EFFECT OF BIOCLIMATE AND MILKING FREQUENCY ON MILK PRODUCTION OF HOLSTEIN DAIRY COWS IN SUMMER

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ABSTRACT

The objective of this study was to determinate the effect of bioclimate and milking frequency on milk production of Holstein dairy cows in summer. Measured properties were microclimate: average barn airspace temperature (BAT), relative humidity, temperature-humidity index (THI). The study lasted thirty-one days (data analyzed daily), in the period from 1 June 2013 to 1 July 2013 with BAT from 11.59 to 28.31 ° C. Data comes from University farm. The farm is situated in Žabčice (GPS49°0'51.786"N, 16°36'14.809"E). Total number of cows was divided into two groups by milk yield. Almost 40 % of cows milked more than 25 kg of milk per day per cow so cows are milked twice during the morning. The other more than 60 % of dairy cows milked per day less than 25 kg of milk per day, and these cows are milked once during the morning. Based on the correlation of milk production data of Holstein cows was found that with increasing BAT and THI statistically significantly reduces average morning milk yield per cow on the second morning milking (at 8.00 a.m.) (BAT: $r = -0.48$, $P < 0.01$, THI: $r = -0.47$, $P < 0.01$) and total average morning milk yield per cow in dairy cows milked twice during the morning (BAT: $r = -0.36$, $P < 0.05$, THI: $r = -0.35$, $P > 0.05$). Furthermore, the results indicate that with increasing BAT, THI was reduced second morning total milk yield in dairy cows milked twice during the morning (at 8.00 a.m.) (BAT: $r = -0.48$, $P < 0.01$, THI: $r = -0.47$, $P < 0.01$) and total milk yield in dairy cows twice milked during the morning (BAT: $r = -0.37$, $P < 0.05$, THI: $r = -0.36$, $P < 0.05$). Other analyzed parameters were not affected by microclimate ($P > 0.05$).

Key words: Holstein cows, milking frequency, milk production, barn airspace temperature, relative humidity, temperature-humidity index

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INTRODUCTION

Milk production is a complicated physiological property, which primarily related to the anatomical formation of the udder (with development organs, the activities of organs, blood and circulatory system, with breathing and transformation of nutrients). Milk yield is influenced by genetic factors and environmental influences (60 – 70 %) (Vaněk M., Štolc L. 2002), e.g. nutrition situation and frequency of milking (Lollivier V., Marnet P-G. 2005). It is generally known that it is unnatural to highly productive dairy cows were milked twice a day. More frequent milking (three times a day or more) increases the production of milk, lactation curve is higher and very balanced course, the result is the growth of performance of dairy cows (Fleischmannová H. 2005). Simply put, more frequent milking reduces the pressure in the mammary gland and milk production accelerates, from the physiological viewpoint (Anonym 1 2003). Rabold K. *et al.* (2002) said that with increasing frequency milking increases quality of the milk and total milk yield, compared with twice daily milking about 12 to 15 % (Doležal O. *et al.* 2000). Pařilová M. (2006) even report an increase milk yield about 6 to 25 % per lactation. Doležal O. *et al.* (2000) confirmed other positive the knowledge related to multiple frequency milking increases: the total production of protein and fat, reduces the number of somatic cells, shortens the time of mastitis treatment, increased frequency of legs and feet illness. On the other hand, it must take account of extending the service period, poor physical fitness, higher feed, process water, disinfectant consumption. Multiple milking become a widespread practice, not only here but also in North America and in Israel. We can assume that cows milked once during the morning, have lower milk production than cows milked twice during the morning and that milk production changed in connection with bioclimate. The aim of the study was evaluate the effect of bioclimate, milking frequency on milk production of Holstein of dairy cows in summer.

MATERIAL AND METHODS

Measured dates came from University farm in Žabčice (GPS49°0’51.786”N, 16°36’14.809”E), which reared with Holstein breed. During the 31 days (from 1. 6. 2013 to 1. 7. 2013) were collected data after the morning milking. The total number of dairy cow was divided into two groups according to the average daily milk yield. The first group of cows (average of 157 cows, i.e. almost 40 %), with milk yields of 25 l of milk per day were milked twice during the morning (at 4.00 a.m. and 8.00 a.m.). Cows were in the first to sixth lactation from 21 to 405 lactation day. The second group of cows (average 239 cows), with a maximum milk yield 25 kg per day was milked once (at 5.00 pm). Cows were the first to seventh lactation from 11 to 554 of lactation. All cows were milked again in the afternoon. This study does not deal with afternoon milk yield. The cows were stabling in free boxing with bedding of straw and dairy cows were fed a TMR ("total mix ratio"). Barn airspace temperature represents the average of the temperatures in the control days. It was measured every 15 minutes by 3 sensors with HOBO data logger (Onset Computer). Relative humidity in barn was recorded the same sensors and in the same intervals like barn airspace temperature. THI values were calculated according to the equation (Hahn G.L. 1999):

$$THI = 0{,}8 \cdot t_{db} + \frac{(t_{db} - 14{,}4) \cdot RH}{100} + 46{,}4 ,$$

where t_{db} = barn airspace temperature and RH = relative humidity.

Milk production (used as a average morning milk yield per cow and total morning milk yield) was obtained from the computer database of university farm in Žabčice. MS Office Excel 2003 and Unistat version 1.5 were used to evaluate the results of the data.

RESULT AND DISCUSSION

Values of mean, minimum, maximum and standard deviation of bioclimate, average morning milk yield one cow and total morning milk yield of Holstein cows with twice and once morning milking are presented in Tab I. It was selected for 31 days with a range of average daily temperatures in the barn from 11.59 ° C to 28.31 ° C, with an average daily temperature in the barn 18.37 ± 4.75 °C. This means that in some periods the monitored cows were exposed to a heat stress. Temperature 20 °C is considered a risk for the creation of heat stress (Zejdová P. *et al.* 2013). Relative humidity was measured from 61.36 % to 88.53 %, with an average of 72.13 ± 8.05%, in these days. Relative humidity in the barn should be in the range of 40 – 80 %. The relative values should not exceed 85% in the barn (Zejdová P. *et al.* 2013). This means that in some periods the monitored cows were exposed relative humidity higher than its optimum value. These data show that an average of 157 cows (40 percent) cows were milked again in the morning, while 239 cows (60 percent) cows were milked only once during the morning. In the morning twice milking cows been reported average milk yield per cow from 14.50 to 17.30 kg per cow, with an average 16.34 ± 0.82 kg per cow at 4.00 a.m. Average morning milk yield per twice morning milking cow was found from 5.40 to 7.00 kg per cow, with an average 6.35 ± 0.45 kg per cow at 8.00 a.m. Average morning milk yield per twice milking cow was measured from 19.90 to 24.30 kg per cow, with an average 22.69 ± 1.21 kg per cow. Average morning milk yield per once milking cow was found from 13.50 to 15.70 kg per cow, with an average 14.77 ± 0.56 kg per cow. Along with the average morning milk yield per cow were recorded as the total morning milk yield of cows in two groups divided by the maximum daily milk yield. Total morning milk yield of cows (milked twice) group was detected from 2223 to 2732 kg with an average value 2546 ± 174.68 kg at 4.00 a.m. Total morning milk yield of twice milking cows was found from 807 to 1109 kg with an average value 991.60 ± 84.04 kg at 8.00. Total morning milk yield of twice milking cows was recorded in the range from 3053 to 3801 kg with an average value 3538.05 ± 249.33 kg. In dairy cows milked once in the morning was found lower total morning milk yield (from 3124 to3769 kg with the average 3490.39 ± 152.59 kg) than cows milked twice during the morning.

Tab. I: Bioclimate, milk production of twice and once morning milking of Holstein cows in summer

Parameter		Hour	unit	n	$\bar{x}$	min	max	SD
Bioclimate	BAT		°C	31	18.37	11.59	28.31	4.75
	RH		%	31	72.13	61,36	88.53	8.05
	THI		-	31	63.73	53.34	77.59	6.99
Number of cows	Twice MM		-	31	157	149	163	4
	Once MM		-	31	239	232	258	7
Average morning milk yield per cow	Twice MM	4.00 a.m.	kg/cow	31	16.34	14.50	17.30	0.82
		8.00 a.m.		31	6.35	5.40	7.00	0.45
		∑		31	22.69	19.90	24.30	1.210
	Once MM	5.00 a.m.		31	14.77	13.50	15.70	0.56
Total morning milk yield	Twice MM	4.00 a.m.	kg	31	2546	2223	2732	174.68
		8.00 a.m.		31	991.60	807.00	1109.00	84.08
		∑		31	3538.05	3053	3801	249.33
	Once MM	5.00 a.m.		31	3490.39	3124	3769	152.59

Note: BAT – barn airspace temperature, RH – relative humidity, THI – temperature-humidity index, MM – morning milking

Values of coefficients of correlation of bioclimate, milk production of twice and once morning milking of Holstein cows in summer are presented in Tab. II. The table shows the effect of temperature on milk production. Based on the correlation of milk production data of Holstein breed was found with increasing barn airspace temperature reduces average morning milk yield per twice milked cow on the second milking at 8.00 a.m. ($r = -0.48$, $P < 0.01$) and total average morning milk yield per twice milked cow ($r = -0.36$; $P < 0.05$). In milk production data was observed that with increasing barn airspace temperature reduces total morning milk yield per twice milked cow on the second milking at 8.00 a.m. ($r = -0.48$, $P < 0.01$) and total morning milk yield per twice milked cow ($r = -0.37$; $P < 0.05$). Milk production of cows is influenced by environmental factors, especially high temperature during summer (Brouček J. *et al.* 2009). Many times was stated that high yielding cows that are at the top of lactation are particularly sensitive to heat stress (Doležal O. *et al.* 2000). Metabolic heat production increases as the productive capacity of dairy cows improves. Cows yielding 18.5 and 31.6 kg/day of milk produced 27.3 and 48.5 % more heat, respectively, than dry cows (Purwanto B.P. *et al.* 1990). Bernabucci U. *et al.* (2002) found a 10 % lower milk yield in summer than in spring. There was no statistically significant difference ($P > 0.05$) between the barn airspace temperature in and milk production of cows milked once during the morning. Cows with high production were probably less sensitive to the effects of high ambient temperatures (Brouček J. *et al.* 2009).

Tab. II: Values and cogency of correlation coefficientf of bioclimate, milk production of twice and once morning milking of Holstein cows in summer

Parameter		Hour	unit	BAT (°C)	RH	THI
Average morning milk yield per cow	Twice MM	4.00 a.m.	kg/cow	-0.26 N.S.	0.12 N.S.	-0.26 N.S.
		8.00 a.m.		-0.48**	0.27 N.S.	-0.47**
		∑		-0.36*	0.18 N.S.	-0.35 N.S.
	Once MM	5.00 a.m.		-0.05 N.S.	-0.10 N.S.	-0.04 N.S.
Total morning milk yield	Twice MM	4.00 a.m.	kg	-0.14 N.S.	0.02 N.S.	-0.13 N.S.
		8.00 a.m.		-0.48**	0.34 N.S.	-0.47**
		∑		-0.37*	0.20 N.S.	-0.36*
	Once MM	5.00 a.m.		-0.23 N.S.	0.08 N.S.	-0.21 N.S.

Note: Signification: N.S. - $P > 0.05$; * - $P < 0.05$; ** - $P < 0.01$
BAT – barn airspace temperature, RH – relative humidity, THI – temperature-humidity index, MM – morning milking

Relative humidity had no statistically significant difference ($P > 0.05$) milk production. The table shows the effect of temperature-humidity index on milk production. In milk production data was observed that with increasing temperature-humidity index reduces total morning milk yield per twice milked cow on the second milking at 8.00 a.m. ($r = -0.47$, $P < 0.01$) and total morning milk yield per twice milked cow ($r = -0.36$; $P < 0.05$). Daily THI was negatively correlated to milk yield ($r = -0.76$) (Bouraoui R. *et al.*, 2002). Doležal O. *et al.* (2000) argues that in a herd of lactating dairy cows to heat stress are much more sensitive cows with high milk yield than cows with low yield or dry cows. There was no statistically significant difference ($P > 0.05$) between humidity-temperature index and milk production of cows milked once during the morning.

CONCLUSIONS

The aim of this research was to evaluate effect of bioclimate and milking frequency on milk production of Holstein dairy cows in summer.Based on the correlation of bulk milk samples of Holstein breed was found that with increasing barn airspace temperature and temperature-humidity

index highly reduces average morning milk yield per cow, total morning milk yield on the second morning milking (at 8.00 a.m.) and total average morning milk yield per cow, total morning milk yield of dairy cows milked twice during the morning. We conclude that the temperature and temperature-humidity index statistically significantly affects more milk production of dairy cows with a milk yield over 25 kg per day milked twice during the morning than milk production less productive of dairy cows milked once during the morning.

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