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Post-Feeding Behaviors of Newborn and Peak Lactation Dairy Cows

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ABSTRACT
This study compared the behavioral characteristics of newborn and peak lactation dairy cows in the barn after feeding. The study used 10 newborn and 10 peak lactation Holstein cows. Behavior was directly observed for 10 consecutive days between 11:00-13:00 at five-minute intervals using the time sampling method. After the morning feeding, eating, lying down, locomotion, lying, and standing rumination, friendly interaction, and abnormal stereotypic behavior of newborn and peak dairy cattle were significantly different (P≤0.05). Cows in the peak period (33.7%) showed more feeding behavior than cows in the neonatal period (12.4%) (P=0.0001). Lying behavior was 21.9% in the neonatal group and 15.7% in the peak group (P=0.0561). Locomotion behavior was 12.3% in the neonatal group and 17.1% in the peak group (P=0.0028). Lying rumination was 19.8% in the newborn group and 8.7% in the peak group (P=0.0022). Standing rumination was significantly different in the neonate (8.2%) and peak (1.2%) groups (P=0.0008). In conclusion, it was observed that the transition and peak periods in dairy cattle caused differences in the behavioral characteristics of the animals. It can be said that the difference in feeding visits and activities due to the continuity of feeding behavior and the difference in the ratio of roughage in the daily rations is the most important source of behavioral differences between the groups, in which different physiological and metabolic reactions occur.

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Yeni Doğuran ve Pik Dönemindeki Süt Sığırlarının Beslenme Sonrası Davranışları

ÖZET
Bu çalışmada, yeni doğuran ve laktasyonun pik dönemindeki süt sığırlarının yemleme sonrasında barınak içindeki davranış özellikleri karşılaştırmalı olarak irdelenmiştir. Çalışmada, 10 yeni doğuran ve 10 pik dönemindeki Siyah Alaca (Holstein) sığırlarından yararlanılmıştır. Davranışlar ardışık 10 gün boyunca 11:00-13:00 arasında beşer dakika aralıklılarla zaman örneklemesi yöntemiyle doğrudan gözlenmiştir. Sabah yemleme sonrasında yeni doğuran ve pik dönemlerinde bulunan süt sığırlarının beslenme, yatma, lokomosyon, yatarak ve ayakta geviş getirme, arkadaşça etkileşim ve anormal stereotipik davranışları önemli ölçüde farklılaşmıştır (P≤0.05). Pik (%33.7) dönemindeki sığırlar yeni doğuran (%12.4) dönemindeki sığırlardan daha fazla beslenme davranışı göstermiştir (P=0.0001). Yeni doğuran grubunda yatma davranışı ortalama %21.9, pik grubunda ortalama %15.7 olmuştur (P=0.0561). Dikilme davranışı benzer gerçekleşen gruplarda, lokomosyon davranışı yeni doğuran grubunda %12.3, pik grubunda ise %17.1 olarak saptanmıştır (P=0.0028). Yatarak geviş getirme davranışı yeni doğuran grubunda ortalama %19.8, pik grubunda ortalama %8.7 olmuştur (P=0.0022). Ayakta geviş getirme davranışı yeni doğuran (%8.2) ve pik (%1.2) grubuna göre önemli ölçüde farklılık göstermiştir (P=0.0008). Sonuçta, süt sığırları için geçiş dönemi ve pik dönemlerinin hayvanların davranış özelliklerinde farklılığa neden olduğu

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görülmüştür. Farklı fizyolojik ve metabolik reaksiyonların gerçekleştiği iki grup davranış farklılıklarının en önemli kaynağının beslenme davranışının devam etmesine bağlı yemlik ziyareti ve aktiviteleri ile günlük rasyonlarındaki kaba/kesif yem oranı farklılığından olduğu söylenebilir.

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INTRODUCTION

It is possible to state that the 'annual production cycle' for dairy cattle consists of the sum of 'lactation' and 'dry period' that it goes through consecutively following the first calving, at which point it joins the milking herd. In the postpartum period, milk yield increases rapidly in proportion to the growth needs of the newborn, after which it begins to decrease gradually. The period when milk yield peaks in the first 60-100 days after calving is defined as "early lactation" (Hutjens, 2016). The 3-week period before and 3 weeks after birth is considered the "transition period" (Grummer, 1995; Neave et al., 2017). It has been reported that dairy cows during the transition period face very important rapid changes in nutritional requirements, internal physiological conditions, and the social environment to which they are exposed, with the risk of triggering health problems of infectious and metabolic origin (Goff & Horst, 1997; LeBlanc et al., 2006; Cattaneo et al., 2023).

The productivity of the lactation period can be greatly influenced by the success of transition period management. During this process, the constraints of feeding herd management and systematic environmental factors (lactation order, calving season, calving year, service period etc.) can have a significant impact on the level of peak performance of dairy cattle (Tüzemen & Tankal, 2024). The most fundamental change occurring during this period is the sudden increase in nutrients needed to produce milk. Dry matter consumption, and therefore nutrient consumption, has lagged in this increase over the same period. It is stated that the net energy of lactation and metabolic protein consumption lagged the net energy of lactation and metabolic protein consumption by 26% and 25%, respectively (Bell, 1995). Total dry matter intake in dairy cows is reported to increase rapidly from early lactation, +0.8 kg dry matter/cow per week by week 6, and +0.3 kg dry matter/cow per week from week 7 to week 12 (Walsh et al., 2024).

Huzzey et al. (2005) emphasized that the changes in feed intake during the transition period are regulated together with the changes in feeding behavior, but explained that the scientific knowledge on this subject is insufficient. Keyserlingk & Weary (2011), who state that changes in animal behavior during the transition period can also be used to predict the risk of health and foot problems, point to the existence of previous studies (Sowell et al., 1999) describing the relationships between morbidity and feeding behavior in beef cattle. The authors also emphasize the nature of the changes in dietary and related behaviors.

It can be said that the behavior of cattle under grazing conditions is usually coordinated. In addition, feed intake, rumination, and subsequent resting behavior may be associated with a significant proportion of the group (Arave & Albright, 1981; Miller & Wood-Gush, 1991). It has been reported that dairy cattle exhibit diurnal feeding activity, and that feeding activity increases at sunrise and sunset (Albright, 1993). It has also been reported that under indoor conditions, an individual within a group can significantly stimulate the entire group to go to the feeder (DeVries & Keyserlingk, 2008). Primiparous, multiparous, or parity status has been found to influence postpartum behavior in cattle (Neave et al., 2017; Peiter et al., 2021; Cattaneo et al., 2023).

One of the most important aspects that has a determining influence on the general characteristics of daily feeding behavior is the level of yield (Peiter et al., 2021). Therefore, all sorts of directive aspects related to the individual and the animal that have a directive effect on this trait can create identifiable differences in behavioral characteristics as a means of adaptation (Dado & Allen, 1994; Peiter et al., 2021). While studies in dairy cattle have focused on the transition period, including the prenatal and postnatal periods (Neave et al., 2017; Peiter et al., 2021), it has been noted that there is limited research on behavior during the peak period (DeVries et al., 2003). In addition, dairy cattle during the neonatal period and the peak period can suffer from a high incidence of diseases of metabolic origin. A comparative study of the behavior of cattle during this period will help in the early diagnosis of these diseases. The objective of the current study was to compare the post-feeding behavior of newborn and peak lactation dairy cows in shelters.

MATERIAL and METHOD

Animals and study design

This study was carried out in a dairy cattle farm in the Yenişehir district of the province of Bursa with a total of 20 head of dairy cattle. There were no deviations from routine farming practices in the study. Cows that gave birth at the beginning of lactation were grouped as "newborn" and those in the highest milk yield period of lactation were grouped as "peak". The study used 10 newborn and 10 1st and 2nd lactation peak Holstein cows. Cows were numbered and marked with spray paint for each group, selected from a group of approximately 200 cows. The newborn group was selected from cows that gave birth within 1 week, while the peak group was selected from cows in the 85th-90th day of lactation. At the beginning of the study, the average milk yield of the cows in the newborn group was 22.7±2.17 liters, and the average milk yield of the animals in the peak period was 28.5±1.83 liters. Newborn and peak period cows were fed according to the values reported by NRC (1989).

Feeding and Management

On the farm, cows are divided into the dry period, newborn, and peak groups. The barn has no resting stalls and consists of an enclosed feeding system followed by a manure cleaning alley and an open resting area. The resting area consists of a compact area of soil and a certain amount of accumulated manure. It is equipped with fans and scratching brushes. The area immediately behind the locked feeding system is concrete and is cleaned with the help of a tractor in the morning and evening when the cows are milked. The water needs of the cows are met with automatic drinkers.

The shelter is semi-open, and the animals are free to roam around the inside of the shelter. The cows are fed twice in the lock system, once in the morning and once in the evening, and the cows that come out of milking stay in the lock system for 1 hour. Animals can pass from the resting place to the milking unit with special partitions. Milking is carried out in 2 × 24 parallel milking units.

Behavior Observation

The cows were observed by two observers using the direct observation method for a period of 10 consecutive days in July. After milking in the morning, each group was taken to feed. Observations began after the locks were opened. Behaviors were sampled for five minutes between 11:00 and 13:00 by the time sampling method. In the study, feeding (feed consumption, tendency to feed, and attend to with feed), lying down, standing up, locomotion, lying rumination, standing rumination, aggressive interactions (butting, head shaking, mouthing, threatening, etc.), friendly interactions (licking hair, rubbing, etc.), abnormal stereotypies (biting and licking equipment, manipulation to litter, etc.), tendency to water (consumption, tendency, etc.), and other behaviors (urination, defecation, scratching, etc.) were observed.

Statistical Analysis

The behavioral traits of the cows were recorded and analyzed as "1" for present and "0" for absent. A discrete model (GEE) based on the repeated binomial distribution method was used to analyze the behavioral traits. The model included group (newborn, peak), day of observation (1,...,10), interaction, and individual repeated effect. Pairwise contrast based on the Wald Chi-square test was used for significant factors (SAS, 1999).

RESULTS and DISCUSSION

Table 1 presents the mean behavioral traits of newborn and peak cattle, while Table 2 presents the results of the statistical analysis of behavioral traits. The factors observation day and group x observation day did not have a statistically significant effect on any behavior ($P>0.05$; data not shown). It was found that the cows in the peak group (33.7%) showed more feeding behavior than the cows in the newborn group (12.4%) (Table 1). Nielsen (1999) stated that the increase in energy requirements during the lactation process, beginning with calving, may be the main reason for the increase in dry matter intake and that differentiation in the number of meals, meal duration, and intake rate parameters can be used strategically to increase the level of intake. It is known that dairy cattle during the transition period experience very important and rapid changes in terms of nutrient requirements, physiology, and social environment (Goff & Horst, 1997; Neave et al., 2017; Cattaneo et al., 2023). The dry matter intake of cattle is estimated to be 10-12 kg/day, increasing to 21 kg/day during lactation, according to NRC (1989). In the study, it was observed that feeding activity (consumption, tendency, feeder visits) was significantly higher in cows in the peak group than in cows in the newborn group. Huzzey et al. (2005) stated that cattle spend less time consuming at the feeder during the post-calving transition period compared to the prenatal period. The authors state that the reason for this may be an increase in the feed consumption rate. This was the case for animals in the newborn group of the present study, but not for animals in the peak period. It is likely that the

increase in the rate of consumption during the peak period of daily milk production may not have been sufficient for nutrition. A higher level of nutritional activity has been found in cows with a higher milk yield (Johnston & DeVeries, 2018). It has been observed that cows spend a greater proportion of their mealtimes at the feeder during the peak period and reduce the number of meals spent away from the feeder (DeVeries et al., 2003).

The average lying behavior was 21.9% in the newborn group and 15.7% in the peak group (Table 1). This difference between the groups was found to be statistically significant (Table 2). The difference between the groups is further increased by the addition of the behavior of the lying ruminants. This may be since cows in the peak period exhibit more feeding behavior (consumption and tendency to eat). Lying time and feeding behavior have been found to be inversely related to dairy cows, with lying behavior being at its lowest during peak feeding (Fregonesi et al., 2007). On the other hand, it has been observed that there is an increasing relationship between lying down and ruminating behavior in cattle during the newborn period (Schirmann et al., 2012).

It was found that the standing behavior of cows, which showed an average of 16% standing behavior, was close between the groups (Table 1; P=0.1030). Huzzey et al. (2005), who studied behavioral changes in dairy cows during the transition period, found that standing behavior increased after calving and that the increase in standing time was expected. It was found that cows in the peak group (17.1%) exhibited locomotor behavior at a higher rate than cows in the newborn group (12.6%) (Table 1). The fact that the cows in the peak group showed more locomotor behavior than the cows in the newborn group may be due to the mobility of the cows during their visits to the feeder, when they show more feeding behavior. Cows with higher milk yield have been found to have increased feeding behavior, as well as increased feeder head activity and number of meals (Johnston & DeVeries, 2018).

Table 1. Mean observation rates and standard errors (SE) of behaviors by lactation period group, %.
Çizelge 1. Laktasyon dönemi gruplarına göre davranışlara ait ortalama gözleme oranları ve standart hata (SH) değerleri, %

Behavior (*Davranış*)	Newborn (*Yenidoğan*)		Peak (*Pik*)		Overall (Genel)
	Mean (*Ortalama*)	SE (*SH*)	Mean (*Ortalama*)	SE (*SH*)	
Feeding (*Beslenme*)	12.4	0.66	33.7	0.96	23.1
Lying (*Yatma*)	21.9	0.84	15.7	0.74	18.8
Standing (*Dikilme*)	16.8	0.76	14.9	0.72	15.9
Locomotion (*Lokomosyon*)	12.6	0.67	17.1	0.76	14.9
Lying rumination (*Yatarak geviş*)	19.8	0.81	8.7	0.57	14.3
Standing rumination (*Ayakta geviş*)	8.2	0.56	1.2	0.22	4.7
Tendency to water (*Suya yönelim*)	3.7	0.38	4.0	0.40	3.9
Abnormal Stereotype (*Anormal stereotipi*)	0.8	0.18	0.2	0.08	0.5
Friendly interaction (*Arkadaşça etkileşim*)	0.5	0.15	1.6	0.25	1.1
Aggressive interaction (*Agresif etkileşim*)	0.5	0.15	0.3	0.11	0.4
Other (*Diğer*)	2.8	0.33	2.6	0.32	2.7

It is known that cattle ruminate by lying down (Cooper et al., 2007). The standing ruminations were 14.3%, while lying ruminations were 4.7% (Table 1). It was found that the cows in the newborn group had significantly more ruminating behavior in both the lying and standing positions than the cows in the peak group (Table 2; P≤0.05). Cows in the peak period had higher total dry matter intake than cows in the newborn period, while time spent feeding was higher in behavioral observations. Although total dry matter intake determines rumination behavior (Schirmann et al., 2012), it can be said that decreasing the ratio of roughage to concentrate feed during the peak period decreases rumination behavior in cows. Dado & Allen (1994) found that each 1 kg of NDF consumed resulted in approximately 66 minutes of rumination, while Maekawa et al. (2002) reported that changes in the ratio of roughage to compound feed had a linear effect on rumination. In addition, the fact that the cows in the newborn group stood up more than the peak group may have caused higher levels of standing rumination behavior.

In addition to several factors such as dry matter intake and ambient temperature, characteristics related to the physiological phase the animal is in are important factors in determining the water requirements of dairy cattle. In this sense, lactation has been identified as the physiology that most stimulates water demand (NRC, 2001). Huzzey et al. (2005) reported that the time allocated to water consumption increased by 20% during the transition period compared to the pre-calving period, and this was accompanied by an increase in the number of water-

consuming meals. While water tendencies were similar between the groups, slightly higher water tendency behavior was observed in the peak group with higher milk yield (Table 1).

Table 2. Estimates (b), standard errors (SE), odds ratio (Ψ), and p values of behaviors according to lactation period groups*.

Çizelge 2. Laktasyon dönemi gruplarına göre davranışlara ait tahmin (b), standart hata (SH), odds (Ψ) ve P değerleri.*

Behavior (*Davranış*)	Newborn (*Yenidoğan*)			
	b	SE (*SH*)	Ψ	P
Feeding (*Beslenme*)	-1.31	0.07	0.27	<0.0001
Lying (*Yatma*)	0.37	0.17	1.45	0.0281
Standing (*Dikilme*)	0.14	0.07	1.15	0.1030
Locomotion (*Lokomosyon*)	-0.38	0.08	0.68	0.0028
Lying rumination (*Yatarak geviş*)	0.93	0.08	2.53	0.0022
Standing rumination (*Ayakta geviş*)	1.93	0.19	6.89	0.0008
Tendency to water (*Suya yönelim*)	0.17	0.15	0.84	0.4731
Abnormal Stereotype (*Anormal stereotipi*)	1.56	0.55	4.76	0.0050
Friendly interaction (*Arkadaşça etkileşim*)	-1.16	0.31	0.31	0.0103
Aggressive interaction (*Agresif etkileşim*)	0.69	0.58	1.99	0.2568
Other (*Diğer*)	0.01	0.08	1.01	0.4330

*:b value for peak group is 0.00 Ψ value and 1.00. *: Pik grubuna ait b değeri 0.00 Ψ değeri ve 1.00'dır.

Although at a lower level, cows in the newborn group exhibited more abnormal stereotypic behavior than did cows in the peak group (Table 1, 2; P = 0.0050). The transition period between very different physiological processes, such as pregnancy and lactation, witnesses very important changes in terms of metabolic processes in different tissues of the organism. In this regard, it would not be wrong to say that the nutritional conditions within this process are very critical for dairy cattle (NRC, 2001; Overton & Waldron, 2004). From this point of view, it can be said that the cows in the newborn group are under pressure during the "transition period". However, in the present study, although no clear conclusion can be drawn due to the time sampling of behaviors and the low rate of abnormal stereotypic, the fact that the newborn group is clearly separated from the peak group suggests the need for careful herd management of dairy cows in this group. Redbo et al. (1992) found an increase in oral stereotypic behavior as milk yield increased in dairy cows.

The cows in the peak group (1.6 %) showed more friendly interaction behavior than the cows in the newborn group (0.5 %) (Table 1). The fact that the cows in the peak group were in estrus may have increased the level of friendly interaction. Although cows in the peak group showed significantly more feeding and locomotor behavior than cows in the newborn group, they showed lower levels of aggressive interaction (Table 2; P=0.2568). Although the level of aggressive interactions between animals varies according to the presence of competitive resources, food is one of the most important of these resources (Tölü & Savaş, 2007).

CONCLUSIONS

The feeding, lying down, locomotion, lying and standing, rumination, friendly interactions, and abnormal stereotypic behaviors of dairy cows whose post-feeding behaviors were compared between early lactation (newborn) and peak period were significantly different. It can be said that the physiological activities of newborn dairy cows in the transition period, the nutrient requirements of dairy cows in the peak period, and changes in the ratio of roughage/concentrate in the daily ration cause differences. It appears that the higher feeding behavior of the cows during the peak period and the low roughage content in their rations resulted in lower levels of lying and ruminating behavior and higher levels of locomotor behavior. It is also likely that the level of friendly interaction increased during the peak period because the cows were in estrus. The fact that cows in the newborn group exhibit significantly more abnormal stereotypic behavior than the peak group, even at low levels, may put practices that can reduce abnormal stereotypic behavior during this period on the herd management agenda.

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Contribution Rate Statement Summary of Researchers

The authors declare that they have contributed equally to the article.

Conflict of Interest

The authors declare no conflicts of interest.

REFERENCES

Albright, J.L. (1993). Feeding behavior in dairy cattle. *J Dairy Sci. 76*, 485-498.

Arave, C.W. & Albright, J.L. (1981). Cattle behavior. *J Dairy Sci.* 64, 1318-1329.

Bell, A.W. (1995). Regulation of organic nutrient metabolism during transition from late pregnancy to early lactation. *J Anim. Sci. 73*, 2804-2819.

Cattaneo, L., Piccioli-Cappelli, F., Minuti, A. & Trevisi, E. (2023). Metabolic and physiological adaptations to first and second lactation in Holstein dairy cows. *J Dairy Sci. 106(5)*, 3559–3575. https://doi.org/10.3168/jds.2022-22684

Cooper, M.D., Arney, D.R. & Phillips, C.J.C. (2007). Two-or four-hour lying deprivation on the behavior of lactating dairy cows. *J. Dairy Sci. 90,* 1149-1158.

Dado, R.G. & Allen, M.S. (1994). Variation in and relationship among feeding, chewing, and drinking variables for lactating dairy cows. *J. Dairy Sci. 77*, 132-144.

DeVries, T.J. & Keyserlingk, M.A.G. (2008). Understanding cow behaviour from a nutritional perspective. Tri-State Dairy Nutrition Conference, 13-22. 22-23 April USA.

DeVries, T.J., von Keyserlingk, M.A.G., Weary, D.M. & Beauchemin, K.A. (2003). Measuring the feeding behavior of lactating dairy cows in early to peak lactation. *J Dairy Sci. 86(10)*, 3354-3361. https://doi.org/10.3168/jds.S0022-0302(03)73938-1.

Fregonesi, J.A., Tucker, C.B. & Weary, D.M. (2007). Overstocking reduces lying time in dairy cows. J *Dairy Sci. 90,* 3349-3354.

Goff, J.P. & Horst, R.L. (1997). Physiological changes at parturition and their relationship to metabolic disorders. *J Dairy Sci. 80*, 1260-1268.

Grummer, R.R. (1995). Impact of Changes in Organic Nutrient Metabolism on Feeding the Transition Dairy Cow. *J Dairy Sci. 73*, 2820-2833.

Hutjens, M.F. (2016). *Dry-Lot Dairy Cow Breeds*, Editor(s): Paul L.H. McSweeney, John P. McNamara, *Encyclopedia of Dairy Sciences* (Third Edition), Academic Press, p.234-241,ISBN 9780128187678, https://doi.org/10.1016/B978-0-08-100596-5.00706-X.

Huzzey, J.M., Keyserlingk, M.A.G. & Weary, D.M. (2005). Changes in feeding, drinking, and standing behavior of dairy cows during the transition period. *J. Dairy Sci. 88(7)*, 2454-2461.

Johnston, C. & DeVeries, T.J. (2018). Associations of feeding behavior and milk production in dairy cows. *J Dairy Sci. 101(4)*, 3367-3373.

Keyserlingk, M.A.G. & Weary, D.M. (2011). Identifying transition cows at risk and how best to manage them. tri-state dairy nutrition conference, 45-54. 19-20 April, USA.

LeBlanc, S.J., Lissemore, K.D., Kelton, D.F., Duffield, T.F., & Leslie, K.E. (2006). Major advances in disease prevention in dairy cattle. *J. Dairy Sci. 89*(4), 1267–1279. https://doi.org/10.3168/jds.S0022-0302(06)72195-6

Maekawa, M., Beauchemin, K.A. & Christensen, D.A. (2002). Chewing activity, saliva production, and ruminal ph of primiparous and multiparous lactating dairy cows. *J Dairy Sci. 85,*1176-1182.

Miller, K. & Wood-Gush, D.G.M. (1991). Some Effects of housing on the social behaviour of dairy cows. *Anim. Prod. 53*, 271-278.

Neave, H.W., Lomb, J., von Keyserlingk, M.A.G., Behnam-Shabahang, A. & Weary, D.M. (2017). Parity differences in the behavior of transition dairy cows. *J Dairy Sci. 100(1)*, 548-561. https://doi.org/10.3168/jds.2016-10987.

Nielsen, B.L. (1999). On the interpretation of feeding behaviour measures and the use of feeding rate as an indicator of social restraint. *Appl. Anim. Behav. Sci. 63,* 79-91.

NRC. (1989). Nutrient Requirement of Dairy Cattle. National Research Council. Sixth Revised Edition. National Academy Press, Washington DC.

NRC. (2001). Nutrient Requirement of Dairy Cattle. National Research Council. Seventh Revised Edition. National Academy Press, Washington DC.

Overton, T.R. & Waldron, M.R. (2004). Nutritional Management of Transition Dairy Cows: Strategies to Optimize Metabolic Health. *J Dairy Sci. 87(E. Suppl.)*, E105-E119.

Peiter, M., Phillips, H.N. & Endres, M.I. (2021). Association between early postpartum rumination time and peak milk yield in dairy cows. *J Dairy Sci. 104(5),* 5898–5908. https://doi.org/10.3168/jds.2020-19698

Redbo, I., Jacobsson, K.G., van Doom, C. & Pettersson, G. (1992). A note on relations between oral stereotypies in dairy cows and milk production, health and age. *Animal Science 54(1)*, 166-168.

SAS, (1999). SAS/STAT User's Guide: Version 8. SAS Institute Inc., Cary, NC, USA.

Schirmann, K., Chapinal, N., Weary, D.M., Heuwieser, W. & Keyserlingk, M.A.G. (2012). Rumination and its relationship to feeding and lying behavior in Holstein dairy cows. *J Dairy Sci. 85*, 1176-1182.

Sowell, B.F., Branine, M.E., Bowman, J.G.P., Hubbert M.E., Sherwood, H.EE. & Quimby, W. (1999). Feeding and watering behavior of healthy and morbid steers in a commercial feedlot. *J Anim. Sci. 77*, 1105-1112.

Tölü, C., & Savaş, T. (2007). A brief report on intra-species aggressive biting in a goat herd. *Appl. Anim. Behav. Sci. 102*, 124-129.

Tüzemen, N. & Tankal, M. (2025). The effect of some environmental factors on peak milk yield in Holstein cattle. *KSU J. Agric Nat 27 (Suppl 1)*, 276-286. DOI: 10.18016/ksutarimdoga.vi.1481215.

Walsh, S., Delaby, L., Kennedy, M., Galvin, N., McKay, Z.C. & Egan, M. (2024). Intake profile, milk production, and energy balance of early-lactation spring-calving Holstein Friesian and Jersey × Holstein Friesian dairy cows in high-utilization pasture-based systems. *J Dairy Sci. 107*, 8058–8071.