VARIATIONS IN THE THERMOREGULATORY RESPONSE OF GEESE DURING LOW TEMPERATURE – HUMIDITY INDEX

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ABSTRACT
In a 28–day trial, the effects of sex and daytime on the thermoregulatory response of geese during low temperature – humidity index was investigated. Twenty four geese (12 males and 12 females) were allotted into two treatments according to their sex in a completely randomized design. Their cloaca temperature, respiratory rate and pulse rate were measured and recorded in the morning, afternoon and evening for the entire experimental period. Also, the ambient temperature and relative humidity of the pen were recorded daily. Males had significantly ($p < 0.05$) higher respiratory rate (20.84±2.06 breaths/minute) than females (19.49±1.37 breaths/minute). However, pulse rate and cloaca temperature were not significantly ($p > 0.05$) different between the two sexes. The respective mean temperature, humidity and temperature-humidity index (THI) values recorded were 25.20±1.46^{0}C, 91.93±4.38% and 24.92±1.38 (morning); 28.98±1.87^{0}C, 73.64±9.00% and 27.74±1.37 (afternoon) and 28.88±2.30^{0}C, 72.39±8.87% and 27.60±1.86 (evening). The cloaca temperature in the morning was significantly ($p < 0.05$) lower than in the afternoon and evening while their pulse rate and respiratory rate were not significantly ($p<0.05$) different at the respective daytimes. Hence, sex and daytime independently influenced the thermoregulatory response of the geese.
Keywords: Respiratory rate, Cloaca temperature, Pulse rate, Thermoregulatory response, Geese

INTRODUCTION
Geese reproduction and egg production occurs for a short period between 5 and 6 months within the year, due to seasonal influences. This has often hindered their reproductive efficiency over the years. Temperature humidity index (THI) is mostly used as an environmental factor to predict production losses in animals exposed to hot and humid climatic conditions (Karaman *et al*., 2007). It is an indicator of thermal climatic condition which is estimated from the measurement of temperature and humidity (LPHSI, 1990; Marai *et al*., 2001). Heat stress generate in animals when there is an imbalance between heat production within the body and heat dissipation. It is one of the several problematic factors that make animal production and reproduction difficult in many areas of the world and it is one of the most important stressors especially in hot regions of the world (Yasha *et al.*, 2017). It can affect animals through the association of environmental factors such as high ambient temperature, relative humidity, high solar radiation, low precipitation and low wind speed (Al-dawood, 2017).

Homeostatic responses to thermal stress may include increased respiratory rates, increased heart rates, reduced feed intake, reduced production, and sweating in animals. The animal may have to put biochemical, physiological and physical processes into action to counteract the negative effects of heat stress and maintain thermal equilibrium (Altan *et al*., 2003). Through thermoregulation, animals can maintain their body temperature in cold or hot environments by manipulating physiological, behavioural, and anatomical responses that affect energy metabolism (St-Pierre, 2003)**.** Under normal condition, the chicken's body temperature is 41.5°C, but this can fluctuate based on the temperature of its environment (Sottnik, 2002). Adjustment of animals to heat stress requires the physiological integration of many organs and systems, which are the cardiorespiratory system, endocrine system and immune system (Altan *et al*., 2003). Little research has been documented on the thermoregulatory response of the geese at low temperature – humidity index. Hence, this experiment was designed to study the effects of sex and daytime on the thermoregulatory response of geese during low temperature – humidity index.

MATERIALS AND METHODS
This experiment was carried out at the Poultry unit of the Teaching and Research Farm, University of Ibadan, Nigeria, Latitude 7° 26′ N and Longitude 3° 54′ E. Twelve geese and twelve ganders with an average weight of 5.2±0.69 kg and 3.87±0.49 kg for the males and females respectively, were used for

this experiment. They were purchased from a reputable farm in Jos, Nigeria and the geese were allowed to pass through an acclimatization period before the commencement of the experiment. The 24 geese were divided into 2 groups according to their sex in a completely randomized design and a 2 x 3 factorial arrangement was used. The thermoregulatory parameters were measured from the individual gander and goose, and recorded separately throughout the experimental period. This was done at 3 times daily for 28 days during the period of low temperature-humidity index (July/August). The three times of each day in which the thermoregulatory parameters were measured are as follows: Morning (7am to 9am), Afternoon (12pm to 2pm) and Evening (5pm to 7pm). The parameters measured separately at each day time included pen ambient temperature (°C), pen relative humidity (%), vent or cloaca temperature (°C), respiratory rate (breaths/minute), panting rate (breaths/minute) and pulse rate (beats/minute). Data were analysed using General Linear Model of SAS (2003) and means were separated using Tukey-Kramer Mean Separation Procedure. The temperature humidity index was calculated using the procedure of Marai *et al.* (2001).

THI = Temperature - humidity index = $t - [(0.31 - 0.31 \times RH/100)(t - 14.4)]$ (Marai *et al.* 2001).

<27.8 = absence of heat stress;

27.8 – 28.9 = moderate heat stress;

29.0 – 30.0 = severe heat stress; and

> 30.0 = very severe heat stress

RESULTS

The temperature and relative humidity of the experimental pen are presented in Figures 1 and 2. The afternoon had the highest average temperature than the morning and evening. The lowest humidity was observed in evening while the highest was in the morning. The daily temperature humidity index for the morning, afternoon and evening during the experimental period is presented in Figure 3. The lowest average value of temperature humidity index was observed in the morning followed by the evening, while the peak was observed in the afternoon

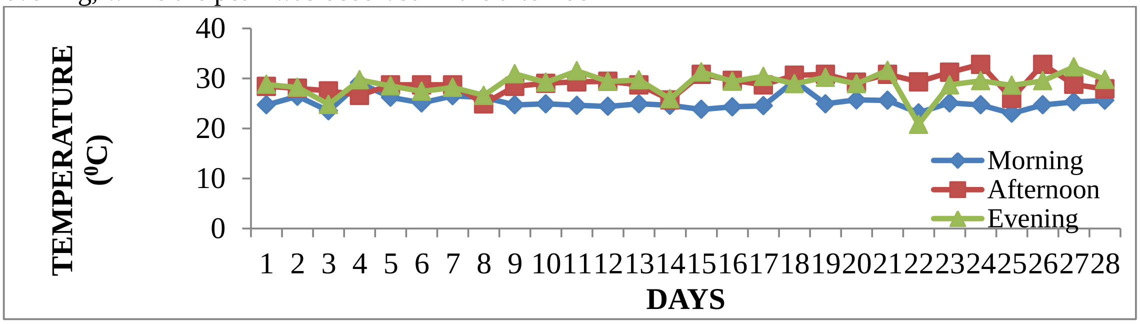

Figure 1: Temperature of the Experimental Pen during Low Temperature Humidity Index

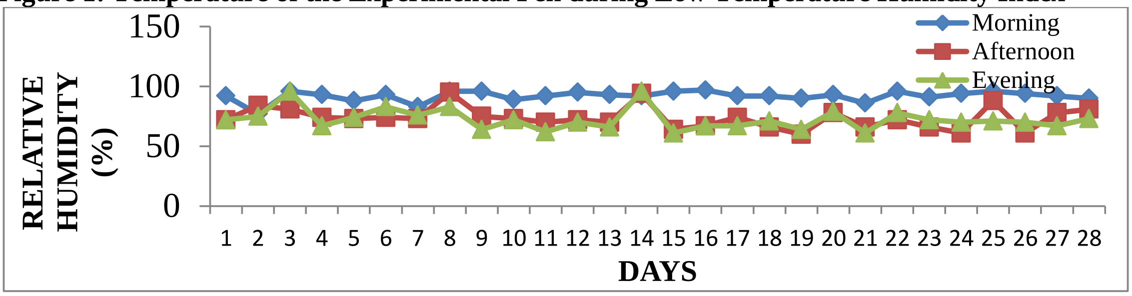

Figure 2: Relative Humidity of the Experimental Pen during Low Temperature Humidity Index

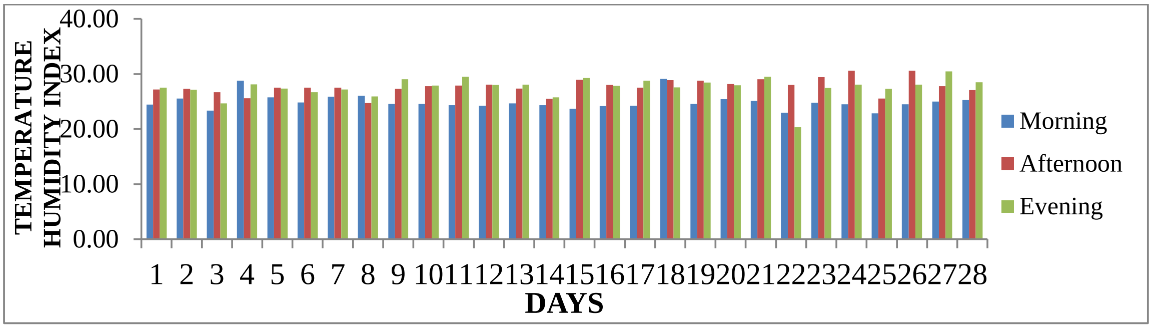

Figure 3: Temperature Humidity Index of the Experimental Pen during Low Temperature Humidity Index Period

The main effect of sex on the thermoregulatory response of geese during low Temperature humidity index is shown in Table 1. There were no significant differences (p>0.05) in the cloaca temperature and pulse rate for both male and female. However, the male had significantly (p<0.05) higher respiratory rate than their female counterpart. The respiratory rate, cloaca temperature and pulse rate values for the males and females ranged from 19.49 – 20.84 breaths/minute, 40.65 – 40.70^{o}C and 158.10 – 158.19 beats/ minute, respectively.

Table 1: Main effect of sex on the thermoregulatory response of geese during low THI

a,b Means in the same column with different superscripts are significantly different (p< 0.05) .

Sex	RR (breaths/minute)	CT (^{0}c)	PUR (beats/minute)	TEMP (^{0}c)	HUM (%)	THI
Female	19.49±1.37^{b}	40.65±0.18	158.19±10.10	27.69±2.59	79.32±11.78	26.75±2.01
Male	20.84±2.06^{a}	40.70±0.25	158.10±13.73	27.69±2.59	79.32±11.78	26.75±2.01

RR = Respiratory rate, CT = Cloaca temperature, PUR = Pulse rate, Temp = Temperature, HUM = Humidity, THI = Temperature – humidity index

The main effect of daytime on the thermoregulatory response of geese during low temperature - humidity index is presented in Table 2 below. Significantly (p<0.05) higher cloaca temperature was observed in the afternoon and evening than in the morning. However, the values obtained for the afternoon and evening were not significantly different from each other (p>0.05). No significant difference (p>0.05) was observed in the respiratory rate and pulse rate at the various times of the day and their values ranged from 19.85±1.52 - 20.45±1.60 breaths/minute and 155.15±11.61-162.01±12.43 beats/minute for the respiratory rate and pulse rate, respectively.

Table 2: Main effect of Day time on the thermoregulatory response of geese during low THI

Day time	RR (breaths/min)	CT (^{0}c)	PUR (beats/min)	TEMP (^{0}c)	HUM (%)	THI
Morning	20.38±2.45	40.54±0.18^{b}	162.01±12.43	25.20±1.46 ^{c}	91.93±4.38^{a}	24.92±1.38^{c}
Afternoon	20.45±1.60	40.79±0.21^{a}	157.26±11.84	28.98±1.87^{a}	73.64±9.00^{b}	27.74±1.37^{a}
Evening	19.85±1.52	40.71±0.21^{a}	155.15±11.61	28.88±2.30 ^{b}	72.39±8.87^{c}	27.60±1.86^{b}

a,b Means in the same column with different superscripts are significantly different (p< 0.05) .

RR = Respiratory rate, CT = cloaca temperature, PUR = Pulse rate, Temp = Temperature, HUM = Humidity, THI = Temperature – humidity index,

DISCUSSION

Sex had no effect on the pulse rate values obtained for the geese but had effect on the respiratory rate as the ganders were observed to have a higher respiratory rate than their female counterparts. This could be as a result of the heavier weight of the ganders above the goose as heavier weight may implicate a faster rate of heat generation in the body. Samour (2006) also reported variation in the respiratory rate as influenced by body weight in healthy birds. This sexual difference was also in accordance with the findings of West Virgina University (2010) who noted that respiratory rate was influenced by the body size of the animals with other factors like age, exercise and environment. The average weight of the male geese used for this experiment was higher than that of the females. However, this finding was contrary to that of Mutibvu *et al.* (2017) who reported the males to have a higher heart rate than females. For the three periods of the day, respiratory rate and pulse rate values were similar. However, the cloaca temperature was lower in the morning than in the afternoon and evening. This could be due to the lower environmental temperature and higher relative humidity observed in the morning compared to the afternoon and evening. The temperature and THI recorded in the morning was lower than what was recorded in the afternoon and evening while that of the evening was also lower than that of the afternoon. Also, the humidity varied with highest value in the morning and lower values in the afternoon and evening. This is expected because the environmental temperature in the morning was cooler than in the afternoon and evening.

CONCLUSION

The values obtained for the male and female geese thermoregulatory response were similar to those of other avian species. Sex and period also influenced the respiratory rate and rectal temperature of the geese respectively while the pulse rate of the birds was not affected by either sex or period.

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