then using the "pivot longer" function, created columns day, group (mean day RT above or below), and the mean RT. Using ggplot, a line graph is created showing the mean RT (min/24hr) for groups above and below from -7d to 7d post-partum. (graph)

Above and Below Groups for Milk Yield (MY):

From the 24 hour mean RT, the groups above or below were assigned to the MY datasets using the "left join" function. New data frames were created for each group, filtering for just above or below, then the "mutate" function was used to convert Cow ID to a factor instead of a character for ease of plotting in ggplot. Using ggplot, two graphs were made, one for the above group and of for below, showing the week of lactation and their weekly MY that was calculated through excel. (2 graphs here)

Similar to creating the mean RT by day for the above and below groups, these steps were copied for mean MY by day (days since last calving) for both above and below groups. Starting with the above group, the days since last calving was used in the "group by" function, followed by "summarise" to find the daily MY mean. The same was applied to the below group. Both data frames were combined using the "left join" function by days since last calving, then using the "pivot longer" function, created columns days since last calving, group (mean day MY above or below), and the mean MY. Using ggplot, a line graph is created showing the mean MY (lbs) for groups above and below in the first 30 DIM. (graph)

total = 3 graphs for this part

Works Cited:

Calamari, L., N. Soriani, G. Panella, F. Petrera, A. Minuti, and E. Trevisi. 2014. "Rumination Time around Calving: An Early Signal to Detect Cows at Greater Risk of Disease." *Journal of Dairy Science* 97 (6): 3635–47. https://doi.org/10.3168/jds.2013-7709.

Drackley, James K. 1999. "Biology of Dairy Cows During the Transition Period: The Final Frontier?" *Journal of Dairy Science* 82 (11): 2259–73. https://doi.org/10.3168/jds.S0022-0302(99)75474-3.

Kaufman, E.I., V.H. Asselstine, S.J. LeBlanc, T.F. Duffield, and T.J. DeVries. 2018. "Association of Rumination Time and Health Status with Milk Yield and Composition in Early-Lactation Dairy Cows." *Journal of Dairy Science* 101 (1): 462–71. https://doi.org/10.3168/jds.2017-12909.

Leblanc, Stephen. 2010. "Monitoring Metabolic Health of Dairy Cattle in the Transition Period." *Journal of Reproduction and Development* 56 (S): S29–35. https://doi.org/10.1262/jrd.1056S29.

McArt, J.A.A., D.V. Nydam, and G.R. Oetzel. 2012. "Epidemiology of Subclinical Ketosis in Early Lactation Dairy Cattle." *Journal of Dairy Science* 95 (9): 5056–66. https://doi.org/10.3168/jds.2012-5443.

Neves, R.C., B.M. Leno, K.D. Bach, and J.A.A. McArt. 2018. "Epidemiology of Subclinical Hypocalcemia in Early-Lactation Holstein Dairy Cows: The Temporal Associations of Plasma

Calcium Concentration in the First 4 Days in Milk with Disease and Milk Production." *Journal of Dairy Science* 101 (10): 9321–31. https://doi.org/10.3168/jds.2018-14587.

Paudyal, S., F.P. Maunsell, J.T. Richeson, C.A. Risco, D.A. Donovan, and P.J. Pinedo. 2018. "Rumination Time and Monitoring of Health Disorders during Early Lactation." *Animal* 12 (7): 1484–92. https://doi.org/10.1017/S1751731117002932.

Schirmann, K., N. Chapinal, D.M. Weary, L. Vickers, and M.A.G. Von Keyserlingk. 2013. "Short Communication: Rumination and Feeding Behavior before and after Calving in Dairy Cows." *Journal of Dairy Science* 96 (11): 7088–92. https://doi.org/10.3168/jds.2013-7023.

Soriani, N, E Trevisi, and L Calamari. 2012. *Relationships between Rumination Time, Metabolic Conditions, and Health Status in Dairy Cows during the Transition Period*.

Tufarelli, Vincenzo, Nikola Puvača, Dragan Glamočić, Gianluca Pugliese, and Maria Antonietta Colonna. 2024. "The Most Important Metabolic Diseases in Dairy Cattle during the Transition Period." *Animals* 14 (5): 816. https://doi.org/10.3390/ani14050816.

R Packages Citations: