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INFLUENCE OF RESPIRATION RATE AND RECTAL TEMPERATURE IN HOLSTEIN COWS TO MILK PRODUCTION DURING HEAT STRESS*

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SUMMARY: The aim of this paper is to examine the relationship between rectal temperature and respiration rate and the production of milk during exposure to heat stress. The results show that increased values of temperature humidity index (THI) cause increases of respiration rate, so that for every unit of THI over 64, respiration rate increases by 0.6. The correlation coefficient between the rate of respiration and THI was 0.55 (p <0.05). Rectal temperature in cows increases by 0.09 ° C for each unit of THI over 64. The correlation between the THI and the mean rectal temperature was highly significant and amounts to 0.92 (p <0.01). The results show a very high negative correlation between the respiration and the production of milk (-0.82, p <0.01) i.e. rectal temperature and milk production (-0.92, p <0.01). For each unit of respiration (breath / min) over 45, the amount of milk decreases by about 0.3 L, while for every degree over for the rectal temperature, the milk production decreases by about 3.5 L (0.35l/0.1 ° C). The respiration rate and THI showed a slight linear dependence, probably because during the trial there was mild to moderate thermal load of cows.

Key words: *heat stress, dairy cows, THI, respiration rate, rectal temperature, milk production.*

INTRODUCTION

Global warming and extreme climate changes led dairy cows to the state of thermal stress. As an index of heat stress the index THI (temperature-humidity index) is used. Numerous results show the negative impact of THI index on the health and pro-

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ductivity of cows (Kadzere, 2002, Hristov et al., 2007, Bernabucci et al., 2010). Although the THI index of quality parameters is used for estimating the heat load of the organism of cows (Dikman and Hansen, 2009), due to various formulas and methods for calculating this index, it is necessary to explore the parameters of adaptation to heat stress indicating thermal overload.

Conducted measurements have given the high correlation between the THI and rectal temperature, rumen contractions and milk production (Cincović and Belić 2009, Belić et al., 2010). During exposure to heat stress there was a diurnal variation in body temperature and respiratory rate, and in the value of various metabolites (glucose, NEFA, urea, cholesterol) (Cincović et al., 2010; Cincović et al., 2010b), which indicates the sensitivity of the indicators to stress.

The aim of this paper is to examine the relationship between rectal temperature and respiration rate and the production of milk during exposure to heat stress.

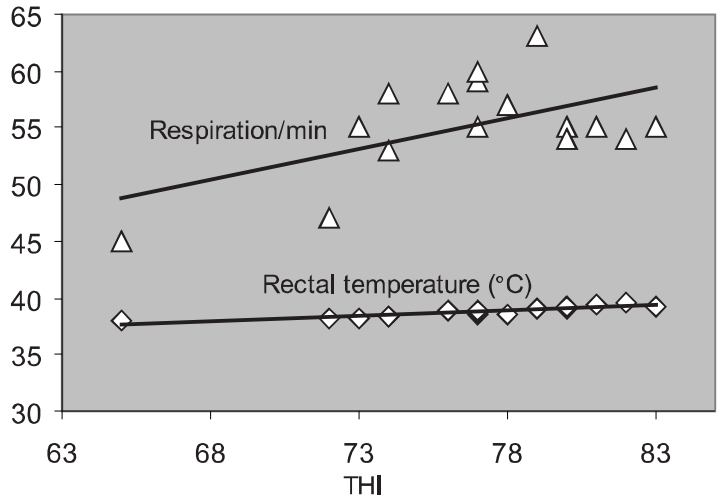
MATERIAL AND METHODS

The experiment included 12 Holstein-Friesian cows in the second and third lactation, which were grown under the same conditions, nutrition and care. The experiment was carried out during July and August 2010. THI value was calculated by formula mean THI = 0.8 x mean AT + [RC mean x (mean BP-14.4)] + 46.4, where AT is the ambient air temperature and relative humidity RH expressed in decimals (McDowell, 1979). Rectal temperature and respiratory frequency were measured every third day, four times a day (at 8, 12, 16, 20 h). Milk production was monitored daily.

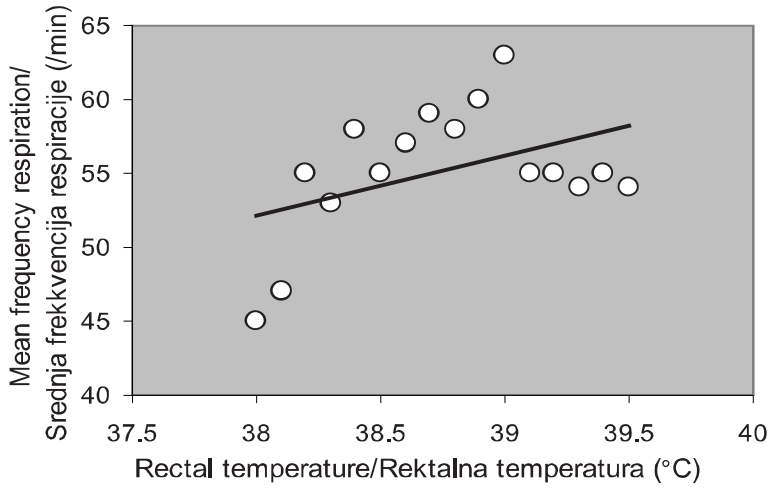
The parameters are compared through linear regression and correlation was calculated for the relationships: THI and rectal temperature, THI and respiration rate and rectal temperature and milk production and respiration rate and milk production.

RESULTS

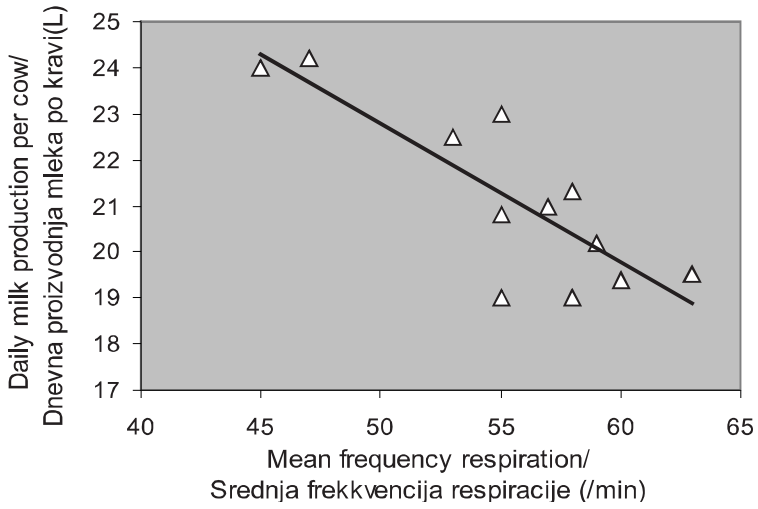
Graph 1 shows the relationship between rectal temperature / respiration rate and the value of THI. The obtained linear equation that links the rectal temperature and THI (Y = 31.4 +0.09 x) and respiration rate and THI (Y = 13.46 +0.6 x) determine that the respiratory organs are more sensitive to higher values of THI (significantly higher b parameter equation). However, by the analysis of the Pearson moment (0.55 for respiration rate and rectal temperature for 0.9), we see that it is significantly higher when it comes to rectal temperature. In addition to the sensitivity of the respiratory tract to higher values of THI, there is their sensitivity to temperature. Respiratory rate was positively correlated with body temperature, but their correlation was insignificant. Chart 3 and 4 show that the rectal temperature and respiration levels negatively correlated with milk production. Both indicators can be used effectively in the future assessment of milk production because the parameter b of linear equations does not differ significantly, and there is a very high correlation with milk production in both cases, which will be further analyzed in the discussion.



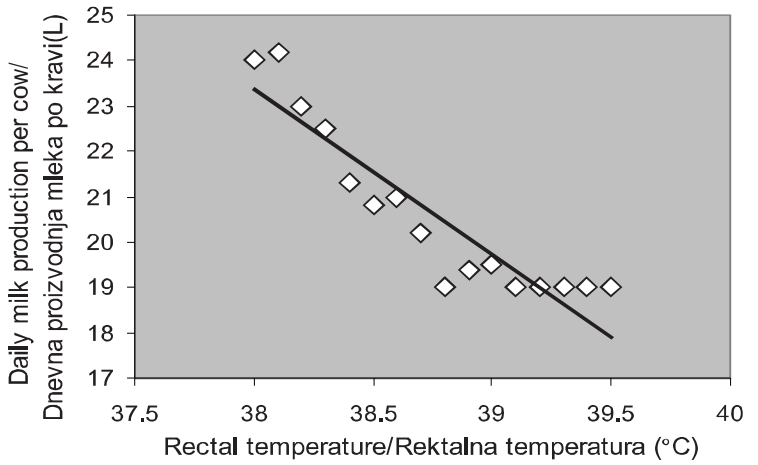
Graph 1. The linear relationship between THI and rectal temperature / respiration rate
Grafik 1. Linearni odnos THI i rektalne temperature i THI i frekvence respiracije



Graph 2. The linear relationship between mean rectal temperature and respiration rate
Grafik 2. Linearni odnos srednje rektalne temperature i vrednosti respiracije



Graph 3. The linear relationship between respiration rate and milk production
Grafik 3. Linearni odnos frekvence respiracije i proizvodnje mleka



Graph 4. A linear relationship between rectal temperature and milk production
Grafik 4. Linearni odnos vrednosti rektalne tempearture i proizvodnje mleka

DISCUSSION

THI values in this study ranged from 63 to 81 (unrepresented results). This range of values THI indicates the presence of heat stress. Initial studies have shown that the critical value of THI above which developing of adaptation of about 72, while later results suggest that the lower critical value is about 64 (Igono et al., 1992).

The results presented in Graph 1 show that with increasing values of THI respiration rate increases, so that for every unit of THI over 64, respiration rate increases by 0.6. The correlation coefficient between the respiration rate and THI is at the level of 0.55 ($p < 0.05$). Also, rectal temperature (Graph 1) in cows increases by 0.09 ° C for each unit of THI over the 64. The correlation between the THI and mean rectal temperature

was highly significant and amounts to 0.92 ($p < 0.01$). For each °C over 38, respiration rate increases by 6 (Graph 2). However, this value is much lower compared to the real one, because they take into account all-day measurements and body temperature in thermal comfort part of the day. Heat stress rapidly leads to more significant growth of respiration rate per unit of body temperature. Thus, Belic et al. (2010) found that the diurnal difference of minimum and maximum rectal temperature during exposure to heat stress is 0.9, and the value of the difference in the respiration rate is even 25. The correlation coefficient between the rectal temperature and respiration level is about 0.4. Elevated rectal temperature during exposure to heat stress caused inability of adequate cooling of the body. The skin and respiratory tract of cattle have great capacity to dissipate heat by evaporation, through sweating and panting, respectively. Increased respiration results from a tendency of the organism that by evaporation through the lungs went to excess heat (Gaughan et al, 2000).

Heat stress significantly decreases milk production. This phenomenon pathophysiologically explains the fact that increased body temperature during exposure to heat stress leads to reduced food intake and reduction of milk production. In a strictly controlled laboratory conditions, Spiers et al. (2004) showed that the food intake (kg) and milk production are of significant correlation, while the importance of food intake is negatively correlated with average daily rectal temperatures. The results show a very high negative correlation between the respiration and the production of milk (-0.82, $p < 0.01$) (Graph 3) and rectal temperature and milk production (-0.92, $p < 0.01$) (Graph 4). For each unit of respiration (breath / min) over 45, the amount of milk decreases by about 0.3 l. The increase in rectal temperature by one degree will lead to a drop in milk production by 3.5 liter (0.35l/0.1 °C).

The results show that the respiration rate is important in assessing the response of cows to the values of THI index, while the rectal temperature is more important to evaluate the possible reduction of milk production during exposure to heat stress.

CONCLUSION

For estimation of milk production in cows during heat stress, the values of rectal temperature and respiration per minute can be used as predictive factors. Rectal temperature was in a stronger correlation with milk production, while the respiration rate per minute was in a stronger correlation with the value of THI. The value of respiration and THI showed a slight linear dependence, probably because during the trial there was mild to moderate thermal load of cows.

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UTICAJ NIVOA RESPIRACIJE I REKTALNE TEMPERATURE HOLŠTAJN KRAVA NA PROIZVODNJU MLEKA TOKOM TOPLOTNOG STRESA

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Izvod

Cilj ovoga rada jeste da se ispita odnos rektalne temperature i frekvencije respiracije prema proizvodnji mleka tokom delovanja toplotnog stresa. Rezultati prikazani u Graph. 1 pokazuju da sa porastom vrednosti THI raste frekvenca respiracije, tako da za svaku jedinicu THI preko 64 frekvenca respiracije raste za 0.6. Koeficijent korelacije između frekvence respiracije i THI je na nivou 0.55 ($p<0.05$). Rektalna temperatura kod krava raste za 0.09°C za svaku jedinicu THI preko 64. Korelacija između vrednosti THI i prosečne rektalne temperature je visoko značajna i iznosi 0.92 ($p<0.01$). Rezultati našeg istraživanja pokazuju vrlo visoku negativnu korelaciju između vrednosti respiracije i proizvodnje mleka (-0.82; $p<0.01$), odnosno rektalne temperature i proiz-

vodnje mleka (-0.92, $p<0.01$). Za svaku jedinicu respiracije (udisaj/min) preko 45 opada količina mleka za oko 0.3 L, dok za svaki stepen više kada je rektalna temperaura u pitanju proizvodnja mleka opada za oko 3,5 L (0.35L/0.1°C). Vrednost respiracije i THI pokazuju blagu linearnu zavisnost, verovatno zbog toga što je tokom ogleda postojala blaga do srednja termalna opterećenost krava.

Ključne reči: toplotni stres, mlečne krave, THI, frekvenca respiracije, rektalna temperatura, proizvodnja mleka.

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