World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:10, No:11, 2016

Thermoregulatory Responses of Holstein Cows Exposed to Intense Heat Stress

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Abstract : Environmental factors adversely influence sustainability in livestock production system. Dairy herds are the most affected by heat stress among livestock industries. This clearly implies in development of new strategies for mitigating heat, which should be based on physiological and metabolic adaptations of the animal. In this study, we incorporated the effect of climate variables and heat exposure time on the thermoregulatory responses in order to clarify the adaptive mechanisms for bovine heat dissipation under intense thermal stress induced experimentally in climate chamber. Non-lactating Holstein cows were contemporaneously and randomly assigned to thermoneutral (TN; n=12) or heat stress (HS; n=12) treatments during 16 days. Vaginal temperature (VT) was measured every 15 min with a microprocessor-controlled data logger (HOBO®, Onset Computer Corporation, Bourne, MA, USA) attached to a modified vaginal controlled internal drug release insert (Sincrogest®, Ourofino, Brazil). Rectal temperature (RT), respiratory rate (RR) and heart rate (HR) were measured twice a day (0700 and 1500h) and dry matter intake (DMI) was estimated daily. The ambient temperature and air relative humidity were 25.9±0.2°C and 73.0±0.8%, respectively for TN, and 36.3± 0.3°C and 60.9±0.9%, respectively for HS. Respiratory rate of HS cows increased immediately after exposure to heat and was higher (76.02±1.70bpm; P<0.001) than TN (39.70±0.71bpm), followed by rising of RT (39.87°C±0.07 for HS versus 38.56±0.03°C for TN; P<0.001) and VT (39.82±0.10°C for HS versus 38.26±0.03°C for TN; P<0.001). A diurnal pattern was detected, with higher (P<0.01) afternoon temperatures than morning and this effect was aggravated for HS cows. There was decrease (P<0.05) of HR for HS cows (62.13±0.99bpm) compared to TN (66.23±0.79bpm), but the magnitude of the differences was not the same over time. From the third day, there was a decrease of DMI for HS in attempt to maintain homeothermy, while TN cows increased DMI (8.27kg±0.33kg d-1 for HS versus 14.03±0.29kg d-1 for TN; P<0.001). By regression analysis, RT and RR better reflected the response of cows to changes in the Temperature Humidity Index and the effect of climate variables from the previous day to influence the physiological parameters and DMI was more important than the current day, with ambient temperature the most important factor. Comparison between acute (0 to 3 days) and chronic (13 to 16 days) exposure to heat stress showed decreasing of the slope of the regression equations for RR and DMI, suggesting an adaptive adjustment, however with no change for RT. In conclusion, intense heat stress exerted strong influence on the thermoregulatory mechanisms, but the acclimation process was only partial.

Keywords : acclimation, bovine, climate chamber, hyperthermia, thermoregulation
Conference Title : ICB 2016 : International Conference on Biometeorology
Conference Location : Cape Town, South Africa
Conference Dates : November 03-04, 2016