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The feed push-up as a factor influencing health of dairy cows

Přihrnování krmiva jako faktor ovlivňující zdraví dojnic

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ABSTRACT

The effect of feed push-up has already been proven in several studies, so this topic can be considered one of the main points that helps improve the health status of dairy cattle. This study aimed to determine how the frequency of feed push-ups influences the health status of udder (mastitis), somatic cell counts, and reproduction. The effect of feed push-up on mastitis, the somatic cell counts, and the conception of dairy cows was evaluated. The feed was pushed-up at a frequency of 2x, 3x, 4x, 5x, and 6x a day for one calendar month. The effect on the number of dairy cows treated with mastitis was insignificant ($P \geq 0.05$). The lowest number of cows with mastitis was found when feed was pushed-up five times daily. The effect on the somatic cell counts was insignificantly, too ($P \geq 0.05$). The worst milk quality was found in the experimental group, which had a frequency of push-up 5x/day. However, it has been shown that the frequency of food push-up positively affected the conception rate in dairy cows ($P < 0.001$).

Keywords: cattle, feed intake, mastitis, somatic cell counts, reproduction, animal behavior

ABSTRAKT

Vliv přihrnování byl prokázán již v několika studiích, proto lze považovat právě toto téma za jedno z hlavních bodů, které napomáhá ke zlepšení zdravotní stav dojného skotu, jelikož má významný vliv na zdravotní stav dojnic, ale také na mléčnou užitkovost. Cílem této studie bylo zjistit vliv frekvence přihrnování krmiva na zdravotní stav vemene (mastitida), počet somatických buněk a reprodukci. Byl hodnocen vliv přihrnování na mastitidu, počet somatických buněk a schopnost zabřezávání. Přihrnování krmiva probíhalo ve frekvenci 2x, 3x, 4x, 5x a 6x denně po dobu jednoho kalendářního měsíce. Vliv na počet léčených dojnic s matitidou byl nevýznamný ($P \leq 0.05$). Nejnižší počet krav s mastitidou byl zjištěn při podávání krmiva pětkrát denně. Vliv na počet somatických buněk byl rovněž nevýznamný ($P \leq 0.05$). Nejhorší kvalita mléka byla zjištěna u pokusné skupiny, která měla frekvenci přihrnování 5x/denně. Bylo však prokázáno, že frekvence přihrnování pozitivně ovlivnila míru zabřezávání dojnic ($P < 0.001$).

Klíčová slova: skot, příjem krmiva, mastitida, počet somatických buněk, reprodukce, chování zvířat

INTRODUCTION

The large increases in milk yield and structural changes in the dairy industry have caused major modifications in housing, feeding, and management of dairy cows (Ingvartsen and Moyes, 2013). Feed intake significantly affects milk production and changes of conditions in dairy cows during lactation. The strategy of group feeding that affects daily feed intake significantly impacts the production of dairy cows, animal welfare, the health of the herd, and farm profitability (Sniffen et al., 1993; Rabelo et al., 2003). It has been proved that milk production largely depends on the amount of nutrients consumed, i.e., the total dry matter intake in the feed (Veerkamp, 1998; Zábranský et al., 2015). The production performance of dairy cows is also affected by behavioural patterns such as rest, rumination, and feeding time (Grant and Albright, 1995; Provolo et al., 2008). While eating, the cows "take over and sort" the fodder, and push it further away from each other until the fodder lying on the feed table or alley becomes unreachable for them. To alleviate or eliminate this problem regular pushups are carried out to supply the animals with accessible feed (DeVries et al., 2003; Havlík, 2009). It is well known that more frequent feeding results in an increased total feed intake and higher milk production in dairy cows. In addition, more frequent feeding has a positive impact on the health of dairy cows. Feed availability may be more important than the actual amount of nutrients provided (Grant and Albright, 2001).

Dairy cows are typically fed a feed mixture called total mixed ration (TMR) (Krause and Oetzel, 2006). Mixed feed rations alleviate health problems in the first phase of lactation, which could occur during individual feeding of core feed in high quantities (possible occurrence of acidosis) (Strapák et al., 2013; Zábranský et al., 2019).

In general, mastitis is a very painful condition (Fitzpatrick et al., 1998; Medrano-Galarza et al., 2012). Early diagnosis of mastitis is essential for effective treatment and prevention of losses associated with lower milk production (Hovinen et al., 2008; Viguir et al., 2009; Sathiyabarathi et al., 2018). Mastitis is generally defined as inflammation of the mammary gland. It is an expensive and comprehensive disease with different origins and severity (Thompson-Crispi et al., 2014). Damage to the glandular tissue reduces the number and activity of milk-producing epithelial cells and contributes to reduced milk production, reduced milk quality, decreased animal health and welfare, and increased treatment costs (Sharma and Jeong, 2013).

Somatic cell counts (SCC) in milk are commonly used as indicators of mammary health on the basis that they reflect the immune response and thus the presence of infection in the mammary gland. It has been reported that an SCC of <100,000 cells/ml is normal in a healthy mammary gland (Sharma et al., 2011; Barata et al., 2015; Alhussien and Dang, 2018), whereas an SCC of >200,000 cells/ml suggests a bacterial infection (Bradley and Green, 2005). Its permitted limit value in a pooled sample is SCC < 400 thousand in 1 ml of raw milk (Hanuš and Vyletělová, 2012). While the greatest variability in SCC results from the presence or absence of infection, it is influenced by several other factors including parity, stage of lactation, time of day, and season (Dohoo and Meek, 1982; Laevens et al., 1997; Schepers et al., 1997; Green et al., 2006).

Worldwide, there is a significant improvement in milk production, which is primarily due to intensive selection and improved nutrition. However, a continuous downward trend in reproductive performance (RP) is observed in high-producing cows (Lucy, 2001; Pryce et al., 2004; Dobson et al., 2007). This decline in RP may be due to prolongation of the period of the first insemination, poor exhibition of estrus behavior, prolongation of the service period, decreased success rate of artificial inseminations (AIs), and high culling rates due to poor RP (Thatcher et al., 2006; Lucy, 2019).

The experiment with different intensities of feed push-up aimed at finding the most effective feeding system that would suit the breeder and dairy cows regarding health.

MATERIALS AND METHODS

The experimental work took place on a dairy farm where about 300 dairy cows of the Czech fleckvieh breed were kept from 2017-2021. The experimental sample consisted of 32-37 selected dairy cows one to two months after calving. Primarily, the activity of intake of the mixed feed ration by dairy cows was monitored for 15 minutes from the time the feed was delivered in the feeding trough and each subsequent feed push-up to the trough in the regularly tested frequencies. Fresh feed was provided always at 6:00 a.m. Experiments were divided into five different frequencies of feed push-ups (2x to 6x) in a 12-hour interval. In each experimental year, one frequency of push-up was observed for 30 days (Table 1). After every experiment, dairy cows were fed for 30 days in a standard mode. Dairy cows were monitored for their somatic cell counts, health status, and reproductive indicators.

Table 1. Schedule of feed push-up frequencies

Number of feed push-ups	Time schedule
2 x daily	at 12.00, and 18.00
3 x daily	at 10.00,14.00, and 18.00
4 x daily	at 9.00, 12.00, 15.00, and 18.00
5 x daily	at 8.25, 10.50, 13.15, 15.40, and 18.00
6 x daily	at 8.00, 10.00, 12.00, 14.00, 16.00, and 18.00

The cows were housed in a cubicle lined with straw, and barnyard manure was removed twice a day. The capacity of box beds was 45 dairy cows. The dairy cows of the experimental group were regularly milked twice a day at 4:30 a.m. and 4:30 p.m. The feed was delivered always at 6:00 a.m., followed by a 12-hour time interval in which the dairy cows were monitored for 15 minutes after feeding, depending on the selected frequency of feed push-ups.

An insemination technician inseminated the dairy cows. Health and reproductive indicators were taken from veterinary and breeding records. Ethological observations of animals were carried out by personal observation. The results were statistically evaluated and processed into tables and graphs indicating the health status, productivity, and reproduction.

Statistical analysis

The statistical software R was used to evaluate the results. All dependencies during the experiment were tested on the following fixed facts: number of push-ups, year of the experiment, and number monitored of cows. The random effects were the season in which the experiment took place, the ambient temperature measured during the experiment, and the interaction of these two random effects.

The statistical evaluation is based on the fact that each frequency of push-ups was tested during four years in the same season. First of all, the relationship between push-ups and feeding behaviour was analyzed in the study. Furthermore, the effect of the number of push-ups on the number of cows with mastitis, the somatic cell counts, and conception rate. Data were analyzed with a general linear model. The tested parameters were compared with the fixed effect of push-up frequency, year, and the other effects affecting the observed parameter.

Each frequency of push-ups was tested at the same time of the year, therefore the season, the average daily temperature, and the interaction between two parameters were added as a random effect. Season and temperature can integrate together and independently. When the interaction effect was significant ($P \leq 0.05$), pair-wise differences between means were explored using Tukey's test.

RESULTS

This study dealt with the effect of the number of feed push-ups on the health status of dairy cows. For 15 minutes after the feed delivery, ethological monitoring of dairy cows was used, while the number of animals that went to receive feed at this time was recorded. The observation took place in 12-hour intervals. In all observed animals, the number of animals treated with mastitis, the somatic cell counts, and the conception rate of dairy cows were recorded. The experimental group did not always consist of the same number of animals, which was taken into account in the statistical processing of the results.

Mastitis is the most common disease of cattle and causes great economic losses. Figure 1 shows the percentage of cows treated with mastitis from the total number of monitored animals.

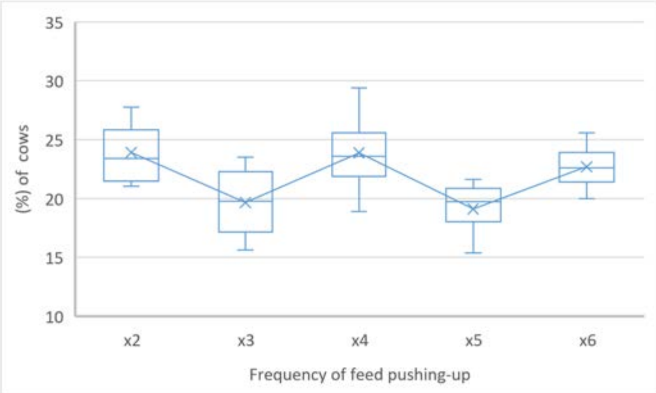

Figure 1. Percentage representation of dairy cows treated with mastitis

Data on the ratio of treated dairy cows range from 18.84% to 24.04% in different experimental groups. The evaluation parameter was determined by the percentage of dairy cows treated for mastitis at a specific feed push-up frequency. This parameter was not significantly influenced by the number of feed push-ups [F (3;5) = 1.66; *P* = 0.29] nor the year of the experiment [F (3;5) = 4.18; *P* = 0.08] (Table 2). The highest percentage representation of dairy cows treated with mastitis was found at a frequency of 2 push-ups. The lowest number of cows with mastitis was found when feed was pushed-up five times a day, as shown in Table 2.

The somatic cell count is one of the leading hygienic indicators of raw cow's milk and also an indicator of the health status of the mammary gland. Figure 2 shows the somatic cell count in the milk of dairy cows of all experimental groups.

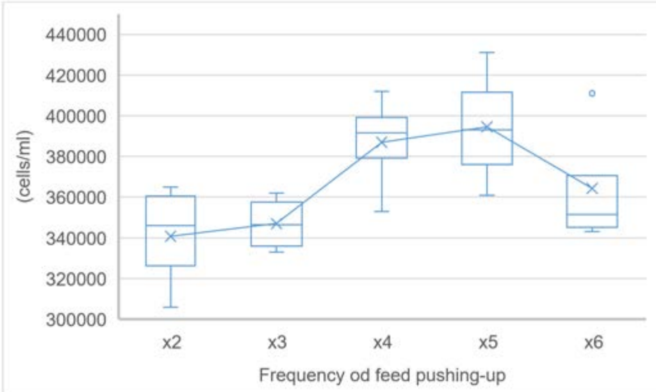

Figure 2. Somatic cell count in the milk of dairy cows

The somatic cell count was not significantly affected by the number of feed push-ups [F (3;5) = 3.30; *P* = 0.12], nor by year [F (3;5) = 1.50; *P* = 0.32] (Table 3), nor by the number of dairy cows in the experiment [F (1;5) = 0.13; *P* = 0.74). The worst somatic cell count was found in the experimental group, which had a frequency of push-up 5x/day. This means that the somatic cell count worsened with the increasing frequency of feed push-ups, as the lowest values were reached when feed push-ups were twice a day (Table 3).

Table 2. Percentage representation of dairy cows treated for mastitis in individual years

Percentage of dairy cows treated with mastitis with feed push-up frequency	2015 (%)	2016 (%)	2017 (%)	2018 (%)
2 x daily	27.78	21.62	25.71	21.05
3 x daily	21.88	15.63	17.65	23.52
4 x daily	24.32	18.92	22.86	29.41
5 x daily	18.92	15.38	21.62	19.44
6 x daily	25.00	23.34	20.00	21.88

Table 3. An average somatic cell count in the milk of dairy cows in the experimental group in the system with different frequencies of feed push-ups

An average somatic cell count with the frequency of feed pushing-up	2015 (x10³)	2016 (x10³)	2017 (x10³)	2018 (x10³)
2 x daily	365	359	333	306
3 x daily	356	337	362	333
4 x daily	388	395	412	353
5 x daily	361	405	431	381
6 x daily	346	357	343	411

Improving and maintaining conception rates is of primary importance for the profitability of dairy cattle breeding because fertility and milk yield correlate closely. Figure 3 shows the ability of the experimental group to conceive.

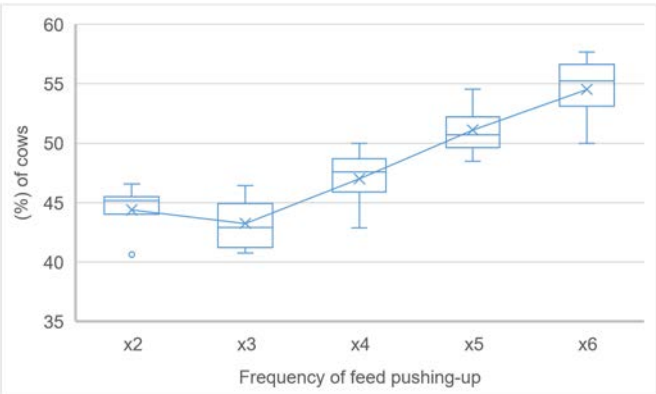

Figure 3. Conception in the experimental group in the system with different frequencies of feed pushing-up

The ability to conceive was significantly influenced by the number of feed delivery [F (3;5) = 8.62; *P* = 2.02×10-2], but also by the year [F (3;5) = 6.99; *P* = 3.07×10-2] (Table 4). More frequent feed push-ups were mirrored in a better conception percentage.

DISCUSSION

The stable environment differs significantly from pasture conditions. Changes in physical and social factors (e.g. artificial lighting, restrictions, and limited space availability) during housing significantly alter cow behavior in terms of the layout of different behavioral activities (DeVries et al., 2005). It is therefore essential to maintain the number of feeding places to allow all animals to receive feed. This rule was followed during this study. The barn's capacity was designed for 45 feeding places, and the number of dairy cows during the experiment did not exceed the number of 37 cows. The benefit of increased frequency of feed push-ups can significantly affect the feeding behavior, health, and productivity of the cows, which is confirmed by the study of DeVries et al. (2005).

Placing fresh feed in the trough is an important factor stimulating the dairy cow to feed. (DeVries et al., 2005). The main principle of feeding is to regularly push-up the feed, using any tool or method so that the animals have feed available *ad libitum*. The study by Havlík. (2009) shows that more frequent feeding can lead to more

Table 4. Conception ability in the system of different insemination frequencies during individual years

Percentage of pregnant cows with the frequency of feed push-ups	2015 (%)	2016 (%)	2017 (%)	2018 (%)
2 x daily	45.16	46.57	45.16	40.62
3 x daily	44.44	46.43	41.38	40.47
4 x daily	46.88	50.00	48.28	42.86
5 x daily	48.48	51.43	54.55	50.00
6 x daily	57.69	54.17	56.26	50.00

frequent visits of dairy cows to the feed table, resulting in a higher feed intake, more stable pH in the rumen, and above all, higher average efficiency, and reduction of feed residues.

Mastitis is the most common disease with a serious economic impact on dairy cows breeding, as it contributes to reduced production and deterioration of milk quality, including the presence of residues in milk, and is the cause of premature slaughter of animals and increased treatment costs (Bradley 2002; Seegers et al., 2003; Petrovski et al., 2006; Kim et al., 2019). Bedding, moisture, and manure are common reservoirs of mastitis pathogens in the environment (Ruegg, 2012). In the experimental breeding establishment, basic preventive measures against the occurrence of mastitis (milking hygiene, teat disinfection, clean bedding, etc.) are observed, but the effect of the number of push-ups fed on the number of treated dairy cows has not been proven.

Bertoni et al. (2015) and Zábranský et al. (2022) state that good health is essential for good performance and welfare of dairy cows, and nutrition is an important component of good health. Good nutrition is essential to maintaining a functional immune system while also serving as prevention against other causes of inflammation, such as tissue damage, digestive disorders, and metabolic syndrome. Somatic cell counts (SCC) mainly consist of immune cells that enter the mammary chamber of the udder (Madouasse et al., 2010). A study by Grimble (2001) states that metabolic or infectious diseases, as well as tissue damage responsible for inflammation, can be reduced to some extent by nutrition, but based on the results of this experiment, somatic cell counts cannot be reduced by the number of feed push-up. Furthermore, it is evident that the somatic cell count may not always be affected only by mastitis.

Environmental factors, such as temperature and nutrition, have a significant effect on the manifestations of estrus (Orihuela, 2000) and, in consequence, on the ability to conceive. Stable stocking density also significantly affects estrus (Roelofs et al., 2010). Dairy cows fed more frequently tend to consume the feed more evenly after each feed delivery (Mantysaari et al., 2006) or push-up. When cows are fed only once a day, there is a significant difference in feeding activity after feed delivery compared to feed delivery occurring twice a day (DeVries et al., 2005).

Furthermore, this increases physical activity, which has a favourable effect on the conception of dairy cows. Deming et al. (2013) reported a positive correlation between feeding frequency and total time of laying. This leads to a more efficient intake of feed and regular physical activity, and at the same time, dairy cows have enough time to rest, which has a demonstrable effect on the ability to conceive.

CONCLUSION

Five different frequencies of feed push-ups were evaluated. When assessing the effect of the number of feed push-ups on the number of cows treated with mastitis, certain trends were found, but not a demonstrable effect. The somatic cell count was the lowest in the group with the frequency of feed push-up 2 times/day. The ability to conceive was demonstrably the highest, with the feed push-up frequency of 6 times/day. The obtained results confirm that more frequent push-ups and continuous availability of feed ensure better health of dairy cows.

If feed is added regularly, reproduction will improve as dairy milk cows move more regularly. The results also show that the somatic cell count in the milk can also be influenced by the frequency of push-ups.

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