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# THE EFFECT OF THE SEASON ON THE BEHAVIOR AND MILK YIELD OF THE CZECH FLECKVIEH COWS

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## Abstract

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The aim of this study was to evaluate the seasonal behavior and milk yield of dairy cows of Czech Fleckvieh cattle. The subject of the monitoring was one section (housed in one quarter of barn) with 103 free cubicle beds with an average of 95 lactating dairy cows of Czech Fleckvieh cattle. In the seasons (spring, summer, autumn, winter) temperature (°C), relative humidity (%) and temperature-humidity index (THI) were monitored. Furthermore, behavioral signs were also observed (a total of 4,940 observations): dairy cows were either lying down (3,432 observations) or standing up (1,508 observations). In the conditions that dairy cows were standing up in the cubicle, up to 585 observations were proved. If dairy cows were standing up outside of the cubicle (923 observations), they were either lying on the left side (1,924 observations) or right side (1,508). Significant seasonal influence was found out ($p < 0.05$) on the number of dairy cows standing up (a maximum of 410 observations in the spring, a minimum of 342 observations in the summer) and then the number of cows lying both on the left (a maximum of 519 observations in the autumn and a minimum of 444 observations in the spring) and on the right side (a maximum of 415 observations in the winter, a minimum of 320 observations in the autumn). The seasonal influence was no significant ($p > 0.05$) in the remaining behavioral signs. With regard to milk yield, a significant seasonal influence was proved. The highest milk yield was reached with dairy cows in spring (29.27 kg of milk) and the lowest in the autumn (24.58 kg of milk). No significant differences of milk yield were detected between behavioral signs ($p > 0.05$). The maximum difference of milk yield was found out up to 1.39 kg between dairy cows lying down on the left side (28.35 kg) and the dairy cows standing up in a cubicle (26.96 kg) in the winter but even this difference was not statistically significant ($p > 0.05$).

Keywords: season, milk yield, Czech Fleckvieh cattle, behavior

## INTRODUCTION

A complicated system of environmental factors influences the health stutus of animals. A person excluded the animals from their natural environment and put them in inadequate conditions of their natural needs and demands. a breeder should eliminate a large part of the factors exciting defense mechanisms in the animal organism in their extreme values or in certain combinations and thereby reduces the potential yield (BOUŠKA *et al.*, 2006). Welfare or well-being of cows are the important factors in terms of animal health and profitability, and thus contributes to the economy of dairy farms (VOIGT *et al.*, 2007).

An important element, most affecting barn microclimate, is the air temperature (BÍLEK, 2002). The animal organism with constant body temperature may immeditately react on the air temperature affecting the yield or animal health in the extreme cases (KURSA *et al.*, 1998) According to RICHTER *et al.* (1983), thermal equilibrium zone is the temperature range of barn air enabling the highest yield in a condition of the maximum feed

utilization. As the authors also add, the exceeding or reducing of the temperature can cause lower yield and thus the increased losses.

Apart from the temperature, other climatic conditions such as airflow, air humidity etc. prove an important role (LOUDA *et al.*, 1999). The negative impact of the increased temperature multiplies the air humidity according to KOUKAL (2001). In higher humidity, the lower temperature is needed for the developing of a problem in a barn. The author also states that heat stress can be induced from temperatures above 20 °C in less ventilated barns.

As mentions WEST (2003), temperature-humidity index (THI) includes a combination of temperature effect and relative humidity. Currently, the determining value of THI method is used in many countries because weather stations provide routinely this information in most countries (SILANIKOVE, 2000). KENDALL *et al.* (2006) establish the temperature-humidity index, in which THI = 72 (corresponds to 25 °C and 50 % of relative humidity) for the detection of the thermal comfort generally considered as the upper critical threshold for dairy cows. The exceedance can cause a decrease in milk yield.

Cattle are ranked among species with excellent thermoregulation abilities. Cattle body is equipped with a number of mechanisms maintaining thermal balance of the body, even in unfavourable cold conditions. Cattle are therefore better adapted to the conditions of low air temperatures than higher (KNÍŽKOVÁ, 2005). According to ŠOCHA *et al.* (2003), coldness does not cause any negative effect on housed dairy cows (the authors confirm this fact by reaching high milk yield). On the other hand, VOKŘÁLOVÁ *et al.* (2007) reported that dairy cows can begin to show signs of cold stress in the exposure to the temperatures outside the thermoneutral zone ie. in the condition that the temperature falls below 0 °C.

The conditions begin since May for the creation of heat stress in Central Europe. Recently, the number of summer days is increasing (max. temperature up to 25 °C). The highest number of these days together with tropical days (over 30 °C) is monitored from June to August. The last possibility of heat stress is finished during September. Up to 130 days can be the risk days in a year ie. about a third of the year (DOLEJŠ *et al.*, 2004).

The influence of air temperature on the behavior of dairy cows also describes ZEJDOVÁ *et al.* (2011), who reported that at temperatures above 20 °C, the number of lying down dairy cows is decreased and the number of dairy cows standing up is increased. O'DRISCOLLA *et al.* (2009) specify that in winter, dairy cows are more lying down than in the summer – no matter what technology is used for housing. It also confirms VEČEŘA *et al.* (2012), who found out a higher proportion of dairy cows lying down compared to standing up during a lower temperature.

The aim of this study was to evaluate the effect of the seasons and the associated influence of air temperature, relative humidity and THI (temperature-humidity index) on milk yield and behavior of Czech Fleckvieh cattle.

## MATERIALS AND METHODS

The observation was carried out on a farm of a breeder called GenAgro Říčany a.s. (49°12′31.494″ N, 16°23′43.197″E) at an altitude of 349 metres above sea level. The average annual temperature ranges about 6.54 °C. The subject of monitoring was one section (housed in one quarter of barn)) with 103 free cubicle beds arranged in three rows. In the cubicle beds as a bedding, the digestate enriched limestone was used from the nearby biogas plant. Throughout the year, the side walls of the barn are permanently open. In this barn, ERBEZ *et al.* (2012) and VEČEŘA *et al.* (2011) also did their research.

The observation lasted for one year (from April in 2010 to March in 2011). In the observed barn, the dairy cows of Czech Fleckvieh cattle in the second or higher level of lactation since the thirtieth day of calving were housed. The data about the actual milk yield were assessed at each milking (i.e. twice a day) using the program called FASTOS 2000, which is a part of the milking house. The data were classified according to the season subsequently averaged in the Tables III and IV. The evaluated climatic characteristics are temperature (°C), relative humidity (%) and temperature-humidity index (THI). These characteristics were monitored inside the barn. Temperature and relative humidity were continuously measured during 15 minute intervals using three HOBO sensors placed in a monitored section of life in the animal zone (ie. equally in a height at the withers of dairy cows) – in order to eliminate the influence of one place. THI values were calculated according to the following equation given by HAHN (1999):

$$THI = 0.8\ tdb + (tdb - 14.4)*RH/100 + 46.4$$

where:tdb = temperature in the barn
RH = relative humidity in the barn

The records of air temperature, relative humidity and THI were averaged from all three sensors for each day. They also investigated the behavioral signs of dairy cows. In the barn, once a week at 10.00 am, the activity of all dairy cows was recorded using the method of group viewing into the pre-printed form according to the diagram below.

Schematic representation of the observed activities:

Dairy cows → lying down in a cubicle → on the left side
→ on the right side
→ standing up → in a cubicle
→ outside of a cubicle

Dairy cow standing up only forelegs in a cubicle was counted as standing up in a cubicle. All detected values of observed behavioral signs were divided into four periods: spring (April, May in 2010, March in 2011), summer (June, July, August in 2010), autumn (September, October, November in 2010) winter (December in 2010, January and February in 2011 ), (spring, summer, autumn, winter) and statistically analyzed in Statistica 10.0.

All the values and behavioral signs and the data of milk yield were statistically analyzed using the one factor analysis (ANOVA – Tukey HSD test) STATISTICA 10.0.

## RESULTS AND DISCUSSION

### Barn climatic chracteristics

Barn climatic characteristics are shown in Table. I. The table shows the average, maximum and minimum values of the characteristics of microclimate (temperature, relative humidity and THI) divided into four seasons. The differences between the various characteristics of microclimate in all seasons have been expected statistically highly significant.

### Influence of the season on cow behavior

The influence of season on the behavior of the dairy cows is described in Tab. II. From this table, it is obvious that the total number reached up to 4,940 observations. Dairy cows were either lying down (3,432 observations) or standing up (1,508 observations). If they were standing up, dairy cows were inside of the cubicle (585 observations) or outside (923 observations). If they were lying down, dairy cows were either on the left (1,924 observations) or right side (1,508 observations). Significant influence of the season was monitored ($p < 0.05$) on the number of cows standing up (a maximum of 410 observations in the spring, a minimum of 342 observations in the summer) and then, the number of dairy cows lying down both on the left (a maximum of 519 observations in the autumn, a minimum of 444 observations in the spring) and on the right side (a maximum of 415 observations in the winter, a minimum of 320 observations in the autumn). The influence of the season was not detected significant on the remaining behavioral signs ($p > 0.05$).

As stated DOLEJŠ *et al.* (2002), the number of dairy cows lying down should reflect the environment comfort. In their observation, the number of dairy

I: *Barn climatic characteristics*

| Climatic characteristics | | | Season | | | | Sig. |
|---|---|---|---|---|---|---|---|
| | | | spring | summer | autumn | winter | |
| **Temperature (°C)** | mean | 10.56 | 10.72 | 20.88 | 10.75 | -0.11 | ** |
| | min. | -8.79 | 2.36 | 14.92 | 3.05 | -8.79 | |
| | max. | 26.62 | 17.10 | 26.62 | 16.55 | 5.81 | |
| **Relative humidity (%)** | mean | 77.32 | 70.93 | 73.67 | 78.51 | 86.98 | ** |
| | min. | 46.22 | 46.22 | 53.71 | 68.18 | 55.28 | |
| | max. | 97.96 | 93.57 | 94.47 | 94.41 | 97.96 | |
| **THI** | mean | 51.20 | 51.97 | 67.30 | 51.68 | 33.78 | ** |
| | min. | 19.44 | 38.62 | 58.58 | 38.41 | 19.44 | |
| | max. | 75.10 | 62.17 | 75.10 | 60.96 | 42.60 | |

THI – temperature-humidity index calculated according to HAHN (1999) – see chapter called Materials and Methods
The different values are indicated ** ($P < 0.01$)

II: *Influence of season on behaviour of dairy cows*

| Behavioral signs | | Season | | | | Total | Sig. |
|---|---|---|---|---|---|---|---|
| | | spring | summer | autumn | winter | | |
| **Lying down (n)** | | 825 | 893 | 839 | 875 | 3 432 | NS |
| **Standing up (n)** | | 410 | 342 | 396 | 360 | 1 508 | * |
| **Lying down** | Left side (n) | 444 | 501 | 519 | 1 924 | * | * |
| | Right side (n) | 381 | 392 | 320 | 1 508 | * | * |
| **Standing up** | Outside cubicle (n) | 242 | 217 | 257 | 923 | NS | NS |
| | Inside cubicle (n) | 168 | 125 | 139 | 585 | NS | NS |
| **Total (n)** | | **1235** | **1235** | **1235** | **1235** | **4 940** | |

The different values are indicated * ($P < 0.05$) in a row or difference is not significant (NS).

cows lying down was decreasing while the number of dairy cows standing up was increasing in higher temperatures followed by the risk of heat stress. This is confirmed by ZEJDOVA *et al.* (2011), who stated that the number of cows lying down decreased at temperatures above 20 °C. It totally disagrees with our findings because the highest number of dairy cows lying down was recorded in the summer with an average temperature of 20.88 °C in a barn. Longer time of dairy cows standing around is one of the typical symptoms of heat stress compared to shorter time of lying down (DOLEŽAL, 2010).

At the temperature above 22 °C, the time of lying down is extended up about 70 % (DOLEJŠ *et al.*, 2004). This statement do not correspond with our results. We have found out the highest number of dairy cows standing up in the spring and autumn, which are the seasons with air temperature, relative humidity and THI within the range of the optimal values.

## Influence of season on milk yield

The influence of season on milk yield of dairy cows is shown in Tab. III. The influence of season was evident. The highest milk yield was reached with dairy cows in the spring ( up to 29.27 kg of milk) and the lowest in the autumn (up to 24.58 kg of milk). No significant differences between behavioral signs were detected in milk yield. The maximum difference of milk yield of 1.39 kg was observed between dairy cows lying down on the left side (up to 28.35 kg milk) and dairy cows standing up in a cubicle ( up to 26.96 kg of milk) in winter.

As stated Fryč (2002), the highest influence of high temperature on milk yield was proved during the first 60 days of lactation. As indicated in PENNINGTON, Van Devender (2006), a weak heat stress can cause approximately 10 % of decrease in milk yield. In a high heat stress, milk yield can be decreased by more than 25 %. It can be assumed that low milk yield in the autumn was found out in our observed dairy cows because of temperature stress during the previous summer period and even though the average temperature and THI in the autumn almost did not differ from those in the spring. TOUFAR, DOLEJŠ (1996) mentioned that if a high temperature was discontinued and the thermal environment has been returned to

III: *Influence of season on milk yield of dairy cows*

| Behavioral signs | | Milk yield (kg) | | | | mean (kg) | Sig. |
|---|---|---|---|---|---|---|---|
| | | spring | summer | autumn | winter | | |
| **Lying down (n)** | | 29.49$^{a}$ | 27.75$^{b}$ | 24.71$^{c}$ | 28.17$^{b}$ | 27.53 | * |
| **Standing up (n)** | | 28.83$^{a}$ | 27.47$^{b}$ | 24.32$^{c}$ | 27.68$^{ab}$ | 27.08 | * |
| **Lying down** | Left side (n) | 29.39$^{a}$ | 27.83$^{b}$ | 24.76$^{c}$ | 28.35$^{ab}$ | 27.58 | * |
| | Right side (n) | 29.60$^{a}$ | 27.66$^{b}$ | 24.61$^{c}$ | 27.96$^{b}$ | 27.46 | * |
| **Standing up** | Outside cubicle (n) | 29.18$^{a}$ | 27.70$^{a}$ | 24.27$^{b}$ | 28.22$^{a}$ | 27.34 | * |
| | Inside cubicle (n) | 28.32$^{a}$ | 27.07$^{a}$ | 24.39$^{b}$ | 26.96$^{a}$ | 26.69 | * |
| **Total** | | 29.27$^{a}$ | 27.67$^{b}$ | 24.58$^{c}$ | 28.02$^{b}$ | 27.39 | * |

The values in the rows marked with different letters (a, b, c) are statistically significantly different at a level of $P < 0.05$ (*) or difference is not significant (NS)

IV: *Influence of season on the order and stage of lactation*

| Behavioral signs | | Lactation number (n) | | | | Year mean (n) | Sig. | Stage of lactation (n = days) | | | | Year mean (day) | Sig. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | spring | summer | autumn | winter | | | spring | summer | autumn | winter | | |
| **Lying down (n)** | | 2.95$^{ab}$ | 2.83$^{a}$ | 2.90$^{ab}$ | 3.03$^{b}$ | 2.93 | * | 127.1$^{a}$ | 154.4$^{b}$ | 145.9$^{c}$ | 118.6$^{a}$ | 136.5 | * |
| **Standing up (n)** | | 2.99$^{ab}$ | 2.91$^{ab}$ | 2.90$^{a}$ | 3.15$^{b}$ | 2.99 | * | 131.5$^{a}$ | 154.2$^{b}$ | 154.3$^{b}$ | 114.9$^{a}$ | 138.7 | * |
| **Lying down** | Left side (n) | 2.95$^{ab}$ | 2.79$^{a}$ | 2.88$^{ab}$ | 3.03$^{b}$ | 2.91 | * | 125.1$^{a}$ | 154.6$^{b}$ | 142.3$^{c}$ | 113.5$^{a}$ | 133.9 | * |
| | Right side (n) | 2.95 | 2.87 | 2.94 | 3.04 | 2.95 | NS | 129.4$^{a}$ | 154.2$^{b}$ | 151.8$^{b}$ | 124.3$^{a}$ | 139.9 | * |
| **Standing up** | Outside cubicle (n) | 2.88 | 2.84 | 2.86 | 3.05 | 2.91 | NS | 120.2$^{a}$ | 155.5$^{b}$ | 159.3$^{b}$ | 112.7$^{a}$ | 136.9 | * |
| | Inside cubicle (n) | 3.15 | 3.03 | 2.96 | 3.28 | 3.11 | NS | 147.6 | 151.9 | 145.1 | 118.0 | 140.7 | NS |
| **Total** | | 2.96$^{ab}$ | 2.85$^{a}$ | 2.90$^{a}$ | 3.07$^{b}$ | 2.95 | * | 128.5$^{a}$ | 154.4$^{b}$ | 148.6$^{b}$ | 117.5$^{c}$ | 137.3 | * |

The values in the rows marked with different letters (a, b, c) are statistically significantly different at a level of $P < 0.05$ (*) or difference is not significant (NS)

the temperature optimum (13–16 °C), the milk yield was not reversible increased such as on the discontinuation of low temperatures. In our case, the second highest milk yield (up to 28.02 kg of milk) was recorded in winter. It can be concluded that dairy cows even at the average low temperatures (-0,11 °C) did not suffer from cold stress in the winter. According to the results of DOLEŽAL *et al.* (2004), the negative economic impact of cold stress can be recorded up to a temperature of -7 °C. Also DRAGOVICH (1980), who compared the milk yield of cows in Australia at different temperatures (less than 0 °C and higher than 0 °C), detected minor differences in milk production. As the authors summarized, prolonged period of cold weather (i.e. days when the temperature fell below 0 °C) were associated with only a very weak reduction of the daily milk yield and significant decrease of milk yield was not related with the low temperatures.

Milk yield is significantly affected by the order of lactation and its stages. The average values of lactation number and stage of lactation of dairy cows in different seasons and during the observation of behavioral activities are stated in Tab. IV. It is evident that the difference of milk yield between the seasons caused significant differences in the order and stage of lactation in our experiment.

## CONCLUSION

On the basis of the annual observation of the seasonal influence on the behavior and milk yield of Czech Fleckvieh cattle, we can state that a significant influence of the season was detected on the number of dairy cows standing up and lying down either on the left or on the right side. For the remaining behavioral signs (dairy cows lying down or standing up inside and outside the cubicle), the influence of the season was not significant. As regards to a milk yield, a significant influence of the season was evident. The highest yield was reached with dairy cows in the spring and the lowest in the autumn, while no significant differences were found out in milk yield of dairy cows with the observed activity. Overall, we can say that the influence of the season on the observed behavioral signs and milk yield of Czech Fleckvieh cattle was significantly detected lower than those determined in dairy cows of Holstein cattle. This fact can be explained by lower yields of our observed dairy cows and their consequent lower metabolic load.

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