The Environmental Effects on the Activities and Rectal Temperatures of Holstein Cows in a Summer Season

B. S. Ahn, H. Y. Jeong, K. S. Ki, Y. L. Choi, U. G. Kweon and N. C. Kim
National Livestock Research Institute, Rural Development Administration
Seongwhan-Eup Cheonan-Si, Chungnam-Do, 330-800 Korea

하절기 홀스타인 젖소의 행동 및 체온에 미치는 환경 효과

안병석·정하연·기광석·최유림·권응기·김남철
축산기술연구소, 농촌진흥청

ABSTRACT

This study was carried out to estimate the effects of environmental factors on the activities and rectal temperatures(heat tolerance) of Holstein dairy cows in a summer season. An activity-meter(Alpro system®) was used to record activities of 77 cows for 24 hours. The feeding standards for milking and dry cow were formulated with concentrates and corn silages based on the NRC(1998). Cows to check temperature were kept in stanchions and temperature was checked in rectum. Ambient temperature was 29.0℃ between 1 p.m. and 3 p.m. of the day.

The rectal temperatures were affected by parities and status of milking or dry($p<0.01$). The activities recorded between 9 a.m. and 12 a.m., and between 1 p.m. and 4 p.m. were not effected by the status of lactating and dry. The rectal temperature of lactating cow was 39.0±0.03℃, it was higher than dry cow(38.6±0.04℃). A higher activity of cow under third parity at 1 p.m. to 4 p.m. was observed comparing with fourth and above. The activities were tended to decrease with an increase of parity.

Rectal temperature was negatively correlated with milk compositions, which were fat, protein, solid-not-fat and total solid except lactose.
(**Key words** : Holstein dairy cattle, Heat stress, Rectal temperature, Activity, Milk composition)

Ⅰ. INTRODUCTION

Heat tolerance of high producing dairy cattle in a summer season is very important, because milk synthesis decreases under stressful environment such as during the summer season and in tropic areas. Much of the decrease in milk production observed under heat stress can be attributed to the decreasing dry matter intake (Linn, 1997). Temperatures between 4.4℃ and 24℃, known as the comfort zone, have no effect on milk production of most dairy cow, but temperatures above 24℃ leads to decrease in milk yield(Schmidt et al., 1988). Finch(1986) suggested that the controlling of the animal of its body temperature under stressful environment,

Corresponding author : B. S. Ahn, National Livestock Research Institute, Rural Development Administration Seongwhan-Eup Cheonan-Si, Chungnam-Do, 330-800, Korea. E-mail : abs3382@rda.go.kr

normally could be expressed as an adaptability of the animal to that environment. Therefore, the cows adaptability or heat resistance, such as normal rectal temperatures under stressful condition, specially that of the dairy cattle during summer season and in tropic areas could be important traits to improve. It can be added that selection of cow that can maintain normal rectal temperature or activity under stressful conditions is important, especially in area with hot and humid climate during the summer season. There are differences between breeds as Brown Swiss is known to possess higher heat tolerance than Holstein breed(Hammond, 1993). To improve performance of dairy cattle during summer season, the cattle have to be cared for so that they will not be affected by heat stress. Breeding of cattle resistant to heat stress must also be done.

This study aims to estimate the environmental effects on the rectal temperature, activity and milk composition of Holstein cow in a summer season characterized by hot and humid climate.

Ⅱ. MATERIALS AND METHODS

An activity meter(Alpro system®) was used to record activities of dairy cows for 24 hours. Holstein dairy cows(77 heads) were used in this experiment from July 6 to 13 in 1999. Milking and dry cow were fed with concentrate and corn silage which was to meet NRC(1989). Rectal temperature of cow kept in stanchion individually was checked from 1 p.m. to 3 p.m. of the day in the barn with 29.0℃ ambient temperature.

The statistical models $y_{ijkl} = \mu + m_i + d_j + p_k + e_{ijkl}$ and $y_{ikl} = \mu + m_i + p_k + e_{ikl}$ were used to measure the effects of the activity and rectal temperature, respectively and designated as follows: y_{ijkl}, observation; μ, mean; m_i, the ith fixed effect for the status of milking or dry(i=1, 2); d_j, the jth fixed effect of observed day(j=1,2,..,8); p_k, the kth fixed effect of parity (k=1,2,..,6); and e_{ijkl} as residual random error.

Ⅲ. RESULTS AND DISCUSSION

The status of milking and dry cow and parity were explained as significant variations on the cows' rectal temperatures(P<0.01). Day, dry or milking cow(DM), and parity on the activity had different effects on times observed(Table 1).

Table 1. Mean squares of rectal temperatures and activities of cows

	df	Mean square
Rectal temperature		
DM	1	8.55**
Parity	5	3.70**

Activity	df	Mean square[1)] P1～4	P5～8	P9～12	A1～4	A5～8	A9～12
Day	7	100133.0**	112532.0**	30561.9**	5180.5**	347048.3**	29310.8*
DM	1	6594.9	64983.5*	239400.6**	68041.0**	416397.2**	34919.4
Parity	5	90781.3**	156656.5**	71281.4**	11021.5**	144702.4**	29211.7

[1)]A: a. m. P: p. m. *: P<.05, **: P<.01.
Effects of parity and DM on total activities were not significant.

Least square means and standard deviations of the rectal temperatures and activities were shown in Table 2. The rectal temperatures of dry cows showed lower than those of milking cows, and the rectal temperatures of cows between first and second parities were higher than those of cows in above 3rd parity. Coefficients of variation for the rectal temperatures were estimated high with increasing of parities, and the coefficients of activities increased with the increasing of parities. This is why there is a need to manage dry cow and lactating cow differently.

A selection for heat tolerance of dairy cattle is important for them to adapt in summer season(Finch, 1986). The rectal temperatures of Holstein show between 41.0 and 41.6℃(Cole and Hansen, 1993), which was higher than that of this study. The smaller breeds are more tolerant of high temperatures than the larger breeds, and Brown Swiss is much more tolerant for heat than Holstein(Schmidt et al., 1988; George, 1998).

According to Kume et al., (1998), rectal temperature showed a variation from morning to evening, but they were not affected by energy intake levels, and feed intake decreased in opposition to increase of rectal temperature. Cole

Table 2. Least square means(LSM) and standard deviations(SD) of rectal temperatures and activities of cows

	Activity		Rectal Temperature	
	LSM	C.V.	LSM	C.V.
Dry or milking				
Milking	840.1±23.2	2.7	39.0±0.03	0.07
Dry	855.1±25.5	2.9	38.6±0.04	0.10
Parity				
Heifer	902.2±29.2	3.2	38.7±0.05	0.12
1	877.3±35.9	4.0	39.2±0.05	0.12
2	916.8±40.4	4.4	39.0±0.07	0.17
3	707.8±31.4	4.4	38.8±0.05	0.12
4	879.7±43.8	4.9	38.5±0.06	0.15
5	801.8±50.7	6.3	38.7±0.07	0.18
Day				
1	986.1±48.3	4.8		
2‡	1,093.1±48.4	4.4		
3‡	1,081.7±47.5	4.3		
4‡	1,095.4±48.5	4.4		
5	561.1±52.4	9.3		
6	647.0±48.6	7.5		
7	721.4±23.4	3.2		
8	594.9±36.8	6.1		

‡ : rained.

and Hansen(1993) reported that two groups consisting of 12 heads for milking and dry cow showed no differences in rectal temperature. When Holstein breed were exposed to sunlight, the breed absorbed 89% of the sun energy, but Brown Swiss breed absorbed only 81%. This explained that Brown Swiss breed is more resistant to heat than Holstein breed.

Since it is important for dairy cattle to maintain normal body temperature under hot weather, ability to maintain rectal temperature can normally be an important trait. However, a difference was observed in the activities of dry and milking cows within the hours recorded. In recording the activities of the cows for 24 hours as shown in Table 3, it can be seen that between 1 p.m. and 4 p.m. the results showed generally uniform trend while the coefficients of variation showed a variation from 56.9 to 89.5%. The coefficients of variation for activities between 9 p.m. and 12 p.m., however, showed variations from 126.8 to 167.7%, which tend to show that the animals moved more actively even if they were under stressful conditions. From this observation much information can be derived. For example, it is advisable to check

Table 3. Least square means(LSM) and standard of deviations(SD) for activities of cows by times

	P1～4	P5～8	P9～12	A1～4	A5～8	A9～12
Parity						
Heifer	320.6± 20.8	255.4± 8.6	59.2± 6.5	34.7±4.0	357.5±19.2	375.4±20.6
1	295.7± 26.5	362.2±10.6	93.2± 7.7	66.7±5.1	295.1±23.3	398.2±22.0
2	273.3± 25.8	312.2±11.8	73.5± 8.6	50.5±5.3	224.3±25.1	346.2±24.0
3	200.8± 23.1	317.1± 9.2	122.0± 6.8	59.2±4.4	238.2±22.2	369.5±22.9
4	263.6± 38.0	277.4±13.3	71.0±10.2	45.9±6.2	253.6±26.4	313.4±27.0
5	172.7± 38.6	314.7±14.9	88.0±10.7	47.9±7.3	261.0±35.8	349.2±35.8
Status						
milking	247.2± 20.9	317.8± 7.5	107.0± 5.6	64.8±3.6	220.5±16.8	374.7±18.5
dry	261.7± 21.1	295.2± 8.8	61.9± 5.0	36.9±3.2	322.8±18.2	342.7±19.8
Day						
1	312.7± 15.7	308.2±14.0	70.1±10.0	53.8±7.3	478.2±44.9	562.4±84.1
2	180.4± 22.3	329.5±14.2	105.0±10.4	50.7±6.0	204.5±18.6	327.4±15.7
3	176.2± 22.1	353.1±13.9	77.5±10.4	62.7±5.7	143.1±18.1	298.0±15.3
4	207.5± 23.4	317.8±14.2	106.3±10.1	64.3±5.9	161.9±18.4	314.5±16.0
5	266.1±113.2	305.6±16.3	114.7±13.5	47.1±8.9	181.4±63.5	324.7±69.2
6	235.7± 47.6	249.5±14.3	50.8±10.5	27.7±8.3	248.4±39.5	385.2±36.3
7	267.6± 17.1	266.6± 6.9	69.2± 5.1	54.0±3.4	328.9±17.2	316.7±15.2
8	389.4± 41.5	321.6±11.2	82.2± 8.2	46.4±4.8	426.6±41.5	340.5±40.4
C.V.	56.9～73.3	89.5～146.4	126.8～167.7	83.3～138.9	56.2～116.0	67.9～88.3

A: a.m. P: p.m. C.V.: coefficient of variation of activities.

Table 4. Means and standard of deviations(SD) for milk composition and correlation coefficients with rectal temperatures

	Fat	Protein	Lactose	SNF	TS	Rectal Temperature (℃)
Means±SD (%)	3.7±1.1	3.2±0.3	4.7±0.0	8.7±0.1	12.0±1.0	38.8±0.6
Coefficients†	−0.20**	−0.18**	0.20**	−0.14**	−0.20**	1.00

† : phenotypic correlation **: P<.01.

the cows' temperature in the early morning during summer.

Fat, protein, solid-not-fat(SNF), and total solid (TS) in phenotype showed negative correlations with regard to rectal temperatures. Conversely, a positive correlation showed between lactose and rectal temperatures(Table 4). This is the same result as milk yield, fat, SNF, and total solid were slightly decreased with increasing temperatures(Schmidt et al., 1988). The modern dairy cow thrives under optimum feeding condition and management, but it does not function well under poorer conditions(Petersen, 1995). If certain characteristics related with economic production traits function well under poor condition, the traits could be very important to adapt under the undesirable condition. So more studies of activity and rectal temperature regarding resistant traits to stressful circumstances should be conducted.

Ⅳ. 요 약

본 연구는 하절기 홀스타인 젖소의 행동과 체온(내서성)에 관하여 환경효과를 추정하기 위하여 1999년 7월 6일부터 13일까지 수행하였다. 행동지수를 조사하기 위하여 Holstein 젖소 77두를 공시하였으며 사양은 NRC 사양표준에 의거 농후사료와 옥수수 사일리지 위주로 관리하였다. 체온은 스탄촌에 계류된 상태에서 오후 1시부터 3시 사이에 직장내 온도를 측정하였으며 이때 기온은 29.0℃ 이었다.

건유 및 착유 상태, 산차에 따라 체온이 달랐으나(p<0.01), 행동지수에 대하여 착유우와 건유우는 오전 9시부터 정오까지, 오후 1시부터 4시까지는 차이가 없었다. 착유우의 직장내 체온은 39.0±0.03℃으로서 건유우의 체온(38.6±0.04℃)보다 높았다. 오후 1～4시까지는 3산차 이하의 개체들이 4산차 이상의 개체들에 비하여 행동지수가 높았고, 산차의 증가에 따라 감소하는 경향이었다. 우유 성분과 체온과의 상관에 대하여 유당을 제외한 지방, 단백질, 무지고형분율 및 총고형분 등과는 부의 표현형 상관을 나타내었다.

Ⅴ. REFERENCES

1. Cole, J. A. and Hansen, P. J. 1993. Effects of administration of recombinant bovine somatotropin on the responses of lactating and non-lactating cows to heat stress. JAVMA, Vol. 203(1):113.
2. Finch, V. A. 1986. Rectal Temperature in Beef Cattle: Its Control and Tolerance to Production in the Tropics. J. Anim. Sci. 62:531.
3. George, F. W. 1998. How to Different Breeds Compare on Hot Summer Days? http://bluehen.ags.udel.edu/deces/dairycol/dmc6-98.htm.
4. Hammond, A. C. 1993. Evaluation of the Senepol Breed: Heat Tolerance and Grazing Activity. 42nd Annual Florida Beef Cattle Short Course Pro-

ceedings; http : //www.animal.ufl.edu/short93/hammond.htm.
5. Kume, S., Toharmat, T., Nonaka, I. and Shimizu, M. 1998. Effect of feeding level and heat stress on thermoregulation and mineral status of periparturient cows. The 8th World conference on Animal Production. Seoul National University. Seoul. Korea. Proceedings Contributed Papers(1) : 386.
6. Linn, J. G. 1997. Nutritional Management of Lactating Dairy cows During Periods of Heat Stress. http://www.ansi.umn.edu/dairy/du125.htm.
7. NRC. 1989. Nutrients Requirements of Dairy Cattle.
8. Petersen, P. H. 1995. Agricultural Sciences for Biodiversity and Sustainability in Development Countries-Proceedings of a Workshop. http://www.ihh.kvl.dk/htm/php/tune95/8Petersen.htm.
9. Schmidt, G. H., VanVleck, L. D. and Hutjens, M. F. 1988. Principles of dairy Science. 2nd ed. Prentice Hall.

(접수일자 : 2002. 10. 7 / 채택일자 : 2003. 4. 7)