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Assessment of ventral tail base surface temperature for early detection of calves with fever in Japanese black calves

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Bovine respiratory disease (BRD) is the most common and costly disease of beef cattle, and calves with BRD usually indicate fever with depression, loss of appetite, and dull eyes. In Japan, Japanese Black calves aged 3 to 4 months were introduced to a farm, called calf station, that raise calves until 10 months old. In the calf station, calves were raised with free barn and grouped into 4 to 6 calves, and it is difficult to timely detect calves with fever. The objective of present study was to assess the ventral tail base surface temperature (ST) for early detection of calves with fever in Japanese Black calves. Data were collected from a calf station in Miyazaki, Japan, including 153 calves aged 3 to 4 months. A wearable wireless ST sensor was attached to the surface of ventral tail base of each calf at the introduction to the farm. The ventral tail base ST was measured every 10 min for one month. Study 1 was performed to investigate associations of actual rectal temperature with ST and the other three variables calculated by using the ST: 1) estimated ST that calculated by the equation obtained from our previous study, 2) residual ST that calculated by the ST minus mean ST for the same time on the previous 3 days, and 3) residual estimated ST that calculated by the estimated ST minus mean estimated ST for the same time on the previous 3 days. Results of R-squared values by general linear model indicated that residual estimated ST was the best indicator for actual rectal temperature among four variables (P<0.05). Study 2 was conducted to detect calves with fever using residual estimated ST, with machine learning algorithms. Machine learning algorithms applied was random forest, and 26 futures such as minimum and maximum value during the last 3 to 48 hours, difference between the current value and past value, and information of calf at the introduction to the farm. Fever was defined if a calf had ≥1°C residual estimated ST for four consecutive hours. The variable importance score (Gini Index) represented that the most important predictors for detection of calves with fever were minimum and maximum values during the last 3h and difference between the current value and 24 and 48 hours minimum. The present study indicated that early detection of calves with fever can be predicted by monitoring ventral tail base ST using a wearable wireless sensor. This research was supported by a grant (The Research Project for The Future Agricultural Production Utilizing Artificial Intelligence; grant no. ai01) form the Project of the Bio-oriented Technology Research Advancement Institution, NARO.

Keywords: body surface temperature, calf, fever, supervised machine learning, wearable wireless sensor