Improvement of Feed Intake and Blood Chemistry Status by Cooling in Holstein Dairy Cows under Heat Stress Condition

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Introduction

Homeostasis is the ability or tendency of an organism or a cell to maintain internal equilibrium (normal temperature, chemical balance, etc.) by adjusting its physiological processes. The most comfortable environmental temperature range for dairy cattle is between 5°C and 25°C, which is regarded as the thermal comfort zone. Within this zone, minimal physiological cost and maximum productivity are normally achieved. As the core body temperature increases, the cow responds by increasing heat-loss mechanisms such as panting and sweating (Spain and Spiers 1998). These responses are physiological strategies to transfer heat from the cow's body to the environment. However, these physiological responses have negative effects on the body metabolisms and feed intake and as a result, blood homoeostasis and the levels of macro elements and hormones vary. One of the keys to success in dairy production is to design and manage facilities to maximize the dry matter intake of dairy cattle by providing cooling systems. Environmental modifications, such as water sprays, fans and evaporative cooling have been recommended to reduce heat stress, including water sprays and fans (Armstrong 1994) and evaporative cooling (Ryan et al. 1992) under shades. The objective of this study was to evaluate the effect of two different cooling systems on thermoregulatory responses, dry matter intake (DMI) and freely or drinking water intake (DWI) of heat-stressed Holstein cows under local shaded conditions and to study the level of hormones associated with heat stress as a criteria to define its intensity.

Materials and Methods

Housing and cooling systems: The study was carried out from the July 20th to Sept. 20th, 2002 in a Northern Iran. Twenty-four cows were assigned to one of the three treatments (C, F and F/S), randomized by days in milk and lactation number. The control group (C) was kept only under six fans, a second group (F) of cows was exposed to twelve fans and a third group (F/S) of cows was cooled with twelve fans like the second group plus sprinkler cooling system. The THI was calculated by the equation: $THI = Td - (0.55 - 0.55RH)(Td - 58)$, where Td is the dry bulb temperature (°F) and RH the percentage of relative humidity expressed in decimals. Data analysis A total mixed ration for highly producing cows was offered ad libitum and was not modified during the trial. DMI for four times daily (5, 13, 18 and 24 hours) and DWI were measured four times daily (8, 14, 22 and 24 hours) for each treatment. The blood samples were collected on eight animals (four first-parity and four second-parity) of each treatment at approximately 13:00 by jugular venipuncture into EDTA tubes, placed in ice and regional within on hour for twelve blood chemistry. The collected data were analyzed by the GLM procedure using SAS. The blood analysis model for DMI and DWI only included treatment as fixed effect and to analysis blood it was included treatment (C, F, F/S) and lactation number as fixed and days in milk as a linear co-variable.

Results

Environmental modifications led to improvements in DMI, ($p<0.0001$) and the ratio of DMI to DWI. The average daily DMI for each of the treatments was 19.15±3.095, 21.63.7±2.284 and 22.51±2.844 kg/day for C, F and F/S respectively. The average daily DWI was 100.7±9.56 l/day versus 111.4±11.09 and 94.5±12.76 for C, F and F/S respectively. THI average was 83.8±2.97 (min. 73.9, max. 88.8) during the trial period. The ratio of DMI to DWI was 5.258, 5.150 and 4.197 for C, F and F/S respectively. Differences in cortisol and triiodothyronine level and chemical components including phosphorous, potassium, cholesterol and glucose among treatments were statistically significant ($p<0.05$).

Significance

Therefore, the effects of HS on DMI and blood chemistry in dairy cattle can be alleviated by artificial cooling methods as have been suggested by others.