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BRIEF COMMUNICATION: Effects of the SLICK gene on heat tolerance in grazing dairy cattle

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Abstract

The heat tolerance of Senepol beef cattle (Bos taurus) has been causally linked to a mutation in the prolactin receptor (PRLR) on BTA20. This variant of PRLR has become known as the SLICK gene because it is also associated with a short-hair coat. We have investigated the heat tolerance of New Zealand dairy cattle bred to carry the SLICK gene, using measurement of vaginal temperature. Hair length differed ($P<0.001$) between SLICKs and controls at the neck (4.3 ± 0.5 mm vs 13.8 ± 1.2 mm, respectively), shoulder (6.5 ± 0.7 mm vs 14.9 ± 1.5 mm, respectively) and pin bone (6.9 ± 0.6 mm vs 15,2 ±1.4 mm, respectively). Vaginal temperatures of SLICK animals were 0.5 - 1°C lower than controls at peak ambient temperature (28.4°C; 16.00h). SLICK dairy cattle show a markedly improved ability for temperature homeostasis under mild heat load, relative to control cattle.

Keywords: heat tolerance; dairy cattle; SLICK; genetics

Introduction

Heat stress has significant welfare implications for dairy cattle, impacting dry matter intake, daily milk production, calf birthweight, cow fertility and other important traits (Garner et al. 2017). Climate change is driving a need to improve heat tolerance of the New Zealand (NZ) dairy population to protect animal welfare and maintain milk production. The NZ pastoral system does not allow, in practical terms, for use of many of the cooling systems available within housed systems, which puts increased emphasis on finding alternative, including genetic, solutions.

The Senepol breed of cattle, a beef breed that originates from the Caribbean, is unusual among Bos taurus breeds in that it is heat tolerant. The heat tolerance has been causally linked to a mutation in the prolactin receptor (PRLR) on BTA 20 (Littlejohn et al. 2014). This variant of PRLR has become known as the "SLICK gene" because it is also associated with a short-hair coat. Both the SLICK coat and heat tolerance are dominant traits.

Since 2014, a breeding programme has been underway at LIC to introgress the SLICK variant into elite NZ dairy cattle. In addition to enhancing the genetic merit of SLICK offspring, studies are underway evaluating the heat tolerance of NZ dairy cattle carrying the SLICK gene with control cattle.

Materials and methods

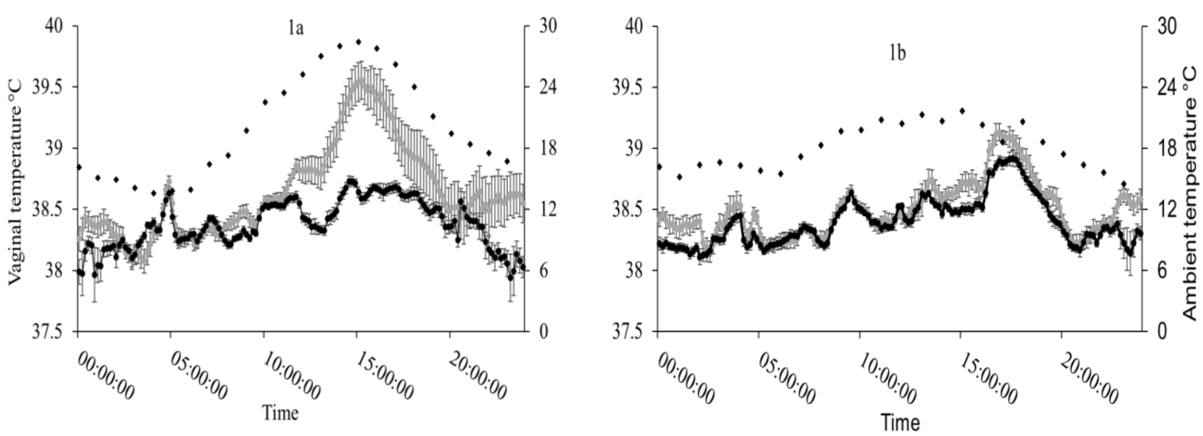
The trial was conducted January/February 2021 at the LIC Innovation farm, Hamilton. All procedures involving animals were approved by the Ruakura Animal Ethics Committee (Approval Number 15178) under the New Zealand Animal Welfare Act 1999.

Nine, 2018 born, heterozygous SLICK heifers (12.5% Senepol 87.5% NZ Holstein Friesian/ Jersey crossbred) calved in August 2020 and were studied as part of LIC's commercial milking herd during the second lactation. The SLICK heifers were matched (age, size and coat colour) with a control group of nine Friesian-Jersey crossbred heifers. Animals remained within the herd for the duration of the trial and were milked twice a day. Vaginal temperature was recorded every 10 min by Star Oddi DST Centi-T temperature loggers (Star-Oddi, Gardabaer, Iceland). Loggers were attached to a shortened cow CIDR (hormone-free; Zoetis, New Zealand) with 2 layers of heat-shrink and inserted into the vagina for 7 days (Schutz et al. 2023). Hair samples were collected in summer (January) by taking a finger-pinch of hairs from 3 regions (pins, shoulder and neck) for length measurement using ImageJ software. A total of 15 hairs were measured from each region sampled, for all animals. Air temperature (°C), and relative humidity (%),were recorded at 10-min intervals (Wireless Vantage Pro2™ Integrated Sensor Suite, model 6322, Davis Instruments Hayward, CA, USA) and the temperature-humidity index (**THI**; Igono et al., 1992) calculated. THI is an estimate of the environmental impact on the cow's ability to lose heat by convection and evaporation. However, THI does not include solar radiation load and windspeed which are important parameters in the environment of grazing cattle.

Results

The mean vaginal temperature was similar in both groups in the morning on both days of observation (~38.3°C; Fig 1) with a small increase seen around morning milking (~5.00h). Vaginal temperature was similar in both SLICK and control groups on the hot day (THI 76 at 15.00h) until around 12.00h. Between 14.00 and 20.00h, vaginal temperature in the SLICK cows was relatively constant at ~38.5°C while the mean vaginal temperature in the control group rose to a peak of 39.5°C, declining back to 38.5°C by 20.00h (Fig 1). The temperature increase can be associated, in part, with the heat generated by walking to the shed for afternoon milking (~14.30h). Vaginal temperature among the SLICK animals was less variable than the controls, particularly during the afternoon when temperatures were at their highest. Vaginal temperatures observed on the cooler day (Fig. 1, 1b, THI 67 at 15.00h)) remained relatively constant for both groups, with just a small increase in vaginal temperature observed in both groups in late afternoon.

Figure 1 Mean vaginal temperature for SLICK (black) and control (grey) cows on two days, where the THI and ambient temperature (dotted line) at 15.00h was: 1a, 76 and 28.4°C, 1b, 67 and 21.7°C. Standard error bars are shown.



Hair samples collected and measured from all three locations were significantly shorter (P<0.001) in the SLICK cattle than controls. For both groups, hair length was shortest on the neck and longest on the pin (Table 1).

Table 1 Mean hair length measurements (± SEM) collected from SLICK and control cattle in mid-summer.

	Hair length (mm)		
Location	Control	SLICK	P value*
Neck	13.8 ± 1.16	4.3 ± 0.46	<0.001
Shoulder	14.9 ± 1.50	6.5 ± 0.70	<0.001
Pin	15.2 ± 1.42	6.9 ± 0.61	<0.001

***By Student's 't' test.** JMP (Version 8, SAS Institute Inc., Cary, NC)

Discussion

The results from this study are consistent with previous findings that under a relatively mild, summer heat load, SLICK cattle have a markedly improved ability for temperature homeostasis (Dikmen et al. 2014), associated with substantially shorter hair length. Several physiological factors may be involved with SLICK cattle's improved ability to regulate body temperature. The short summer coat observed in SLICK cattle should aid in increasing the rate of heat loss via convection and conduction (Berman, 2004). Further, Dikmen et al. (2014) observed that the SLICK trait was also associated with an increased sweating rate. Respiration rate has also been reported to be lower in SLICK relative to control dairy cows when under heat load (Dikmen et al. 2014), a response we have also observed (data not shown).

Further investigation of the mechanism of action of the SLICK variant/prolactin pathway is needed. Improved heat dissipation is likely the primary mechanism of SLICK as limited data shows that the SLICK variant allows dairy cattle to maintain a higher level of production when under heat stress (Dikmen et al. 2014). Hair length in heat tolerant, Bos indicus breeds is even shorter than that seen in SLICK cattle (Davis et al. 2017) contributing to the well-known, heat tolerance of zebu breeds. Definition of the role of the SLICK coat in enabling heat dissipation is needed, including the impact of the SLICK variant on the characteristics of the winter coat.

However, also of interest is the greater variability in heat tolerance that is seen among the control cows (Fig. 1a). Some of these animals had similar heat tolerance ability to the SLICK group indicating that, as might be expected, there are other genetic influences on heat tolerance in NZ cattle that have yet to be identified. Nevertheless, introgression of the SLICK gene into the dairy cattle population in New Zealand has the potential to substantially improve heat tolerance and enhance productivity during heatwaves, which will assist in mitigation of the predicted effects of climate change.

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