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Genomic selections depending on heat tolerance of dairy animals

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DESCRIPTION

For numerous millions of people globally, dairy products provide a significant source of essential proteins and lipids. Dairy cattle are particularly vulnerable to heat stress-induced reductions in milk production, and the long-term security of nutrition from dairy products is at risk as the frequency and length of heat-stress events rises. To develop dairy herds that are better adaptable to changing climates, it would be vital to identify dairy cattle that are more tolerant to heat stress situations. Using genome-wide DNA markers that foretell tolerance to heat stress, genomic selection may speed up the process of breeding for heat tolerance. Here, we use controlled-climate chambers that simulate a moderate heat wave event to show the value of genetic predictions for heat tolerance in cohorts of Holstein cows projected to be heat tolerant and heat susceptible. Future temperature and humidity rises are anticipated to have a severe detrimental impact on the production and wellbeing of ruminants, which give milk, meat, and energy to humans all over the world. Increased core body temperature, increased respiration and panting rates, sweating, and endocrine system changes all of which are crucial to health and productivity are linked to significant declines in feed intake, milk production, and fertility in dairy cattle when temperature and humidity levels exceed species thresholds. The adverse consequences of heat stress are most dangerous to nursing dairy cow, which are the highest producing domesticated production animals.

Dairy cows respond to heat stress differently than other animals, and some of this diversity is heritable. The genetic variability for heat tolerance increases as climatic conditions exceed the thermo neutral cow comfort threshold, opening up opportunities for selection to increase heat tolerance and production. Genetic adaptations are largely responsible for the threshold of environmental conditions that cause production declines. It is well documented to compare the effects of heat stress in various dairy breeds. In our study, we concentrate on taking use of breed-specific variation because it is more important for many dairy companies around the world. Particularly the Holstein breed we utilised in our experiment, a small number of breeds are becoming more and more dominant in dairy herds.

Long generation gaps in traditional selective breeding of dairy calves result in modest rates of genetic gain. Faster genetic increases are preferred given the rate at which days of heat stress are increasing. Young bulls and heifers can be selected based on their Genomic Estimated Breeding Values (GEBV), thereby accelerating genetic gain, using genomic selection. Genomic selection uses genome-wide DNA markers to capture the effects of the numerous mutations that influence variation in a complex trait like heat tolerance. Combining weather station data, milk outputs from more than 366,000 cows on herd test days, and genomic data (SNP markers totaling 632,003), genetic predictions for heat tolerance in dairy cattle were created. The rate of milk production reduction with rising THI was calculated for each cow in their data set. The genetic predictions for the trait were then derived from this heat tolerance phenotype. In this study, we take things a step further and try to test these predictions in a cohort of 24 cows that were exposed to heat-stress conditions in controlled-climate chambers and were projected to be Heat Tolerant (HT) and 24 cows that were anticipated to be Heat Susceptible (HS).

The 48 cows were randomized into climate-controlled chambers for a four-day heat test and a subsequent 14-day recuperation phase. Cows were also observed over a baseline of seven days before the heat test. The controlled-climate chambers' temperature and relative humidity were adjusted to imitate the diurnal patterns in the heat load placed on dairy cows during heat-wave events. Prior to the experiment, severe heat stress thresholds for respiratory rate, panting score, and rectal temperature were established. The affected cow would be removed from the heat challenge if these limits were exceeded. Three HS cows were taken out of the heat challenge during the trial, and no HT cows went over the limits for these parameters. Finally, we have shown that dairy cattle predicted by genomic breeding values to be heat tolerant, have less decline in milk output and fewer increases in core body temperature during a simulated heat wave event than cows projected to be heat susceptible. Therefore, in a future with more frequent and prolonged heat stress events, genetic selection for heat tolerance could improve the resilience and wellbeing of dairy herds globally as well as the productivity of dairy production.