Effect of cold drinking water on performance, rectal temperature, respiratory rate of Zebu and Jersey cattle in Ibadan, Nigeria

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Abstract

High ambient temperature and relative humidity exert a negative effect on the performance of both *Bos taurus* and *Bos indicus* cattle in Nigeria. The use of water sprinklers to shower cattle may have the ability to mitigate the effect of heat stress. In this study, cold drinking water (10 °C - 15 °C) and ordinary drinking water (20 °C - 25 °C) were offered to six Jersey and six Sokoto Gudali heifers to compare the effect on heat stress. They were divided into two treatments each. Each treatment had three replicates and cattle were assigned in a completely randomised design to the treatment. Rectal temperature, respiratory rate, dry matter intake, daily weight gain and percentage body weight were measured. At three months of administration of treatment, mean morning and afternoon RT varied from 37.94 °C to 39.17 °C for Sokoto Gudali and 37.97 °C to 39.21 °C for Jersey heifers, RR varied from 20.54 bpm to 30.73 bpm for Gudali and 32.17 bpm to 42.63 bpm for Jersey heifers. There were significant ($P < 0.05$) differences in respiratory rate, rectal temperature and dry matter intake between both the zebu and exotic heifers given ordinary water and those given cold water when treatments were administered. Mean RT was 38.99 °C and 38.14 °C for Gudali and 38.98 °C and 38.34 °C for Jersey heifers while mean RR was 28.12 bpm and 23.11 bpm for Gudali and 39.89 and 33.78 bpm for Jersey heifers. DMI were 4.14 kg/d and 6.01 kg/d, daily weight gain were 0.27 kg/d and 0.50 kg/d and FCR were 15.33 and 12.02. Cold drinking water is an effective method of ameliorating heat stress in zebu and Jersey breeds of cattle.

Keywords: Zebu heifers; Jersey heifers; Temperature; Respiratory rate

Introduction

Over the years, cattle have been raised and selected especially for meat and dairy production and the majority of breeds are either *Bos taurus* or *Bos indicus* (Zebu). Some of the *Bos taurus* breeds, such as Holstein and Jersey, have been selected for high milk production, and others for beef production. Due to intensive selection, *Bos taurus* breeds are very efficient for food production as compared to other breeds; however, they are not well adapted to tropical environments and cannot maximize their potential for production in the tropics. The main problem with *Bos taurus* cattle in the tropics is the very low tolerance to heat stress. As compared to *Bos taurus*, *Bos indicus* (Zebu) breeds experience a less severe reduction in feed intake, growth rate, milk yield and

reproductive function in response to heat stress (Adeyemo *et al.*, 1979; Bennett *et al.*, 1985; Pegorer *et al.*, 2007). Chrousos and Gold (1992) defined stress as “a state of disharmony, or threatened homeostasis.” Homeostasis is the ability of the body to maintain a constant internal environment. It is a basic physiological theme across all organisms. Stress challenges homeostasis, but does not disrupt it, in an adapting organism. Homeostatic control mechanisms are first and foremost designed to maintain a constant local cellular environment in the face of a variety of stressors. A failure to adapt is a lack of ability to cope with the stress, if left unchecked, will lead to death. Environmental factors such as, ambient temperature, solar radiation, and humidity have direct and indirect effects on animals (Collier *et al.*, 1982) and impact

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worldwide livestock production (Nienaber *et al.*, 1999). Direct effects include altered production, reproduction and resistance or susceptibility to disease. Indirect effects involve changes in pathogen and pest populations as well as animal behaviour, that can cause increases in exposure to pathogens and pests, such as lying in muddy, wet areas to cool themselves when heat-stressed. The effects of heat stress can be directly related to the increase in body temperature in heat-stressed cows. Ulberg and Burfening (1967) showed that small increase in maternal body temperature would cause decreased pregnancy rates in cattle. Excessive heat load has been used to describe heat stress in cattle and occurs when a combination of local environmental conditions and animal factors leads to an increase in body heat content beyond the animals' normal physiological range (Young, 1993). The physiological responses of cattle to acute periods of excessive heat load have been well described (Blackshaw and Blackshaw, 1994; Gaughan *et al.*, 1999) and include increased respiratory rate (**RR**), decreased feed intake, increased water intake, and imbalances in blood gases and plasma electrolytes. It is also well-known that heat stress reduces feed intake, milk production and reproduction rate. Increased rectal temperatures (an indication of body core temperature) as well as respiration are usually indications of heat stress (Thompson, 1973; Singh, 1980; Shafie, 1989). The present study was designed to determine the effect of cold drinking water on feed intake and rectal temperature as it affects performance of Jersey and Sokoto Gudali cattle.

Materials and methods

Experimental site

Experiment was conducted at the Dairy

Unit of the Teaching and Research Farm, University of Ibadan, Ibadan, Oyo state (3°45'E, 7°27'N; at 220 m above sea level). Annual rainfall ranges from 1150 - 1500 mm.

Preparation of silage

Elephant grass (leaves with young stems) cut at 60 cm from the ground level were harvested from a fodder plot and chopped to 3 cm lengths using an automated forage chopper. The forage (40%) was mixed with chopped cassava peels (20%) and brewer spent grains (40%). Silage materials were mixed on a wet basis. The mixture were ensiled inside four litre plastic bucket for laboratory analysis, and three series of two tonnes silos for feed intake study.

Silage examination and laboratory analysis

Mini silos were opened at 21 days of ensiling and samples were analyzed for proximate composition using the general procedure of AOAC (2005). DM concentration in the silage was determined using a forced draught oven at 65 °C and values obtained were corrected for loss of volatile compounds by multiplying with the correction factor of 1.056 (Fox and Fenderson, 1978). Detergent fibre components were determined according methods of Van Soest and Robertson (1985).

Field pasture measurement

The predominant pasture in the paddock was *Panicum maximum* with traces of *Centrosema molle* and *Calopogonium mucunoides*. Pasture intake was estimated using a quadrat. The quadrat measuring 1 x 1 m was thrown inside the paddock in a random manner before heifers were grazed and herbage within the quadrat was cut to 50cm height. After grazing, the quadrat was thrown again and herbage measured. The difference between herbage on offer before grazing and after (corrected to the size of the field and animal number) was assumed to be

the daily pasture intake per animal

Cold water preparation

Cold water was prepared by putting ice block in the water for about thirty minutes prior to usage for the temperature to drop to about 10 °C before being offered to the animal. The water temperature was then monitored with a thermometer while more iced block were added to maintain the temperature.

Experimental animals, design, diet and management

Six Jersey and six Sokoto Gudali breeds of cattle were used for the experiment. They were divided into two treatments each with three replicates per treatment in a completely randomized design. The animals were sheltered in individual pens and they were allowed to graze from 8 am in the morning till 12 pm in the afternoon.

Before taking them out for grazing in the morning, rectal temperature and respiratory rate were determined. They were then allowed to stay in the sun by locking them up in the paddock where there was no shade. By 12 pm, the animals were then allowed in and the rectal temperature and respiratory rate were also determined before the administration of treatment. Ordinary water of temperature 20 to 25 °C were administered to the first treatment of zebu and exotic breeds. Cold water of temperature 10 to 15 °C were then administered to the second treatment of zebu and exotic breeds. After about one hour of administering the treatments, rectal temperature and respiratory rate were also taken. The cattle were fed ad libitum with silage throughout the duration of the experiment.

Treatment

The Jersey and Sokoto Gudali heifers were divided into two treatment each.

For Jersey heifers

Treatment 1: exotic heifers given ordinary

water i.e T1_e

Treatment 2: exotic heifers given cold water i.e T2_e

For Sokoto Gudali heifers

Treatment 1: zebu heifers given ordinary water i.e T1_z

Treatment 2: zebu heifers given cold water i.e T2_z

Data collection

Data were collected in the course of the experiment and the data collected included;

Environmental temperature

This was determined with the use of minimum and maximum thermometer. The readings was taken three times daily that was early in the morning between 7.00 a.m and 7.30 a.m, immediately after grazing by 1 p.m in the afternoon, before administration of treatment and one hour after administration of treatment.

Relative humidity

This was determined with the use of hydrometer. The readings were obtained by deducting the minimum readings recorded from the maximum readings recorded to obtain a single value. The readings was taken three times daily that was early in the morning between 7.00 a.m and 7.30 a.m, immediately after grazing by 1 p.m in the afternoon, before administration of treatment and one hour after administration of treatment.

Rectal temperature

This was carried out by inserting a digital thermometer into the anus of the animal and tilting it sideways in order to get the temperature of the rectal wall. The thermometer tip were lubricated and cleaned with methylated spirit for easy passage into the rectum. The thermometer was inserted for one minute before removal. The reading was taken three times daily that was early in the morning between 7am and 7.30 am, immediately after grazing by 1 pm in the afternoon before administration of treatment

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and 1 hour after administration of treatment.

Respiratory rate

This was determined by counting the flank movement for one minute.

The reading was taken three times daily that was early in the morning between 7am and 7.30 am, immediately after grazing by 1 pm in the afternoon before administration of treatment and 1 hour after administration of treatment.

Performance

Feed intake was determined by subtracting the amount of feed refused in kilogram from the amount of feed allotted to the animal.

Daily weight gain was calculated by determining the monthly weight gain and dividing it with the number of days in that month and it was expressed in kilograms per day. Percentage body weight was calculated by dividing dry matter intake by the average body weight multiply by 100

Statistical analysis

All data obtained were subjected to statistical analysis of variance as described by Steel and Torrie (1980) at 5% probability test using SPSS 15.00 software .Significantly different means were compared using Duncan's Multiple Range Test.

Results and discussion

Table 1 shows the differences in temperature, relative humidity and temperature humidity index during the months of the experiment. The minimum, maximum and mean daily temperature declined from March to May which may be due to seasonal changes from dry season to raining season. Relative humidity also increased from March to May because of increasing rainfall and subsequently reducing environmental temperature and increasing environmental moisture.

Table 1: Mean daily temperature, humidity and temperature humidity index of study area during March, April and May

Parameter	March	April	May
Ambient temperature			
Minimum	24.64	23.52	23.15
Maximum	33.62	33.37	32.20
Mean daily temperature	28.31	27.32	26.53
Relative humidity	77.34	80.66	82.11
Temperature humidity index (THI)	70	72	71

Rectal temperature

Table 2 shows the morning rectal temperature of the zebu heifers were 38.17 °C and 38.03 °C respectively for those given ordinary water (20 °C-25 °C) and cold water (10 °C-15 °C) in the month of March .However, in the afternoon their temperature rose to 39.23 °C and 39.43 °C respectively which were above the cattle optimum condition hence it can be seen that both groups were undergoing stress even though their temperature were not

significantly different ($P>0.05$). This agrees with Gaughan *et al.* (1999) that there was an increase in rectal temperature when *Bos indicus* was subjected to extremely hot condition. One hour after the administration of the treatment, their temperature became 39.03 °C and 38.33 °C respectively which were significantly different ($P<0.05$) from each other. The temperature of the animals in the treatment given ordinary water reduced by 0.2 °C, even though there was reduction but the rate of the reduction in temperature

was slow but in the case of the animals given cold water, the change in their rectal temperature was 1.10°C within the same time frame. There were also significant difference ($P<0.05$) between the change in

rectal temperature of the heifers given ordinary water and those given cold water. This difference showed the effect of the administration of treatment. Their rectal temperatures follow the same trend for the month of April and May

Table 2: Rectal temperature of zebu breed for the month of March, April and May

Rectal temperature (°C)	Ordinary water (T1 _Z)	Cold water (T2 _Z)	SEM
MARCH			
Morning	38.17	38.03	0.01
Afternoon	39.23	39.43	0.01
1hour after treatment	39.03 ^a	38.33 ^b	0.004
Change in RT	0.20 ^b	1.10 ^a	0.005
APRIL			
Morning	37.97	37.90	0.002
Afternoon	39.17	39.37	0.023
1hour after treatment	8.93 ^a	38.00 ^b	0.001
Change in RT	0.14 ^b	1.37 ^a	0.028
MAY			
Morning	37.83	37.90	0.006
Afternoon	39.07	39.02	0.011
1hour after treatment	39.00 ^a	38.10 ^b	0.014
Change in RT	0.07 ^b	0.92 ^a	0.002
Mean morning	37.99	37.94	0.074
Mean afternoon	39.16	39.17	0.179
Mean 1hour after treatment	38.99 ^a	38.14 ^b	0.072
Change in RT	0.14 ^b	1.13 ^a	0.340

ab: means with different superscripts within the row are significantly different ($P<0.05$)

The effect of cold water on the rectal temperature of exotic Jersey heifers (as shown in table 3) was similar to that of their zebu counterpart and the exotic rectal temperature also reduces from March to May. This drop in rectal temperature was because of the onset of rainfall which caused reduction in the environmental temperature. It was observed that the mean morning and afternoon rectal temperature of the exotic heifers (37.97-39.21 °C) were higher than their zebu counterpart (37.94-39.17 °C) which agreed with Finch (1986).

Respiratory rate

The respiratory rate of zebu heifers as shown in Table 5 revealed that the morning respiratory rate for those given ordinary water were 23.00 bpm, 21.33 bpm and

20.33 bpm for March, April and May respectively and 21.47 bpm, 20.67 bpm and 19.48 bpm for those given cold water within the same period of time while the afternoon respiratory rate were 31.33 bpm, 30.33 bpm and 28.00 bpm respectively for those given ordinary water and 32.00 bpm, 30.20 bpm and 30.00 bpm for those given cold water. This increase in respiratory rate in the afternoon for both the exotic and zebu heifers agreed with Mallonee *et al.* (1985) who observed that increase in environmental temperature elevates the respiratory rate. However, after the administration of treatment, the respiratory rate dropped to 29.00 bpm, 28.03 bpm and 27.33 bpm respectively for March, April and May for the heifers given ordinary water and 24.33

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bpm, 23.00 bpm and 22.00 bpm for those heifers given cold water within the same period. This showed that the cold water

administered was able to bring the respiratory rate down faster than ordinary water within the same time frame hence the significant difference observed between them.

Table 3: Rectal temperature of Jersey breed for the month of March, April and May

Rectal temperature (°C)	Ordinary water	Cold water	SEM
MARCH			
Morning	38.07	38.00	0.006
Afternoon	39.20	39.40	0.018
1hour after treatment	39.03 ^a	38.43 ^b	0.008
Change in RT	0.17 ^b	0.97 ^a	0.028
APRIL			
Morning	38.03	37.97	0.002
Afternoon	39.03	39.23	0.018
1hour after treatment	38.93 ^a	38.53 ^b	0.024
Change in RT	0.10 ^b	0.70 ^a	0.008
MAY			
Morning	37.92	37.90	0.006
Afternoon	38.97	39.00	0.057
1hour after treatment	38.80 ^a	38.07 ^b	0.021
Change in RT	0.17 ^b	0.93 ^a	0.025
Mean morning	38.00	37.97	0.025
Mean afternoon	39.07	39.21	0.018
Mean 1hour after treatment	38.98 ^a	38.34 ^b	0.052
Mean change in RT	0.15 ^b	0.87 ^a	0.040

ab: mean with different superscript within the row are significantly different (P<0.05)

Table 4: Respiratory rate for the month of March, April and May for zebu breed

Respiratory rate (Breath/min)	Ordinary water	Cold water	SEM
MARCH			
Morning	23.00	21.47	0.39
Afternoon	31.33	32.00	0.89
1 hour after treatment	29.00 ^a	24.33 ^b	0.56
Change in RR	2.33 ^b	7.67 ^a	1.94
APRIL			
Morning	21.33	20.67	1.11
Afternoon	30.33	30.20	1.06
1hour after treatment	28.03 ^a	23.00 ^b	0.72
Change in RR	2.30 ^b	7.00 ^a	0.83
MAY			
Morning	20.33	19.48	0.44
Afternoon	28.00	30.00	1.33
1hour after treatment	27.33 ^a	22.00 ^b	0.39
Change in RR	1.33 ^b	8.00 ^a	0.70
Mean morning	21.55	20.54	0.57
Mean afternoon	29.89	30.73	0.80
Mean 1hr after treatment	28.12 ^a	23.11 ^b	0.46
Mean change in RR	1.99 ^b	7.56 ^a	0.50

ab: mean with different superscripts within the row are significantly different (P<0.05)

The effect of treatment on the exotic heifers were similar to that of their zebu counterpart (as shown in Table 5) but it was observed that the exotic heifers (32.17-42.63 bpm) have a relatively higher mean morning and afternoon respiratory rate when compared with their zebu counterpart (20.54-30.73 bpm). The higher respiratory

rate was due to the fact that *Bos indicus* breeds are more heat tolerant than *Bos taurus*. This agreed with Blackshaw and Blackshaw (1994) which state that genetic differences exist for heat tolerance of cattle as *Bos indicus* breeds are more heat tolerant than *Bos taurus* because of greater sweating capacity and lower metabolic rate.

Table 5: Respiratory rate for the month of March, April and May for exotic breed

Respiratory rate	Ordinary water	Cold water	SEM
MARCH			
Morning	36.00	34.00	1.33
Afternoon	45.33	46.33	0.94
1 hour after treatment	41.33 ^a	34.67 ^b	1.44
Change in respiratory rate	4.00 ^b	11.66 ^a	2.22
APRIL			
Morning	33.00	32.33	0.56
Afternoon	42.33	41.53	1.55
1 hour after treatment	39.67 ^a	32.67 ^b	0.44
Change in RR	3.66 ^b	8.86 ^a	0.94
MAY			
Morning	31.00	30.19	0.78
Afternoon	40.23	40.00	1.11
1 hour after treatment	38.67 ^a	34.00 ^b	0.89
Change in RR	1.67 ^a	6.00 ^b	1.11
Mean morning	33.33	32.17	0.64
Mean afternoon	42.63	42.62	0.55
Mean 1 hr after treatment	39.89 ^a	33.78 ^b	1.04
Mean change in RR	3.11 ^b	8.84 ^a	0.49

ab: means with different superscripts within the row are significantly different (P<0.05)

Feed intake, daily weight gain and feed conversion ratio

The mean dry matter intake of zebu heifers given ordinary water for the month of March, April and May was 4.14kg/day which consisted of 3.24kg/day of pasture and 0.9kg/day of silage while those of the zebu heifers given cold water was 6.01 which consisted of 3.20kg/day of pasture and 2.81kg/day of silage. Both of the group of heifers given ordinary water and cold water had similar pasture consumption rate

because they were both subjected to similar condition on the field hence there was no significant difference in their pasture consumption. However, their silage consumption were significantly different because of treatment effect on those heifers given cold water which enable them to consume more silage than their counterpart given ordinary water. This supported the argument of Johnston *et al.* (1958) which asserted that there is a negative correlation between THI and dry matter intake.

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Table 6 : Mean intake and weight gain of zebu heifers provided with cold drinking water for the month of March, April and May

	Ordinary water	Cold water	SEM
DMI (Kg)			
Pasture	3.24	3.20	0.167
Silage	0.9 ^b	2.81 ^a	0.026
Total	4.14 ^b	6.01 ^a	0.155
DWG (kg/day)	0.27 ^b	0.50 ^a	11.90
FCR	15.33 ^a	12.02 ^b	0.013

ab: means with different superscripts within the row are significantly different (P<0.05)

*DMI: Dry Matter Intake

*DWG: Daily Weight Gain

*FCR: Feed Conversion Ratio

Mean dry matter intake for Jersey cattle as shown in table 8 above included 5.44kg/day which consisted of 4.05kg/day of pasture and 1.39kg/day of silage for the heifers given ordinary water while those given cold water was 8.01kg/day consisting of 4.40kg/day of pasture and 3.61kg/day of silage. Pasture consumption were not significantly different (P>0.05) but silage consumption were significantly different (P<0.05) because of treatment effect on the heifers given cold water. However, this assertion agreed with Holter *et al.* (1997) who reported a reduction in DMI in Jersey cattle when minimum THI exceed 56 and continued until THI reached 72.

Mean daily weight gain for zebu were shown in table 7 i.e 0.27kg/day for those given ordinary water and 0.50kg/day for those given cold water. This difference showed an improved performance of those

heifers given cold water over those given ordinary water while the same can be seen for the exotic heifers i.e 0.35kg/day for those given ordinary water and 0.7kg/day for those given cold water.

Feed conversion ratio (FCR) is defined as the ratio of feed intake to weight gain. It is used to describe the weight gain performance relative to feed consumed by the animal. For the zebu heifers, the FCR were 15.33 and 12.02 for those given ordinary water and cold water respectively. There was significant difference (P<0.05) in the FCR of the heifers with those given cold water having a lower FCR which implied that they were able to gain more weight per unit of feed consumed when compared with their counterpart given ordinary water.

The same trend was observed in the exotic breed i.e 15.54 and 11.44 for those given ordinary and cold water, respectively.

Table 7: Mean intake and weight gain of exotic heifers provided with cold drinking water for the month of March, April and May

	Ordinary water	Cold water	SEM
DMI (Kg)			
Pasture	4.05	4.40	0.002
Silage	1.39 ^b	3.61 ^a	3.720
Total	5.44 ^b	8.01 ^a	0.125
DWG (kg/d)	0.35 ^b	0.70 ^a	10.330
FCR	15.54 ^a	11.44 ^b	0.040

ab: means with different superscripts within the row are significantly different (P<0.05)

*DMI: Dry Matter Intake

*DWG: Daily Weight Gain

*FCR: Feed Conversion Ratio

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