Original paper

INFLUENCE OF MICROCLIMATE IN A BARN ON DAIRY COWS' WELFARE AND PRODUCTION

Mijić P.[1], Bobić T., Vučković G., Baban M., Gantner V.*

[1]Faculty of Agriculture in Osijek, Kralja Petra Svačića 1d, 31000 Osijek, Croatia
*Corresponding author: Pero.Mijic@pfos.hr

Abstract

Microclimate in a barn has a major influence on cows' health and welfare, as well as on milk production of dairy cows. Extreme values of air temperature and humidity can negatively influence barn conditions, having thus negative effect on cows kept in barns. The research aimed to investigate influence of basic microclimate parameters on a modern dairy farm located in Eastern Croatia. Research period referred to summer season, from 01 June – 31 August 2013. Measurements were carried out in three time intervals (00:00-08:00; 08:00-16:00; 16:00-00:00) for the following parameters: temperature (T), humidity (H) and temperature-humidity index (THI). The results showed that the values of T and THI were higher than optimal values recommended by the scientific literature. Differences between the daily interval for T, H and THI were statistically highly significant ($p<0.0001$). Furthermore, significant difference ($p<0.0001$; $p<0.05$) was determined for all investigated parameters between June and July, and June and August. However, between July and August there was no significant difference. Although measurements were performed on a modern dairy farm equipped with additional cooling by fans, it was not sufficient to create an optimal microclimate environment for dairy cows. Because of that, additional measures need to be undertaken during summer months (for example, installation of water sprinklers) to reduce the air temperature and temperature-humidity index, all with the purpose to increase comfort of dairy cows and to prevent decrease in milk production.

Key words: *ambiance of cows, dairy farm, microclimate parameters*

Introduction

Specific microclimatic parameters occurring in a barn, as caused by high air temperatures and air humidity, can negatively influence animals' health (Kadzere et al., 2002; Mijić et al., 2007) and violate welfare norms (Mačuhová et al., 2008; Brouček et al., 2009). In such conditions, dairy cows are exposed to heat stress, which results in lowered feed consumption and milk production (Young, 1993). In comparison to ordinary cows, high producing dairy cows should be provided with better housing environment, since negative microclimate influences are more exhibited in such cows (Bobić et al., 2011). Heidenreich et al. (2004) stated that microclimate in a barn should be considered as a very important factor in animal welfare measures, while Brunsch et al. (1996) published data on optimal temperature (4 - 16^0C) and optimal air humidity (60 - 80%) for dairy cows. However, unfavorable combination of air temperature and air humidity occurs often. Nauheimer and

Weniger (1986) concluded that both conditions of 30^0C and relative humidity of 50%, and 26^0C and relative humidity of 70% had equally negative influence on dairy cows' welfare. Cows tend to avoid heat stress differently, which depends on environment they are in. Thus, grazing cows will seek for shades, while cows in barns will look for a coolest place (Brouček, 1997). Unfavorable climate and microclimate parameters negatively influence not only animals in barns, but also workers who spend their work time in production facilities (Matković et al., 2006).

The aim of this research was to investigate influence of some microclimate parameters on ambience of dairy cows in a modern dairy farm during summer period.

Materials and methods

The research was carried out on a dairy farm in the Osijek-Baranja County (Eastern Croatia). Experimental animals were primiparous Holstein cows in full lactation stage. The farm was of a modern construction: free keeping of cows, semi-open type, parlor (Figure 1). Research was carried out from 01 June to 31 August, 2013. Measurements were performed by a digital device Data Logger PCE-HT71", which was placed in the middle of a barn at a 2 m height. Every two hours the device recorded air temperature (T) and air humidity (H) in the facility, based on which temperature-humidity index (THI) in a facility was calculated. Daily measurements were divided into three intervals and one interval referred to eight hours, as follows: Interval 1 from 00:00-08:00 hours, Interval 2 from 08:00-16:00 hours, and Interval 3 from 16:00-00:00 hours. Data were processed in the StatSoft Statistica 8 (2008). Differences between mean values were performed by One - Way ANOVA, and significance of differences was tested by Post Hoc and Fisher's LSD tests ($p<0.0001$; $p<0.01$; $p<0.05$).

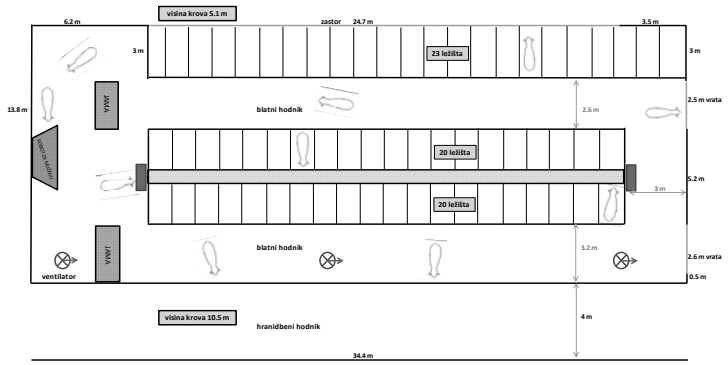

Figure 1. *Scheme of investigated farm*

Table 1 presents average values for investigated parameters. Air temperature was on average 23.54^0C, fluctuating from 13.10 to 38^0C. Average value of air humidity was 67.74%, fluctuating from 28.70 to 90.20%, while THI was on average 70.81, fluctuating between 55.81 and 84.62.

Table 1. *Basic statistical results for investigated microclimate parameters*

Parameters	N	Average	Min.	Max.	S. D.	S. E.
T (^{0}C)	1.104	23.54	13.10	38.00	5.00	0.15
H (%)	1.104	67.74	28.70	90.20	14.23	0.43
THI	1.104	70.81	55.81	84.62	6.12	0.18

T= air temperature; H= air humidity; THI= temperature-humidity index; N = number of measurements; Min. = minimum; Max. = maximum; S.D. = standard deviation; S.E. = standard error

Results and discussion

Referring to the investigated time intervals, research results, as presented in Table 2, indicated that there were statistically highly significant differences ($p<0.0001$) determined between all time intervals for all investigated parameters (air temperature and air humidity, as well as for temperature-humidity index).

Table 2. *Values and significance level of microclimate parameters referring to time interval*

Parameter	Interval (N = 368)			p
	I	II	III	
T(^{0}C)	20.40^a	27.51^b	22.70^c	***
H (%)	77.11^a	54.98^b	71.13^c	
THI	67.14^a	75.10^b	70.17^c	

***$p<0.0001$ = values marked by different letter are statistically significant; I = interval from 00.00 – 08.00 hours; II = interval from 08.00 – 16.00 hours; III = interval from 16.00 to 00.00 hours; T = temperature; H = air humidity; THI = temperature-humidity index

According to Berman et al. (1985), 25^{0}C is an optimal temperature for Holstein cows to maintain stable body temperature. Higher air temperature requires undertaking of measures for air conditioning. Our research showed that the time interval 2 (from 8.00 – 16.00 hours) with an average temperature of 27.51^{0}C was the most unfavorable for cows. Although in that interval the air humidity was the lowest (54.98%), high air temperatures affected also THI (75.10). According to the results of Ravagnolo et al. (2000), critical THI values were from 64 to 77, while West et al. (2003) concluded that production of milk per one THI increase unit lowered for 0.20-0.88 kg/cow. Results of this research showed that THI values were unfavorable for dairy cows and that they exceeded the allowable limits. Obtained THI in this research was higher than the average THI value published by Gantner et al. (2011). Such unfavorable combination of microclimate parameters was surely affecting reduce in milk production of observed primiparous cows, if referring to statement of Bianca (1965), which claimed that barn temperature of 29^{0}C and air humidity of 40% influenced milk yield reduce for about 3.7%.

Table 3. *Values and significance level of microclimate parameters referring to research month*

Parameter	Month			p
	June	July	August	
T(^{0}C)	21.97^a	24.36^b	24.25^{bc}	***
H (%)	72.78^a	66.03^b	64.56^{bc}	***
THI	68.96^a	71.91^b	71.49^{bc}	*

***$p<0.0001$; *$p<0.05$

Referring to research results in Table 3, high air temperature (24.25^0C) and high temperature-humidity index (71.91) were also determined for specific months. Differences in air temperature and air humidity between June and July, and between June and August were highly significant ($p<0.0001$), while differences for THI between June and July and between June and August were less significant ($p<0.05$).

Conclusion

Based on the performed research, it was concluded that values for T and THI were higher than optimal ones. This was especially exhibited during the time interval 2 (from 8.00 – 16.00 hours) and during July. Statistical analysis determined highly significant differences ($p<0.0001$) for T, H and THI between particular time intervals. Referring to month of measurement, there were also highly significant differences ($p<0.0001$) determined for T and H between June and July, and between June and August. Less significant differences ($p<0.05$) were determined for THI between June and July, and June and August. Although measurements were performed on a modern dairy farm, this was not enough to assure favorable microclimate ambience for dairy cows. Therefore, additional measures shall be undertaken (e.g. installation of automatic water mist air conditioning system) to reduce T and THI, in order to improve cow comfort and to prevent reduce in milk production.

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