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THE EFFECT OF LOW AIR TEMPERATURE ON BEHAVIOUR AND MILK PRODUCTION IN HOLSTEIN DAIRY COWS

Martina Vaculíková[1], Irena Komzáková[1], Gustav Chládek[1]

[1]Department of Animal Breeding, Faculty of AgriSciences, Mendel University in Brno, Zemědělská 1, 613 00 Brno, Czech Republic

Abstract

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The aim of this study was to evaluate the influence of low air temperature on behaviour and milk production in Holstein dairy cows. The experiment was carried out at a Mendel University Farm in Žabčice, CZ, between 06-12-16 and 28-02-17. The average outdoor temperature during the above mentioned period was 2.3 °C and the average barn temperature was 1.8 °C. Other known microclimatic parametres were (in average values): relative humidity (56.9 %), refrigerating quantity (37.3 $W.m^{-2}$), light intensity (326.7 lx), and air flow (0.1–0.4 $m.s^{-1}$). The values were always measured at 10:00 am. In the experiment, 75 Holstein dairy cows were observed. These cows were housed in free-stall housing stable in which the number of boxes was higher than the number of housed cows there. The observed dairy cows were either standing (43.8 %) or lying (56.2 %). In case, they were standing, the most of them were found at trough (50.4 %), less of them were found in corridor (30.0 %), and the least of them were found in their boxes. In case, the dairy cows were lying, it was found more of them were lying on their left body side (58.7 %) and less on their right body side (43.8 %). The number of dairy cows standing in boxes had a decreasing character. Concerning the daily milk yield values, these had the same trend as the barn temperature, i.e., in 9 out of 11 cases. In this case (temperature range), the amoung of daily milk yield seems to be the best assessment factor for the infuence of temperature. It is necessary to dedicate attention to air temperature range, in which the experiment was carried out.

Keywords: air temperature, behaviour, daily milk yield, dairy cows, Holstein, microclimatic parameters, milk production

INTRODUCTION

Milk yield of dairy cows is, as well as other properties, limited by genetics of the animal itself. A wide range of inner and outer factors influence milk yield and that happens in the mutual interaction with animal genotypes and environment (Skládanka *et al.*, 2014). As one of the most significant factors is possible to name barn microclimate, which has substantial influence not only on animal welfare but on their milk yield (Zejdová, 2010). How important it is to know impacts of influence of high temperatures might nowadays be known to every farm animals breeder. Many authors have written countless numbers of publications on how high temperatures which exceeded temperature optimum affect high milk performance in dairy cows. All of them know that if temperature exceeds more than 20 °C (Michal, 2006), dairy cows are in heat stress (Hill and Wall, 2017). It is not possible to state exactly a concrete value of temprerature, which we can consider to be still comfortable because it always depends on momentary milk performance of a dairy cow, its individuality, its state of health, as well as on other values of further microclimatic parametres (Zejdová, 2014). Cattle breeders are more and more aware of the fact high temperature stress caused by high temperatures is one of the most significant factors which affect economy of their breeds (Doležal *et al.*, 2010). However, it is very important to know also impacts of low

temperatures of environment because not only due to the influence of high temperatures yet even the low temperatures cause milk yield depression (Zejdová, 2014) and changes in animal behaviour (Michal, 2006). Only a dairy cow which is housed in ideal conditions of stable environment and is not exposed to any stress can provide maximum milk performance (to the intent of its physiologic parametres). Therefore it is extremely necessary to study thoroughly such problematics of individual parametres of stable microclimate and to dedicate appropriate attention to such issues (Zejdová, 2010).

MATERIAL AND METHODS

For the purpose of this experiment, ethological observation of Holstein dairy cows was carried out at an agricultural Mendel University Farm in Žabčice, the Czech Republic, in the period of three winter months (i.e. from 6th December 2016 to 28th February 2017 exactly). This observation was always carried out regularly, once per week. A group of 75 Holstein dairy cows housed in free-stall housing stable were included into the observation. The number of boxes outnumbered the number of housed cows in the stable. In these 75 dairy cows, the following ethological parametres were observed: lying (total number of lying dairy cows) and standing (total number of standing dairy cows). By adding up these two ethological parametres, the total sum of 100% was always gained. Further on, in case the dairy cows were lying, their laterality was examined (i.e. number of dairy cows lying on their left body side and number of dairy cows lying on their right body side). In case the dairy cows were standing, the numbers of them standing at trough, standing in the corridor, and standing in box were monitored. Afterwards, out of the group of 75 Holstein dairy cows, 23 dairy cows were selected and were observed from the very beginning till the very end of the experiment. In these dairy cows, influence of temperature on daily milk yield was monitored and evaluated in each week of the observation. Additionally, in terms of the experiment, other selected microclimatic parametres were moniotred, such as: air temperature (°C), relative humidity (%), refrigeration quantity ($W \cdot m^2$), light intensity (lx), and air flow ($m \cdot s^{-1}$). The selected ethological and microclimatic values were measured and recorded at 10:00 am every week.

RESULTS AND DISCUSSION

In Tab. I, we can see the values of ethological parametres, which were observed on a weekly basis during the experiment – lying (number of lying dairy cows in total) and standing (number of standing dairy cows in total). In case dairy cows were lying, their laterality was examined (number of dairy cows lying on their left body side and number of dairy cows lying on their right body side). Lying on the right and left body side was statistically significant. A higher statistically significant difference was found in lying on right body side. This finding is confirmed by the well-known fact that dairy cows lying more on right body side. If

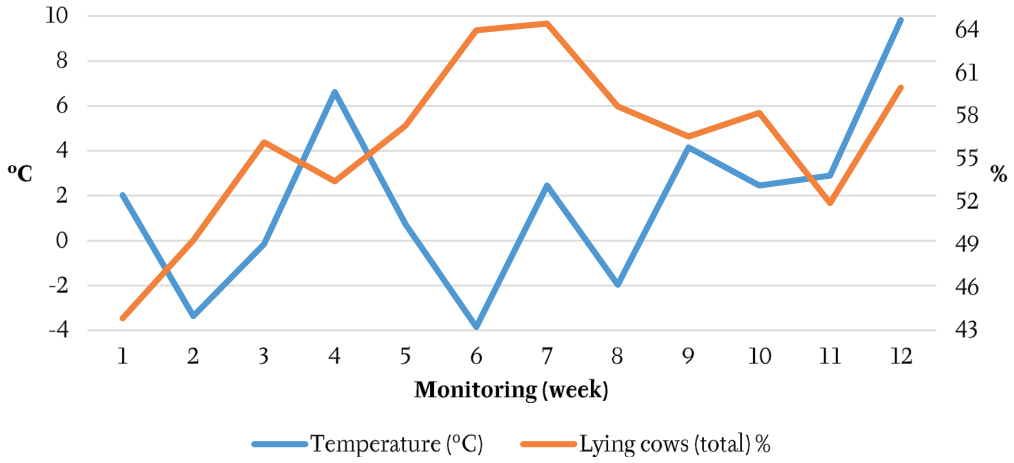
I: *Monitored ethological parameters and average amount of daily milk yield in Holstein dairy cows*

Monitoring (week)	Temp. (°C)	Monitored ethological parameters (%)							$\bar{x}$
		Lying cows (total)			Standing cows				
		Total number	Laterality		Total number	Trough	Corridor	Box	Daily milk yield (kg)
			Left body side **	Right body side ***					
1	2.0	**44**	72	28	**56**	39	29	32	38.2
2	–3.4	**49**	78	22	**51**	38	30	32	37.9
3	–0.2	**56**	51	49	**44**	66	22	13	40.4[b]
4	6.6	**53**	41	59	**47**	53	35	12	40.7[b]
5	0.7	**57**	56	44	**43**	56	28	16	39.8[b]
6	–3.9	**64**	50	50	**36**	44	26	30	36.8
7	2.5	**64**	57	43	**36**	56	26	19	39.3
8	–2.0	**59**	77	23	**41**	48	32	19	38.9
9	4.2	**57**	72	28	**43**	48	36	15	36.8
10	2.5	**58**	43	57	**42**	67	24	9	37.4
11	2.9	**52**	56	44	**48**	50	32	18	34.5[a]
12	9.8	**60**	51	49	**40**	40	40	20	37.2
$\bar{x}$	1.8	**56**	59	41	**44**	50	30	20	38.2
Min.	–3.9	**44**	41	22	**36**	38	22	9	34.5
Max.	9.8	**64**	78	59	**56**	67	40	32	40.7

a, b – $P \leq 0.05$; ** – $P \leq 0.01$; *** – $P \leq 0.001$

II: *Monitored microclimatic parameters*

Monitoring (week)	Microclimatic parameters				
	Temperature (°C)	Relative humidity (%)	Refrigerating quantity (W·m^{-2})	Light intensity (lx)	Air flow (m·s^{-1})
1	$\bar{x}$	53.4	42	522	0.1
2	–3.4	59.6	39	221	0.2
3	–0.2	65.5	34	166	0.4
4	6.6	39.6	38	326	0.3
5	0.7	69.8	39	463	0.1
6	–3.9	58.7	30	204	0.2
7	2.5	40.2	32	204	0.2
8	–2.0	64.8	39	62	0.1
9	4.2	58.4	35	312	0.1
10	2.5	60.5	40	509	0.1
11	2.9	72.8	38	170	0.1
12	9.8	39.9	42	763	0.1
$\bar{x}$	1.8	56.9	37	327	0.2
Min.	–3.9	39.6	30	62	0.1
Max.	9.8	72.8	42	763	0.4

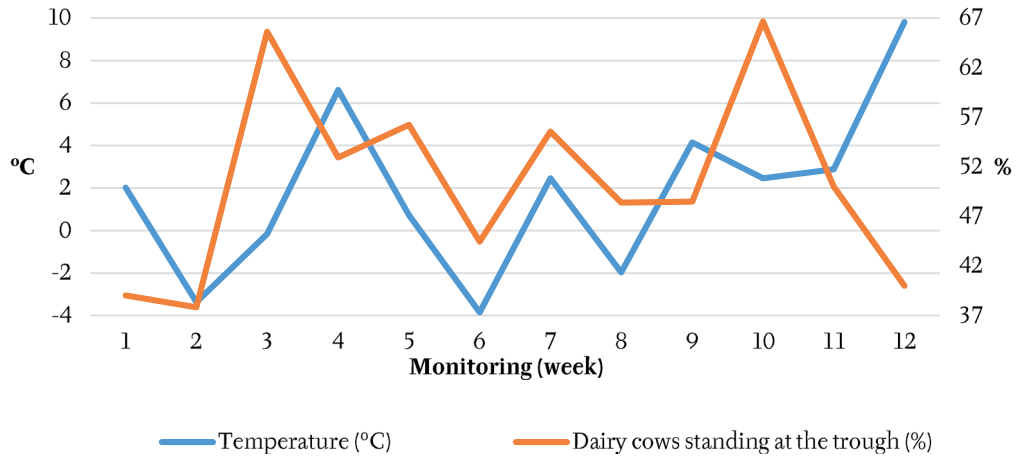


1: *The effect of stable air temperature on behaviour in dairy cows*

dairy cows were standing, the numbers of them standing at trough, standing in the corridor, and standing in box were monitored. In Tab. I, we can see average amount of daily milk yield (kg)in which was established statistically significant difference between 11., 3., 4. and 5. of week monitoring period. Some of the above mentioned values are shown in Figs. 1, 2, and 3.

In Tab. II, we can see monitored values of individual microcilmatic parametres, respectively temperature (°C), relative humidity (%), refrigerating quantity (W·m^{-2}), light intensity (lx), and air flow (m·s^{-1}). The average temperature during observation was 1.8 °C (min. –3.9 °C, max. 9.8 °C), at the average relative humidity 56.9% (min. 39.6%, max. 72.8%), with the average value of refrigerating quantity 37 (W·m^{-2}), ranging from min. 30 (W·m^{-2}) to max. 42 (W·m^{-2}). The average value of light intensity was 327 lx, where minimum was 62 lx and maximum was 763 lx. Speed of air flow was ranging within the following values: from minimum 0.1 (m·s^{-1}) to maximum 0.4 (m·s^{-1}), with the average of 0.2 (m·s^{-1}).

In Fig. 1, which shows influence of barn air temperature on behaviour of Holstein dairy cows, it is possible to see, the graph line representing the total number of lying dairy cows had in 7 out of 11 cases inverse tendency than the graph line indicating the temperature. The graph line indicating proportional representation of the total number of lying dairy cows shows 7 times increase and 4 times decrease. Graph 1 also shows temperature curve, which was in increase 7 times and 4 times in decrease. As well as, out of 11 measured records in total. In this case (temperature range), it is possible to state behaviour of dairy cows is not the best criterion to assess the influence of temperature.

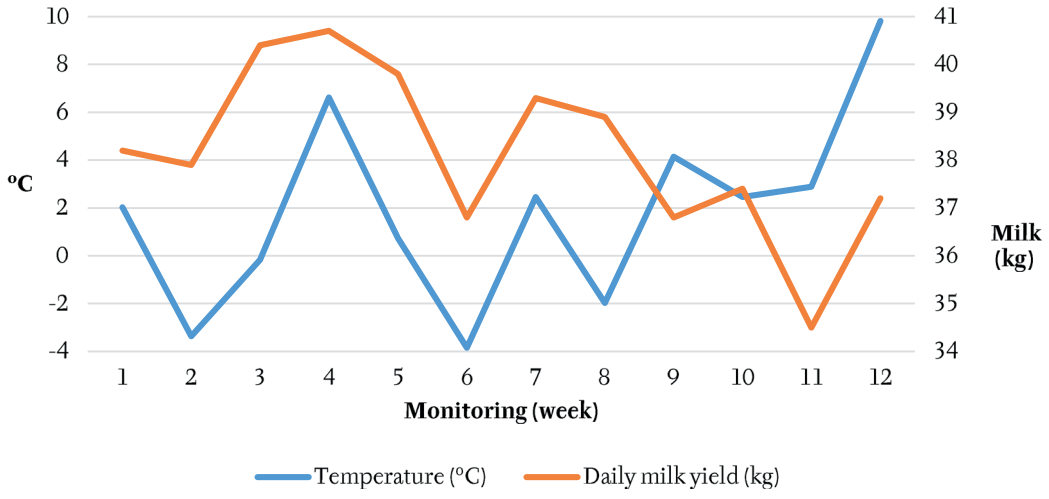


2: *The effect of stable air temperature on eating behaviour in dairy cows*

Michal, (2006) states that at low temperatures, there is possible to observe some changes in behaviour of dairy cows. Specifically, dairy cows lie more (by 6%) at low temperatures than at higher temperatures (>20 °C). *Zejdová*, (2014) also confirms the above mentioned results, i.e. dairy cows tend to lie at low temperatures more than they tend to stand.

Fig. 2 shows the influence of barn temperature on eating behaviour (presence of dairy cows at trough) in Holstein dairy cows. In this graph, it is possible to observe the curve representing the number of dairy cows standing at trough (ingesting food) had inverse tendency in 6 out of 11 cases in contrast to the curve documenting measured temperature. Respectively, the curve, which pictures dairy cows presence at trough (eating behaviour) had decreasing tendency in 7 out of 11 cases and in 4 cases it had increasing tendency. Since, in terms of increases and decreases, the curve showing presence of dairy cows at trough differred from the curve representing dairy cows lying (Fig. 1) only a little (i.e. 5 times they had the same and 6 times different tendency), we can say that eating behaviour of dairy cows is in a narrower relation to temperature than to behaviour of dairy cows (lying/standing). This is also confirmed by Zejdová, (2014) who found out that at temperature of 5.1–10 °C, dairy cows ingest more food. Furthermore she states that, on the contrary, after exceeding the temperature of 10 °C, proportion of eating dairy cows decreases. However, according to Loučka (1995), Knížková and Knížka (1995), low temperatures do not have such significant influence on food intake as this occurs at high temperatures, for example.

In Fig. 3, which shows influence of barn air temperature on the average amount of daily milk yield of dairy cows, there is possible to see that the curve representing average amount of daily milk yield was, in contrast to the curve representing measured temperature, the same, and that occured in 9 out of 11 cases. I.e. specifically, it had 6 times decreasing and 5 times increasing tendency. Therefore, in terms of 9 identical trends out of 11 possible, in both curves, it is possible to say the average amount of daily milk yield among other chosen assessment criteria of influence



3: *The effect of stable air temperature on average amount of daily milk yield in dairy cows*

of temparature (in recorded temperature range) appears to be the best selected criterion, although it demonstrates a trend considerably different from gained data by other authors. According to Angrecky a Herbut (2015), cold stress has impact on the amount of daily milk yield. As well, Gantner *et al.*, (2017), Doležal *et al.*, (2010), Dolejš *et al.*, (2010), Zejdová *et al.*, (2014) state high-performing dairy milk cows are very sensible to cold stres in relation to milk production/yield. It is, however, necessary to mention that our tendencies were recorded in the temperature range between –3.9 °C to 9.8 °C, which is stated to be temperature comfort for cattle breed by Zejdová *et al.* (2014).

CONCLUSION

Based on the experiment results, it is possible to state that in terms of chosen factors (behaviour – standing/lying, eating behaviour, and daily milk yield) for assessing the influence of temperature, the narrowest relation to temperature was found in daily milk yield. Eating behaviour and behaviour in general (i.e. standing/lying) in Holstein dairy cows is not singificantly influenced. It is also necessary to dedicate attention to air temperature range, in which the experiment was carried out.

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Contact information

Martina Vaculíková: martina.vaculikova@mendelu.cz
Irena Komzáková: irena.komzakova@mendelu.cz