SHORT COMMMUNICATION

RESPONSES OF LACTATING DAIRY COWS TO CLIMATIC CONDITIONS IN LOS BAÑOS, LAGUNA, PHILIPPINES

Cesar C. Sevilla, Noe B. Velasco, Karla Joy S. Ty,
Sharmila DL. Ramchand and Ailynn A. Gonzales

ABSTRACT

A study was conducted at Los Baños, Laguna to determine the degree of correlation among productive and physiological responses of local lactating dairy cows with climate variability. From an average of 10 lactating Holstein-Sahiwal dairy cows, the monthly average milk yield, dry matter intake, pulse rate (P), respiration rate (R) and body temperature (T) at 0700, 1100, and 1500 h for 4 consecutive days per month were gathered from September 2011 to June 2012. Heat Index (HI) was calculated from the climatic data from PAGASA Weather Station at UPLB. Correlation analysis was performed to determine the degree of linear relationships between milk yield and dry matter intake, PRT values, environmental temperature, relative humidity, and HI. Milk yield was highly correlated (*P*<0.05) with HI (r=-0.73), environ-mental temperature (r = -0.71), dry matter intake (r = -0.64), and pulse rate (r=-0.68). The effect of increasing HI value (x) on milk yield (Y) is described by the equation: Y = 25.6 – 0.189x (R^2=0.535; *P*<0.05). This indicates that HI negatively influenced milk yield of lactating cows. Further studies are needed to determine the interrelationships of PRT, HI and milk yield for the formulation of adaptive mechanisms to avoid economic loss from decreased milk yield due to heat stress.

Keywords: Milk yield, dry matter intake, physiological responses, heat index, dairy cows

Animal and Dairy Sciences Cluster, College of Agriculture, University of the Philippines Los Baños, College, Laguna 4031 (email: cesarsevilla_adsc@yahoo.com).

INTRODUCTION

Dairy farming is a major project of the Department of Agriculture towards increasing farm income, improving rural nutrition, and generating rural employment. To sustain its effort towards a vibrant dairy industry, a number of production constraints need to be addressed. In particular, climate change will have direct and far-reaching impact due to heat stress among dairy animals raised under hot and humid environment.

Heat stress is brought about by any combination of high levels of temperature, humidity, and solar radiation preventing the animals from dissipating excess body heat to the environment to attain the animal's comfort zone (West, 2003). Most of the local dairy cattle have blood of temperate Holstein breed, which produces optimally at temperature below 23^{o}C (Bianca, 1962). Dairy cattle also produce milk efficiently under an environment where their body temperature is around 38^{o}C (Stokka *et al.*, 1998). However, ambient temperature in the Philippines is generally greater, and for short periods may even reach 35^{o}C. Relatively small increases in body temperature of at least 1^{o}C result in detectable, deleterious effects on metabolism and tissue integrity (Smith *et al.*, 2000).

Heat index, a measure of temperature in relation to relative humidity, is fundamental in assessing heat stress-related losses in dairy animals (Bohmanova *et al.*, 2007). Since no studies have been done to assess the effects of climate on the productivity of local dairy cows, this study was conducted to determine the relationship of productive and physiological responses of local lactating dairy cows with climate variability.

MATERIALS AND METHODS

The study was conducted at the Animal and Dairy Sciences Dairy Farm, College of Agriculture, UPLB from August, 2011 to June, 2012. The average number of animals observed per month was 10 lactating dairy cows with blood composition of more than 75% Holstein Friesian and less than 25% Sahiwal and an average liveweight of 420 kg. The animals were fed concentrate after milking at 0400 h at a rate of 1 kg for every 2 L of milk produced, followed by feeding forage ad libitum until the second milking at 1600 h, and then were allowed to graze in the pasture just before milking of the following day. The daily milk production of each cow was recorded and then the average monthly milk yield was calculated. Pulse rate (P), respiration rate (R), and body temperature (T) of each animal were taken at 0700, 1100, and 1500 h for 4 consecutive days per month and the average was taken as the monthly PRT values of the herd.

Climatic data were gathered from the UPLB Agro-meteorological Station of the College of Engineering and Agro-industrial Technology sourced from the PAGASA Weather Station at UPLB, which is a kilometer

away from the dairy farm. The dry bulb temperature and percent relative humidity values were used to calculate for the heat index (HI) value using the formula provided by the National Oceanographic and Astronomical Administration, USA (http://www.hpc.ncep.noaa.gov/html/heatindex.shtml). Correlation analysis was performed to determine the degree of linear relationships between milk yield and dry matter intake, PRT values, environmental temperature, relative humidity, and HI. The degree of correlation was categorized into 4 levels: high [correlation coefficient (r) ≥ 0.60], moderate (0.60 > r ≥ 0.30), low (r < 0.30), and non-significant (*P*>0.05). Simple regression analysis was performed to develop a model to predict milk yield with increasing HI.

RESULTS AND DISCUSSION

The average calculated HI was 87.5 during the study period, which is greater than the desired value of 72 (Igono *et al.*, 1992). The average dry bulb temperature was 27.2°C, which is above the maximum comfortable environmental temperature of 23°C as suggested by Berman (2005).

Milk yield was highly correlated (*P* < 0.05) with HI (r = -0.73), environmental temperature (r = -0.71), dry matter intake (r = -0.64), and pulse rate (r = -0.68; Table 1). The effect of increasing HI value (x) on milk yield (Y) is described by the equation: $Y = 25.6 – 0.189x$ ($R^2 = 0.535$; *P*<0.05). Results also suggest that other than HI, reduction in milk yield as a result of heat stress can also be related to dry bulb temperature. This may explain the observed lower milk yield of Holstein-based lactating dairy cows in the lowlands compared with those in areas of higher elevation, where the dry bulb temperature is generally lower.

Table 1. Pearson correlation coefficients between milk yield and heat index, dry matter intake, pulse rate, respiration rate and body temperature of lactating dairy cows taken at different times of the day from September 2011 to June 2012.

	Correlation coefficient (r)	
Parameter	Heat index	Milk yield
Milk yield	-0.732*	-
Dry matter intake	-0.099	-0.644*
Pulse rate	-0.417	-0.683*
Respiration rate	-0.534	-0.610
Body temperature	-0.115	-0.411
Environmental temperature	-0.989**	-0.713*
Relative humidity	-0.651*	0.344

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

However, HI was not correlated with body temperature, respiration rate, and pulse rate of lactating cows. This is in contrast with Dikmen and Hansen (2009), where dry bulb temperature was observed to be nearly as good a predictor of rectal temperature of lactating dairy cows in a subtropical environment as HI. Heat index was highly correlated with RH (r =-0.651) and dry bulb temperature (r =-0.989). This indicates that dry bulb temperature but not RH can be used to determine change in milk yield.

No significant correlation was found between PRT values and HI. This could be due to several factors, such as, intensity of stress, length of daily recovery period, night temperature, diet of the animal, level of production and others (West, 2003). However, it is more likely that since the average HI value during the study period of 87.5 was above the critical value of 72, the animals were already under heat stress during most parts of the day. In fact, all the PR values of Holstein-Sahiwal crosses used in this study were greater than the reported highest PR values for the Philippine native cattle of 54.8 beats per minute and 29.1 breaths per minute (Alcaide, 1950). Evidently, the lower adaptability of the Holstein-Sahiwal lactating cows to high temperature readily predisposes them to heat stress as was the case in this study.

CONCLUSION

Milk yield of lactating dairy cows at Los Baños, Laguna was highly influenced by HI. Milk yield was reduced by as much as 1.0 liter per day for every 5 units increase in HI value. Furthermore, pulse rate and respiration rate above 54.8 beats per minute and 29.1 breaths per minute, respectively, are indicators of heat stress. Therefore, more studies are needed in terms of housing management, nutritional intervention and breeding to offset the economic loss due to heat stress in local dairy cows across different agro-ecological areas.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the financial support of the Bureau of Agricultural Research, Department of Agriculture, in the conduct of this study.

REFERENCES

Alcaide AR. 1950. Pulse rate, respiration, and body temperature of native cattle. *Phil Agric* 34: 46-48.

Bianca W. 1962. Relative importance of dry- and wet- bulb temperatures in causing heat stress in cattle. *Nature* 195:251–252.

Berman AJ. 2005. Estimates of heat stress relief needs for Holstein dairy cows. *J Anim Sci* 83: 1377-1384.

Bohmanova J, Misztal I and Cole JB. 2007. Temperature-humidity indices as indicators of milk production losses due to heat stress. *J Dairy Sci* 90: 1947–1956.

Dikmen S and Hansen PJ. 2009. Is the temperature-humidity index the best indicator of heat stress in lactating dairy cows in a subtropical environment? *J Dairy Sci* 92: 109–116.

Igono MO, Bjotvedt G, and Stanford-Crane HT. 1992. Environmental profile and critical temperature effects on milk production of Holstein cows in desert climate. *Int J Biometeorol* 36: 77-87.

West JW. 2003. Effects of heat-stress on production in dairy cattle. *J Dairy Sci* 86: 2131–2144.