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Effect of encapsulated niacin on resistance to acute thermal stress in lactating Holstein cows

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Abstract

Twelve multiparous Holstein cows producing an average of 31.7 kg/d and balanced for parity and stage of lactation were randomly assigned to either 0 g encapsulated niacin/d (C) or 12 g niacin/d (NIASHURETM®) (Trt) and were exposed to two environmental temperature patterns, thermoneutral (TN) and heat stress (HS). The temperature humidity index (THI) range of TN pattern never exceeded 72 while HS consisted of circadian THI temperature range exceeding 72 for 12 hours per day. Milk yields were recorded twice a day and milk sampled once a day for composition. Cows were fed twice a day and refusal and water intake was measured once a day. Respiration rates, surface temperatures of both shaved (S) and unshaved (U) areas were taken at the rump, (ST -R-S, ST-R-U) shoulder, (ST-S-S, ST -S-U), and tailhead (ST -T-S, ST-T-U), and sweating rates (SR) of the shoulder shaved (SR-S) and unshaved (SR-U) areas 4× daily. Rectal temperatures (RT) were measured four times a day. Cows in Trt had increased DMI (40.7 vs 37.7,g/d) compared to cows in C. Surface temperatures were unaffected by Trt but were affected by shaving (32.5 shaved vs. 31.4°C unshaved). Cows given Trt had a tendency for higher average sweating rates when shaved (66.3 vs 57.8 g/M2/hr, P=0.11) and numerically for unshaved (57.4 vs 52.7 g/M2/hr) over the entire 24 hour period and these differences grew larger during periods of peak thermal stress along with the entire study (62.0° shaved vs. 55.0° unshaved). Between 11:00AM and 4:00 PM average sweating rate for Trt group was higher than C (81.1 vs. 68.2 g/M2/hr shaved; P<0.0001 and 70.6 vs. 62.3 unshaved; P<0.0001). Vaginal temperatures recorded at 15 min intervals and averaged over last 72 hours of period 2 (HS) were lower (38.4 vs. 38.0°C; P <.0001) for cows given Trt compared to cows in C. We conclude that cows given encapsulated Niacin had higher sweating rates and lower core temperatures during acute thermal stress.

Key Words: Niacin, Heat Stress, Sweating Rate

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Introduction

Dealing with heat stress is one of the major problems facing dairy producer during the summer months nation wide and for longer periods in the southern dairy production states. Decreases in dry matter intake and lost milk production are the primary problems observed accounting for up to a 35% loss in production during heat stress incidence. Reproduction programs, also, suffer during periods of heat stress were cows fail to conceive or spontaneously abort due to their in ability to handle this heat load.

Niacin, nictotinic acid, causes a unique response in animal causing vasodilation which bring blood to the body surface, ie. Flushing. This action has the potential to increase the transfer of body heat to the peripheral surface of an animal (DiCostanza et al. 1997). Research pursuing this action of niacin has been conducted by feeding high levels of raw niacin (12 to 36g/h/d). The NRC (2001) indicates from a review of the current literature that less than 5% of raw niacin that is fed actually escapes the rumen fermentation to be absorbed in the lower digestive tract. Protecting niacin through encapsulation could be a viable means to feed less total niacin and cost effectively improve an animal's ability to withstand the detrimental effect on production brought about during periods of heat stress.

The objectives of this study were: 1) to evaluate an encapsulated niacin source on its ability to provide niacin to reduce thermal stress during an acute temperature increase; 2) to determine if sweating rate was increased by the feeding of an encapsulated niacin source and if this could be associated with a lowering of body temperature.

Materials and methods

Twelve multiparous Holstein cows producing an average of 25.4 kg/d were used in the study. Groups were balanced for parity and stage of lactation before random assigned to either 0 g encapsulated niacin/d (C) or 12 g niacin/d (Niashure™) (Trt). Two environmental temperature patterns (thermonutral (TN) and heat stress (HS)) were used to evaluate the difference between treatments. Cows were housed in two environmental/climate controlled chambers. The TN pattern was defined as having a temperature humidity index (THI) not to exceed 72. The HS consisted of circadian temperature range where THI exceeded 72 for 12 hours per day, which is considered a mild heat stress

Table 1. Summary of the dry matter intake, water intake and respiration rate, rectal temperature and milk yield.

	Period 1		Period 2		Treatment		Period	
Item	C	N	C	N	SEM	P=	SEM	P=
Dry matter intake, kg/d	39.1	38.7	38.8	36.7	1.69	0.69	1.74	0.05
Water intake, L/d	89.2	116.4	107.3	127.4	2.24	0.11	1.50	<0.01
Respiration rate, bpm	30.6	32.5	50.8	54.5	1.78	0.14	2.12	<0.001
Rectal temperature, C	38.01	38.06	38.34	38.17	0.06	0.05	0.07	<0.001
Milk yield, kg/d	28.4	31.4	28.5	30.4	0.54	0.17	0.32	0.35

C= Control (0g Niashure)
N= 12g Niashure/h/d

incident and not severe. The study was conducted over 18 days consisting of a 4d acclimation period follow by a 7d TN period and a 7d HS period. Milk yield was measured twice daily and sampled once a day for composition analysis. Estimated water consumption was recorded daily. Cows were fed twice a day and refusal was measured once a day. Respiration rates, surface temperatures (ST) of both shaved (S) and unshaved (U) skin areas were taken at the rump, (ST-R-S, ST-R-U) shoulder, (ST-S-S, ST-S-U), and tailhead (ST-T-S, ST-T-U), and EVHL of the shoulder shaved (EVHL-S) and unshaved (EVHL-U) areas four times daily using an evapometer (Delfin Technologies, LTD., Finland). Rectal temperatures (RT) were measured four times a day. Vaginal core body temperature was measure hourly during the last 4d of each environmental temperature phase.

Data was analyzed using ANOVA procedures of SAS (SAS, 1999). Milk yields, composition and DMI measurements during the acclimation period were used as a covariate in the analysis. Dependent variables tested were milk yield, DMI, ST (rump, shoulder, tail head, shaved and unshaved areas), EVHL, RR, CBT, SNF, lactose, fat, protein, SCC, and water. The independent variables included trt, parity, time, room, period, and the respective interactions. The level of significance was set at $P < 0.05$ for all main effects and interactions and the LSMEANS test was conducted when significance was detected.

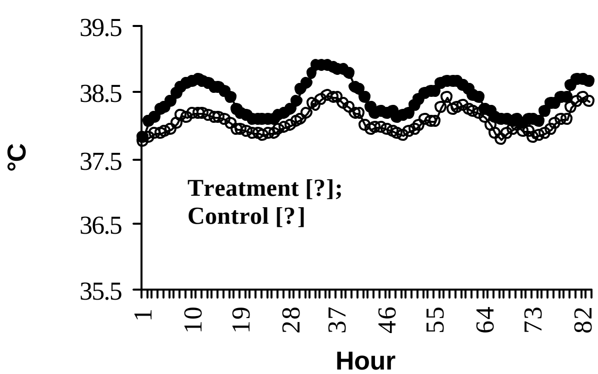

Figure 1. Body core temperatures during period 2 (HS) from day 4 to day 7 period.

Results and discussion

DMI was unaffected by treatment but as expected significantly reduced (P<0.05) by HS (Table 1.) Water intake tended to be higher on N but was only significantly increased (P<0.01) by HS. Respiration rate was significantly increased (P<0.001) during HS. Rectal temperature was significantly increased (P<.001) as expected by HS and significantly reduced (P<.05) by the feeding of Niashure. Milk yield was not significantly affected by either treatment or period, which was expected considering the total number of cows in the study.

Figure 1 shows the response of body core temperature (vaginal probe) over time. Cows receiving Niashure had no change in core body temperature over the 4d while the Control cows has a 0.5 C increase due to elevated environmental temperature.

Table 3 shows the results of surface temperature and evaporative heat loss. There were no significant changes in surface temperature due to treatment. EVHL was significantly increased in those cattle receiving Niashure during HS indicating that part of the reduction in body temperature was due this effect of the product.

Table 3. Surface temperatures and evaporative heat loss (EVHL) for shaved and unshaved areas.

	Period 1		Period 2		Treatment		Period	
Variable	C[2]	N[3]	C	N	SEM	P=	SEM	P=
Surface temperature, C								
Shoulder, shaved	31.3	30.9	34.3	34.1	0.18	0.62	0.18	<0.01
Shoulder, non-shaved	29.9	29.6	33.1	33.6	0.21	0.32	0.20	<0.001
Rump, shaved	30.4	30.3	33.8	33.7	0.24	0.92	0.21	<0.01
Tail head, shaved	30.5	30.7	33.4	33.7	0.19	0.18	0.19	<0.05
Tail head, non-shaved	28.4	28.5	32.8	32.6	0.28	0.93	0.26	<0.001
EVHL[1]								
Shaved	23.2	18.3	92.4	114.4	5.30	0.11	5.80	<0.001
Non-shaved	18.2	13.1	87.2	101.7	4.93	<0.05	4.79	<0.001

1 Closed chamber evapometer
2 C = Control (0g Niashure)
3 N = 12g/h/d Niashure

Summary

During periods of heat stress cattle will undergo stress in being unable to dissipate the increase heat load they will experience resulting in loss of production and overall profitability. The results of this study indicate that being able to deliver niacin to the lower digestive tract for absorption can result in cows being better able to handle periods of heat stress. Further research will be necessary to determine this effect on overall production.