Reducing heat stress of Bali cattle under a tropical condition by water sprinkler

A L Toleng and M Yusuf
Department of Animal Production, Faculty of Animal Science, Universitas Hasanuddin
E-mail: Latief.toleng@yahoo.com

Abstract. Although Bali (native breed of Indonesia) cattle has already adapted to tropical conditions, but this breed was reported to be in heat stressed under the high ambient temperature. This study was conducted to evaluate the effect water sprinkler on the physiological responses of Bali cattle during the hot season. Two groups of 6 young Bali males were used in this study. The animals were kept individually in an animal house and fed with rice straw and native grasses supplemented with rice bran and urea multinutrients molasses block. The first group (control group) was kept without water sprinkler and the second group (treatment group) was treated with an individual water sprinkler located about 1 m above the animal. The water sprinklers were applied for 6 consecutive days, three times a day (8.00, 12.00 and 16.00 hr.) each lasting for 30 minutes. The physiological responses (body temperature, respiration rate and pulse rate) and ambient temperature were measured at 05.00, 09.00, 13.00, 17.00, 21.00 and 01.00 hr. Daily water intake was recorded. Mean ambient temperature at 05.00, 09.00, 13.00, 17.00, 21.00 and 01.00 hr. were 20.50º, 32.17º, 37.33º, 30.00º, 21.67º, and 20.33ºC, respectively. Treatment group showed a significant (P<0.05) lower mean body temperature during day time (09.00, 13.00 and 17.00 hr.) in compared to those in the control group (38.1 ºC vs 38.5 ºC). During the night (21.00, 01.00 and 05.00 hr.), there were no significant different of mean body temperature between the two treatments (38.0ºC vs 38.1ºC). Similar responses were detected for respiration rate and pulse rate. Respiration rate was significantly lower (P<0.01) during day time in the treatment group in compared to that in the control group (18.1 vs 20.8 breaths/minute). Mean pulse rate at 13.00 and 17.00 hr. in the treatment was significantly lower (P<0.01) in compared to that in control group (64.3 vs 70.2 beats/min). Mean daily water intake was significantly (P<0.01) lower in the treatment group in compared to that in the control group (12.1 vs 19.3 liters/day). It can be concluded that high temperature during day time of the hot season induced a heat stress. The application of water sprinkler could effectively reduce the heat stress in Bali cattle.

1. Introduction
It has been recognized that local breeds of animals have adapted to hot climate in the tropics. However, since the productivity and reproductive rate of these animals during hot season were lower than that during wet season, indicating that these animals were adversely affected by heat stress. Climatic factors
are among the first and crucial limiting factors of the development of animal production in warm regions [1]. Both grazing and feedlot cattle suffer from heat stress during periods of high temperature and humidity, which affects the rate and efficiency of beef production [2]. Grazing Bali (a native breed of Indonesian) cattle during hot season in Bombana district, of Southeast Sulawesi, showed a low to moderate productivity during the hot season of the year [3]. Rust and Rust [4] have identified the effect of climate change on dairy and beef production such as; decreased milk production, reduced animal weight gain, decrease in reproductive rate and lower feed conversion efficiencies.

As a homeotherms animal, cattle maintain a relatively constant body temperature over a wide range of environmental conditions. Heat lost needs to either increase or decrease based on the thermal environment and the thermal status of the animal. Brown-Brandl [5] explained that heat can be lost from the body by two physical processes: sensible and latent heat loss. Latent heat is the heat lost by evaporation of moisture from the surface of the skin or the respiratory tract of the animal. Physiological responses of Bali cattle in a micro climates environment indicated that these animals under a heat stress during noon and afternoon [6]. Therefore, the low productivity of Bali cattle under the hot climate might be considered to be affected by heat stress.

Sprinklers are one of the most common and effective methods to alleviate heat loss [1]. In dairy cattle, for heat abatement, dairy producers commonly provide water spray milking herds (USDA, 2010 cited by [7]). Shading alone could not significantly reduce heat stress for the animals [6]. But providing water spray reduce body temperature [8,9] respiration rate, and localized air temperature [9,10].

The purpose of this study was to evaluate the effect water sprinkler on heat stress Bali cattle kept individually in an animal house.

2. Materials and Methods

2.1. Animals
Young male Bali cattle (n=12), 1.5-2 years old, weighing 100-150 kg, were used in this study. The study was conducted during hot season of the year (mid of August). They were kept individually in a barn and fed with natural grasses, rice straw and supplemented with rice bran and urea multinutrient molasses block (UMMB). Water sprinklers were installed about 1 m above the shoulder of the animals.

2.2. Procedures
The animals were randomly divided into two groups of 6 animals. Group 1 (control) without water sprinkler and Group 2 (treatment group) with single water sprinkler for each animal. The sprinklers were applied for 6 consecutive days 3 times a day (8.00, 12.00 and 16.00 hr.) each for 30 minutes. Ambient temperature in the barn, body temperature, respiration rate and pulse rate were measured 6 times a day (9.00, 13.00, 17.00, 21.00, 01.00 and 05.00 hr.) and water intake were measured daily.

Body temperature was measured with a calibrated rectal thermometer. Each reading was made at a constant depth of 10 cm and insertion time for about 5 minutes. Respiration rate was measured by counting flank movements for one minute. Pulse rate was recorded by using a stethoscope through the ventral wall of the chest for one minute. Daily water consumption was measured by calculating the amount of water offered and the amount of water left. The differences in data were treated by Student’s t-test.

3. Results
Ambient temperature was relatively constant from 21.67, 20.33 and 20.50ºC at night time 21.00 pm, 01.00 am and 05.00 am, respectively. Thereafter, the environmental temperature was significantly (p<0.05) increased to 32.17, 37.33 and 30.0ºC at day time 09.00 am, 13.00 am and 17.00 am, respectively (figure
Although the high environmental temperature during the day time increased body temperature of the animals, but this high body temperature was significantly reduced by shower treatment (38.10 vs 38.49°C). There was no significant (p>0.05) different of body temperature between the two treatments during the night time (37.98 vs 38.15°C).

Similar response was detected for respiration rate pulse rate. The high environmental temperature during the day time increased respiration rate of the animals, but this high respiration rate was significantly (p<0.05) reduced by shower treatment (18.09 vs 20.82 breaths/minute). There was no significant (P>0.05) different of respiration rate between the two treatments during the night time (17.4 vs 17.72 breaths/minute). Pulse rate was significantly (p<0.05) reduced by shower treatment (63.66 vs 68.51 beats/minute). There was no significant (p>0.05) different of pulse rate between the two treatments during the night time (60.85 vs 62.02 beats/minute).

Figure 1. Environmental temperature and body temperature (A), Respiration rate (B) and Pulse rate (C) of Bali cattle with and without shower.
The installment of water sprinkler during day time could significantly (p<0.01) reduced water consumption of the animals (12.17 vs 19.33 liter/day).

4. Discussion

Body temperature of homoeothermic animals is maintained within a fairly narrow range by elaborate mechanisms of heat exchange between animal and environment through various routes. Under high ambient temperature the animals dissipate heat by evaporation, conduction, convection and radiation [1] either through body surface or respiration. When the heat cannot be lost efficiently, the body temperature begins to increase. The resulting hyperthermia, in turn, decrease feed intake and increase water intake. The purpose of this study was to evaluate the effectiveness of water sprinkle in reducing heat stress in Bali cattle housed under high ambient temperature.

Bali cattle kept under high ambient temperature in this study showed a heat stress during day time with some indications such as high body temperature, respiration rate, pulse rate, and water intake. By providing water sprinklers for 3 times a day (each for 30 minutes) could effectively reduce the heat stress.

The range of ambient temperature between night and day times (20.33–37.33°C) reported in this study was bigger than those mean diurnal temperature in Kinibalu, Malaysia (24.3–31.2°C) [11] and during the beginning of dry season in Jakarta, Indonesia (25.20–34.45°C) [12]. These different might be due to the different seasons when the data were recorded. The present study was conducted at the peak of hot season.

Mean body temperature for both groups of animals for this study (37.98–38.49°C) were still in the range of normal cattle body temperature of 36.7°C–39.1°C [13], 37–39°C by [14] and 37.9–39.0°C [15]. However, since the increasing of body temperature for more than 0.5°C during the day time in the untreated animals, these animals were considered to be under a mild heat stress. The increasing of respiration rate for about 3 breaths/minute, pulse rate for about 7 beats/minute and drinking water for about 7 liters/day during the day time in compared to those at the night time failed to dissipate of the increments of heat production, therefore the deep body temperature increased.

Water sprinkler was an effective method in reducing heat stress of the animals [1,7,16]. The benefits to sprinkle cattle were increasing evaporation of water from the skin surface, and lowering body temperature, decreasing respiration rate and maintaining feed intake [5]. Showering the animals during the day time in this study effectively reduced body temperature, respiration rate and pulse rate.

5. Conclusion

It can be concluded that the application of water sprinkler as a shower system could minimized heat stress of Bali cattle by reducing body temperature, respiration and pulse rates.

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