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THE EFFECT OF LOW TEMPERATURE IN COW BARN MICROCLIMATE ON MILK PRODUCTION OF CZECH FLECKVIEH COWS

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Abstract

The aim of this research was to evaluate the effect of low temperature in the cow barn on milk production of Czech Fleckvieh cows. Every day in a period from November to February (1.11.2008 – 28.2.2009) the temperature in the barn was monitored (in every 15 minutes) by HOBO sensors (Onset) and daily milk yield (kg) was recorded in a private farm in Radesinska Svratka (Highland Region). 284 Czech Flekvieh cows in their different lactations (from 1. to 8.) with an average milk yield 7.500 kg per lactation were milked in the study.

A strong positive correlation was found between the measured air temperatures in stable (maximum, minimum and mean) and daily milk production, strongest with the maximum air temperature (r = 0.51). We have found slightly lower correlation with the average air temperature (r = 0.46) and the lowest correlation was found with the minimum air temperature (r = 0.38). It can be stated (in contrast to summer season) that increase of temperature in winter season has a positive impact on milk production whereas the limiting factor is minimal stable temperature.

Keywords: cow, milk production, stable temperature

Introduction

A wide range of factors - internal and external - affects milk yield of dairy cows. An important external factor is stable microclimate, as it directly affects the well-being (welfare) of housed animals. Optimal welfare is a prerequisite for high performance not only in cows but also in other farm animals. Therefore, if we want prosperous and healthy animals, must pay attention to stable microclimate.

According to *Webster (1999)* cattle has a remarkably wide "thermoneutral zone," which *Doležal et al. (*2004*)* describes as a certain temperature range, when the constant values of other physical elements are assured an optimal thermal condition of the body and the animal has little energy expenditure to maintain physiological functions and has a sense of thermal comfort. The range of this zone is influenced by the overall level of metabolism and milk yield – higher yield means a wider thermoneutral zone. According to *Gerhold (*2007*)*, cow has the best opportunity to pass a lot of heat through the skin surface, when is cold and dry ambient air. Heat stress can negatively affect the quality of milk at high-yield dairy cows *(Hanuš et al.,* 2008*)* and protection against climatic extremes has a great importance for maintaining milk production (*Brouček et al*., 2006*)*.

Elements of stable microclimate are largely influenced by the outdoor climate, but their seasonal characteristic and daily dynamics in stable are suppressed by the production of heat and water vapour from animals in stable and air ventilation – natural and artificial (*Doležal et al*., 2004*; Novák et al.,* 2002*)*.

This experiment focused on average and extremes values of stable temperatures. The aim of this study was finding the effect of low temperature in cow barn microclimate on milk production of Czech Fleckvieh cows.

Material and methods

The study was performed (from 1.11.2008 to 28.2.2009) in a private farm in Radešínská Svratka being located in a Highland area (49°30'30.451"North, 16°5'23.780"East, altitude 400 m). In this experiment the stable temperatures were evaluated (minimum, maximum, average) in their relation to milk yield. The observed object was a stable for cows. Cows were kept in the same condition in free stall cow-shed with cubicles for 300 pieces, and fed ad libitum a complete ration. Cows were milked twice daily at 4.00 and 16.00 h.

Within the indicated period, temperatures (maximum, minimum, average) and daily milk yields were collected. Temperature measurements were performed every 15 minutes using three HOBO data loggers (Onset Computer Corporation®), which were located approx. 1.40 meters above the floor level in three different locations inside the barn to eliminate the effect of only one place of measuring.

Records of stable temperature were evaluated each day as follows: the maximum daily temperature was considered as the highest recorded temperature in the stable (by any sensor during 24 hours), the minimum daily temperature was evaluated as the lowest recorded temperature (by any sensor during 24 hour). For each sensor daily average temperature was calculated, from those values average daily temperature for each day were calculated. In addition to stable temperatures milk yield in dairy cows for each day were also monitored. The amount of cow milk was recorded at each milking (ie. twice per day). Data from all cows were daily averaged. The data obtained by experiment were analyzed using Statistica Version 9.

Results and discussion

Mean, minimum, maximum, standard deviation and variation coefficient of data from stable temperature and milk yield are shown in *Table 1.* It is visible that average daily temperature in stable resp. average daily yield was -0.86 ^{o}C resp. 23.12 kg (in range -16.11 − 12.61 ^{o}C resp. 20.66 – 25.93 kg). It means that in particular periods dairy cows were exposed to arctic day - according to *Doležal et al. (*2004*)* - when stable temperature was below -10 ^{o}C. The minimum resp. maximum daily temperature was in range (-19.49−10.99 ^{o}C, resp. -10.5−16.38 ^{o}C). The highest variability was found in average daily temperature resp. minimum daily temperature (29.11%, resp. 31.50%). The basic statistical parameters of milk yield and stable temperature are showed in *Figure 1.*, where we can observe a decrease of temperature in relation to milk yield.

Table 1: **Basic statistical parameters of milk yield and stable temperature (from 1.11.2008 to 28.2.2009)**

	Units	Days	Mean	Min.	Max.	Var.(%)	Std.
Average milk yield	kg	120	23.12	20.66	25.93	0.91	0.95
Average daily temperature	°C	120	-0.86	-16.11	12.61	29.11	5.40
Minimum daily temperature	°C	120	-3.09	-19.49	10.99	31.50	5.61
Maximum daily temperature	°C	120	2.21	-10.56	16.38	23.32	4.83

Although adult cattle are resistant to cold (*Jelínek et al*., 2003*)* its thermal comfort temperature considered to be around 3 - 12 °C (*Ticháček et al*., 2007*)*. From this we could deduce the fact that during this experiment (though not for its entire duration) dairy cows were exposed to cold stress - which could negatively affect the daily milk yield.

It is interesting, that compared with the summer period (*Zejdová et al*., 2010*)* – when in all measures of stable temperature (maximum, minimum, average) negative correlation was found to the average milk yield – our experiment showed the opposite trend. All measured temperatures in stable showing a positive correlation in relation to the average daily yield are indicated in *Table 2*. This correlation was strongest at the maximum temperature, slightly weaker at an average daily temperature and the lowest at minimum temperature in the barn, which is in accordance with the work *Zejdová et al. (*2011*)*, where a positive correlation was found for all three parameters (minimum, maximum and average daily temperature). Therefore it can be concluded that the maximum daily temperature in stable microclimate has the greatest effect on milk yield.

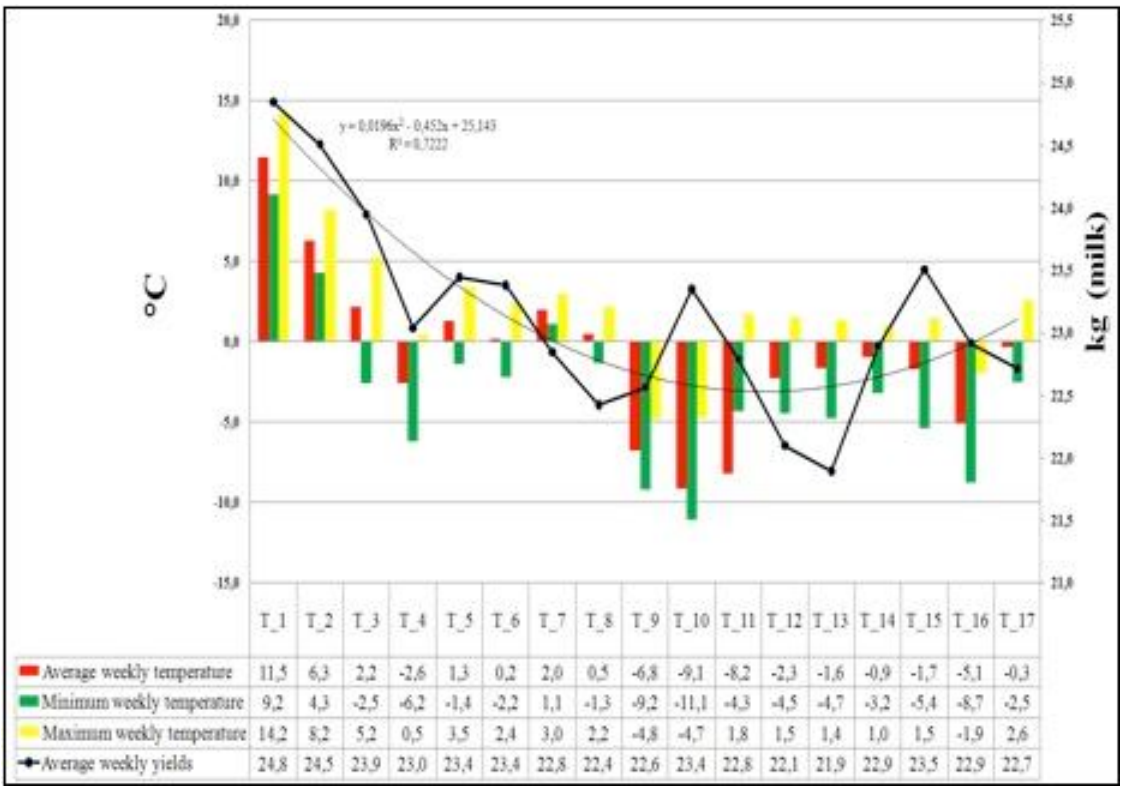

Figure 1: **Values of stable temperature (minimum, maximum, average) and milk yield (period from 1.11.2008 to 28.2.2009 – in week intervals)**

Table 2: **Correlations between average milk yield and stable temperature**

	Average daily temperature	Minimum temperature	Maximum temperature
Average milk yield	r= 0.4571**	r= 0.3847**	r= 0.5083**

**P<0.01 – highly significant

In the difference between the maximum and minimum daily temperature in stable on milk yield a weak positive correlation was found, which is in accordance with a similar study in the summer period, according to *Falta et al. (*2009*)*. Positive correlations between milk yield and stable air temperatures may indicate that – on contrast from summer days – in winter period decreasing temperature has a positive effect on milk production.

Conclusions

This observation showed the necessity of paying attention on the stable temperature monitoring data, not only on average values of climatic elements, but also their extreme levels. Minimum and maximum values (not only temperature), but all elements of stable microclimate, may adversely affect the welfare of dairy cows, which may subsequently manifest as deterioration of milk yield, or even health problems. This is so, despite the fact that effect of these extreme values during the day is rather short, therefore not affect significantly the average surface of microclimatic elements.

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