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CHANGE OF STABLE MICROCLIMATE DURING THE SPRING AND SUMMER AS A CRITERION OF WELFARE AND ITS EFFECT ON MILK YIELD, COMPOSITION AND QUALITATIVE INDICATORS AS HOLSTEIN DAIRY COWS

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Abstract

The aim of this research was to evaluate the change of microclimate as a criterion of welfare and its effect on average milk yield, composition and qualitative indicators in milk at the turn of spring and summer. Overall 25 bulk tank milk samples were analyzed in the period of 27. 5. 2013 to 20. 6. 2013. Samples were taken every day. The farm is situated in Žabčice (GPS49°0'51.786"N, 16°36'14.809"E). Measured properties were microclimate: barn airspace temperature (BAT), relative humidity (RH); average morning milk yield; milk composition: fat content (F), solids non-fat (SNF), protein content (P), lactose content (L) and qualitative indicators: active acidity (AA), titratable acidity (TA), density (D), rennet coagulation time (RCT), quality of curd (QC), somatic cell (SC). Based on the correlation of bulk milk samples of Holstein breed was found with increasing BAT increases AA ($r = 0.84$, $P < 0.01$), RCT (r = 0 .73,), reduces TA ($r = -0.87$, $P < 0.01$). In bulk milk samples was observed with increasing RH increases AA ($r = 0.44$, $P < 0.01$) and reduces TA ($r = -0.47$, $P < 0.01$). Other analyzed parameters were not affected by microclimate.
Key words: Holstein, milk composition, milk quality, welfare, microclimate

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Introduction

Animal welfare is defined as a condition in which the animal is trying to cope with their environment *(Webster, 2005*). Quality of stable environment, nutrition, housing systems and the quality of care among are the main factors that affect the animal organism and affect their well-being and milk production (*Matějka, 1995*). Pressure is growing from the public on livestock farmers, in complying with the conditions of welfare and protection against maltreatment in many European countries. If the animals to behave in the environment in the thermo neutral zone, it would be ideal in terms of welfare. It is practically impossible (*Doležal et al., 2010*). Cows can keep a constant body temperature. This stability is relative. Hypothermia or hyperthermia can be caused enormous decrease or increase barn airspace temperature (*Brestenský et al., 2006*). Heat stress will become more important in livestock due to the forecast of continuing global warming (*Doležal et al., 2010*). Cows receive less energy from food at high temperatures. In the body occurs an energy deficit and reduces the yield of milk at high temperatures (*Brestenský et al., 2006*).

Relative humidity is the second main indicator of the quality of stable microclimate next to environmental temperature (*Šoch et al., 2003*). Seasonal and daily fluctuations in values of humidity are repressed influence of production of heat and water vapor animals accommodated and ventilation air in the breeding barn (*Doležal et al., 2004*).

The amount of evaporation depends mainly on the temperature, the degree of saturation of water vapor and air flow. High relative humidity has a negative impact on the welfare and performance of dairy cows (*Šoch et al., 2003*). Yield of Holstein cows is dynamically increased in recent years. This requires a re-analysis of the basic parameters of their milk. In addition to traditional content components (protein, fat, lactose and solids non-fat) come to the fore, indicators related to technological properties of milk as his rennet coagulation time, quality of curd and titratable acidity (*Čejna and Chladek, 2004*).

Materials and method

Measured samples came from University farm in Žabčice (GPS49°0’51.786”N, 16°36’14.809”E), which reared with Holstein breed. During the 25 days (from 27. 5. 2013 to 20. 6. 2013) were collected daily bulk milk samples after the morning milking.

Milk samples were analyzed next day after taking in the laboratory at department of Animal Breeding at Mendel University in Brno. Measured parameters were chosen: fat content (%), protein content (%), lactose (%), density (kg.l-1) and solids non-fat (%) with MilkoScope Julie C5 Automatic from Scope-Electric. Rennet coagulation time was determined using a "Nephelo-turbidimetric milk coagulation sensor" (*Přibyla and Čejna, 2006*). The test was performed using the preparation Laktochym 1:5000 (from the company Milkom, Inc. based in the Tábor, CZ) in the dose of 1 ml per 50 ml milk (after the dilution of the renneting agent in the ratio 1:4). Quality of curd was evaluated after 60 minutes of incubation of 50 ml of renneted milk at 35 °C and compared with tabular values (*Gajdůšek, 1997*) using the scale from 1 (the best) to 5 (the worst). Active acidity was measured by pH-meters Testo AG - testo 206. Titratable acidity was measured in a milk sample of 100 ml using an alkaline solution up to light pink colour of the mixture (in ml of the 0.25 M NaOH x $100ml^{-1}$). 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. To the resulting program was used MS Office Excel 2003 and Unistat version 5.1

Results and discussion

Values of mean, minimum, maximum and standard deviation of data from analysis of cow’s milk composition, qualitative indicators and barn airspace temperature, relative humidity are shown in Table I. It was selected for 25 days with a range of average daily temperatures in the barn from 17.47 ° C to 25.95 ° C, with an average daily temperature in the barn 20.82 ± 2.47 ° 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 et* *al., 2013*). Relative humidity was measured from 71.83 % to 77.88 %, with an average of 75.69 ± 1.80%, 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. Harmful air is too dry (below 35 %) - which occurs very rarely in our conditions (*Zejdová et al., 2013*). The average morning milk yield was found from 17.46 to 20.11 liters, with an average of 19.14 ± 0.70 liter of milk.

***Table 1*: Mean, minimum, maximum and standard deviation of quantity, composition and average morning milk yield, properties of milk, barn airspace temperature and relative humidity on farm**

Parameter		$\bar{x}$	Min	Max	SD
BAT	**°C**	20.82	17.47	25.95	2.47
RH	**%**	75.69	71.83	77.88	1.80
AMMY	**liter**	19.14	17.46	20.11	0.70
F	**%**	3.78	3.34	4.19	0.22
SNF	**%**	8.54	7.98	9.08	0.29
D	**kg.m^{-3}**	1.0291	1.0273	1.0310	0.0010
P	**%**	3.13	2.94	3.34	0.57
L	**%**	4.69	4.38	4.98	0.16
RCT	**second**	207	185	270	20
QC	**class**	2	1	3	0.45
AA	**pH**	6.60	6.41	6.79	0.13
TA	**°SH**	5.83	5.18	6.16	0.27

BAT – barn airspace temperature, RH – relative humidity, AA – active acidity, TA – titratable acidity, F – fat content, SNF – solids non fat, D – density, P – protein content, L – lactose content, RCT – rennet coagulation time, QC – quality of curd, , AMMY – average morning milk yield

Measured parameters were fat content, protein content, lactose content and solids non-fat content and density. The average values of fat content and its standard deviation for the whole period under study were 3.78 ± 0.22 %. The minimum of value of fat content is 3.34 % and the maximum value was 4.19 %, on the other hand. Values of solids non-fat content were ranged from 7.98 to 9.08%, with an average of 8.54 ± 0.29 % in the samples. The density of the milk samples was determined from 1.0273 to 1.0310 kg.m^{-3}, with an average of 1.0291 ± 0.001 kg.m^{-3}. Next milk component was measured protein content. The lowest value of the protein content was observed 2.94 %, the highest protein content was 3.34 %, with an average value of 3.13 ± 0.57 %. Last measured milk component was lactose content. The lowest value of the lactose content was 4.38 %, while the highest value of the lactose content was 4.98%. The time needed to coagulate milk proteins ranged from 185 to 270 seconds, with an average time of 207 ± 20 seconds in the period. Quality curd ranged from class 3 to class 1, with an average of grades 2 ± 0.45 classes. Active acidity was observed from pH 6.41 to pH 6.79, with an average pH of 6.60 ± 0.13. Last monitored a qualitative indicator was titratable acidity. The lowest value of titratable acidity was 5.18 °SH, while the highest value was observed 6.16 °SH. The average value of titratable acidity was 5.83 ± 0.27 °SH.

Barn airspace temperature and humidity index were compared with the average morning milk yield, composition and quality of milk indicators in Table 2.

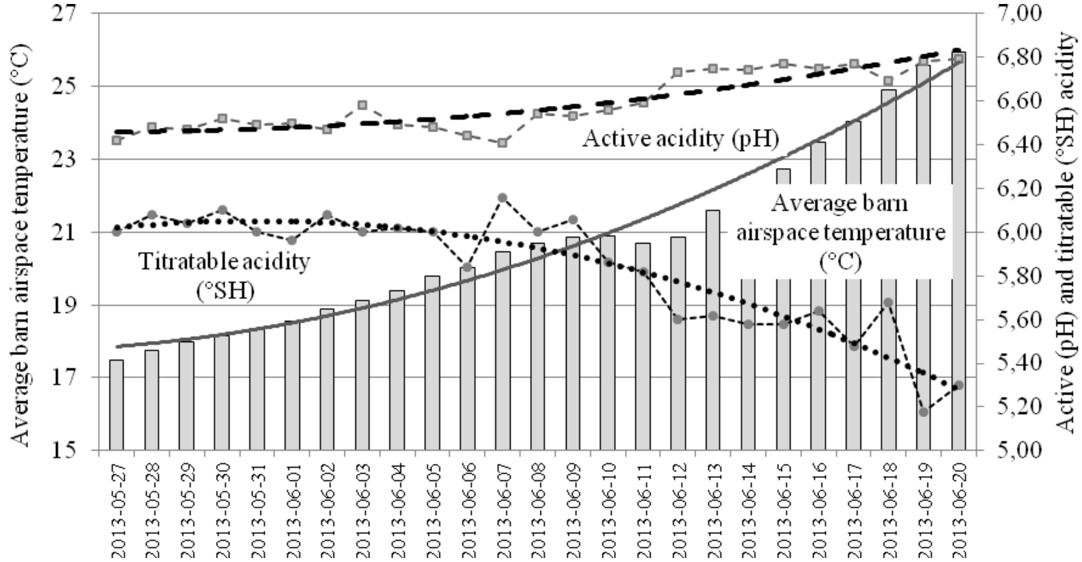
***Table 2*: Correlation between barn airspace temperature, relative humidity and yield, composition and qualitative indicators of milk**

		Parameter of microclima	
		BAT	**RH**
Parameter of quntity, composition and quality of milk	**AA**	0.84**	0.44*
	TA	-0.87**	-0.47*
	F	-0.35 N.S.	0.07 N.S.
	SNF	-0.36 N.S.	-0.38 N.S.
	D	-0.33 N.S.	-0.34 N.S.
	P	0.06 N.S.	-0.02 N.S.
	L	-0.36 N.S.	-0.38 N.S.
	RCT	0.73**	0.33 N.S.
	QC	0.29 N.S.	0.17 N.S.
	AMMY	-0.15 N.S.	-0.39 N.S.

*Signification: N.S. = non signifiant (P > 0.05); * = (P < 0.05); ** = (P < 0.01)*

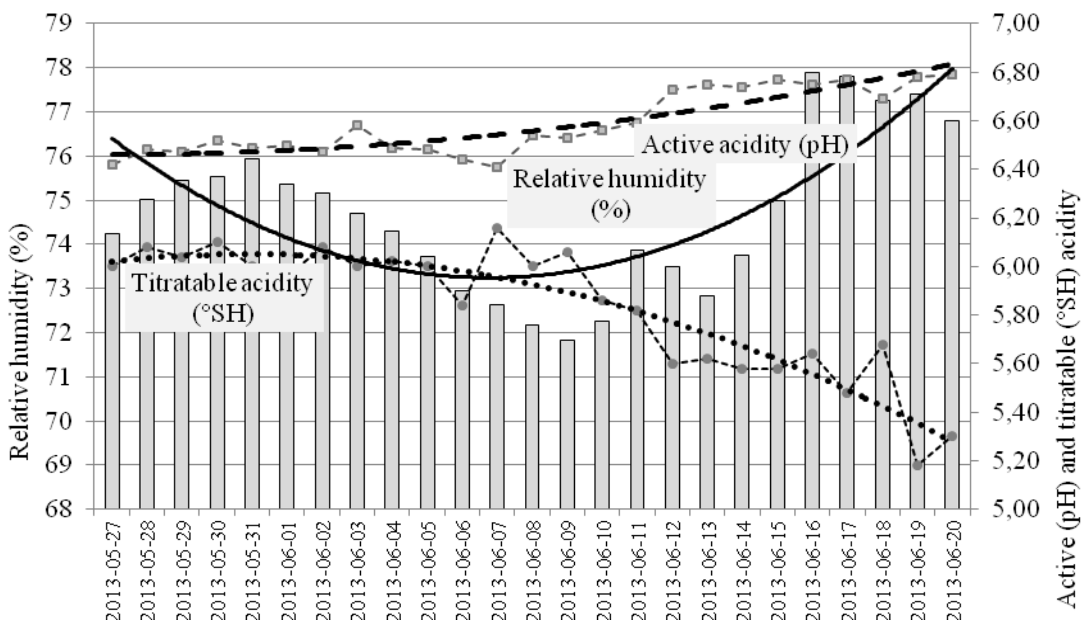
Based on the correlation of bulk milk samples of Holstein breed was found that with increasing average barn airspace temperature increases active acidity (r = 0.84, P < 0.01) (*Figure 1*). Further it was found out that there was a possitive correlation between average barn airspace temperature and rennet coagulation time (r = 0.73, P < 0.01). Polak et al. (2011) reached the same findings on the effect of temperature on rennet coagulation time. Rennet coagulation time is considered the most important technological properties of milk (*Čejna, 2008*). Effect of heat stress is manifested by changes in microbiological and chemical properties of milk (*Dolejš et al., 2006*). In milk samples was found that with increasing average barn airspace temperature reduces titratable acidity (r = -0.87, P < 0.01) (Figure 1). Titratable acidity of milk is dependent on the chemical composition of milk, especially protein, phosphate and citrate (*Gajdůšek, 2003*). Another correlation between average daily temperature and other monitored parameters were not statistically significant (P > 0.05).

***Figure 1*: Effect of average barn airspace temperature on active a titratable acidity in milk**



Based on the correlation of bulk milk samples of Holstein breed was found with increasing relative humidity increases active acidity (r = 0.44, P < 0.01) and reduces titratable acidity (r = -0.47, P < 0.01) (*Figure 2*). Dietary electrolyte balance is especially important in locations where environmental temperatures exceed 24 ºC and is exacerbated if relative humidity exceeds 50% (*Parks, Graham, 1992*). Other analyzed parameters were not affected by microclimate (P > 0.05).

***Figure 2*: Effect of relative humidity on active a titratable acidity in milk**



Conclusion

The aim of this research was to evaluate the change of microclimate as a criterion of welfare and its effect on average milk yield, composition and qualitative indicators in milk at the turn of spring and summer. Based on the correlation of bulk milk samples of Holstein breed was found that with increasing barn airspace temperature increases active acidity, rennet coagulation time, but reduces titratable acidity. In bulk milk samples was observed that with increasing relativity humidity increases active acidity and reduces titratable acidity. Other analyzed parameters were not affected by microclimate.

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