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Variations in the thermoregulatory response of geese during high temperature – humidity index

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Abstract

Geese have a seasonal reproductive pattern governed by environmental fluctuation. Birds must therefore be in homeostasis with their environment for optimum performance and reproductive efficiency. In a 21–day trial, the effects of sex and daytime on the thermoregulatory response of geese during high temperature – humidity index was investigated. Twenty four geese (12 males and 12 females) were allotted into two treatments according to their sexes in a completely randomized design. Their respiratory rate, rectal temperature, pulse rate and panting rate were measured and recorded in the morning, afternoon and evening throughout the entire experimental period. Also, the ambient temperature and relative humidity of the pen were recorded on a daily basis. Results showed that females had significantly ($p<0.05$) higher respiratory rate and pulse rate than males. However, males had significantly ($p<0.05$) higher rectal temperature than the females. The panting rate was not significantly different ($p>0.05$) between the two sexes. The respective mean temperature, humidity and temperature-humidity index values recorded were 26.59^{o}C, 85.65% and 40.69 (morning); 34.16^{o}C, 46.05% and 48.25 (afternoon) and 34.39^{o}C, 47.45% and 47.84 (evening). The rectal temperature in the morning was significantly ($p<0.05$) lower than in the afternoon and evening and their pulse rate decreased ($p<0.05$) inversely with daytime. Hence, it can be concluded that sex and daytime independently has effect on the thermoregulatory response of geese.

Keywords: *Geese, respiratory rate, rectal temperature, pulse rate, panting rate*

Description of Problem

The goose is an animal with interesting biological characteristics, such as high growth rate, good adaptation to free range and grazing and a high dietary quality of meat (1). However, unlike most domestic birds, geese have a relatively short reproductive period and poor egg production governed by environmental and seasonal variation and fluctuation. This makes it difficult to produce goose for meat and other purposes all year round despite the fact that the meat has an optimal composition of essential amino acids and favourable fatty acid profile (2). In order to obtain the best performance of a given animal production system, it is necessary that it operates within the zone of thermal comfort for the animals (3). For birds to also perform at their optimum capacity they need to be in homeostasis with their environment (3**).** The environment may also affect the behaviour of laying birds and it is important to understand its effects on them (4). Thermoregulation is the means by which an animal maintains its body temperature. Under heat stress, a number of physiological and behavioural responses vary in intensity in relation to the animal genetic make-up and environmental factors (5). Temperature, humidity, ventilation and light are all related to the regulation of metabolic processes in animals, affecting the ability of the individual to adapt to its environment (6; 7**).** The thermoregulatory response of some avian species like indigenous chicken and broilers as well as rabbits have been documented either at high or low temperature-humidity index (8; 9;10). However, there is paucity of information on the thermoregulatory response of the geese at high temperature – humidity index in Nigeria. Hence, this experiment was designed to investigate the effects of sex and daytime on the thermoregulatory response of geese during high temperature – humidity index.

Materials and Methods

Location and Duration of the Study

This study was carried out at the Poultry unit of the Teaching and Research Farm, University of Ibadan, lying between Latitude 7.4506 and Longitude 3.8987.The experiment lasted for 21 days.

Source and Management of Experimental Birds

The experimental animals consisted of 12 geese and 12 ganders with an average weight of 5 kg and 3.6 kg for the males and females respectively. These were purchased from a reputable farm in Jos, Nigeria, Latitude $9^{0}36'0''$N and Longitude $9^{0}14'0''$E. The geese were allowed to acclimatize before the commencement of the experiment.

Experimental Design, Data Collection and Statistical Analysis

The 24 geese were divided into 2 groups according to sex using a 2 x 3 factorial arrangement in a completely randomized design. The thermoregulatory parameters were measured from the individual gander and geese and recorded separately throughout the experimental period. This was done at

3 times daily for 21 days during the period of high temperature- humidity index (February/ March). 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 daily period 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). The temperature humidity index was calculated using the procedure of Marai *et al.* (10).

THI – Temperature - humidity index = t – [(0.31- 0.31 x RH/100t – 14.4)] (10)

THI values were classified by Marai *et al.* (10) as

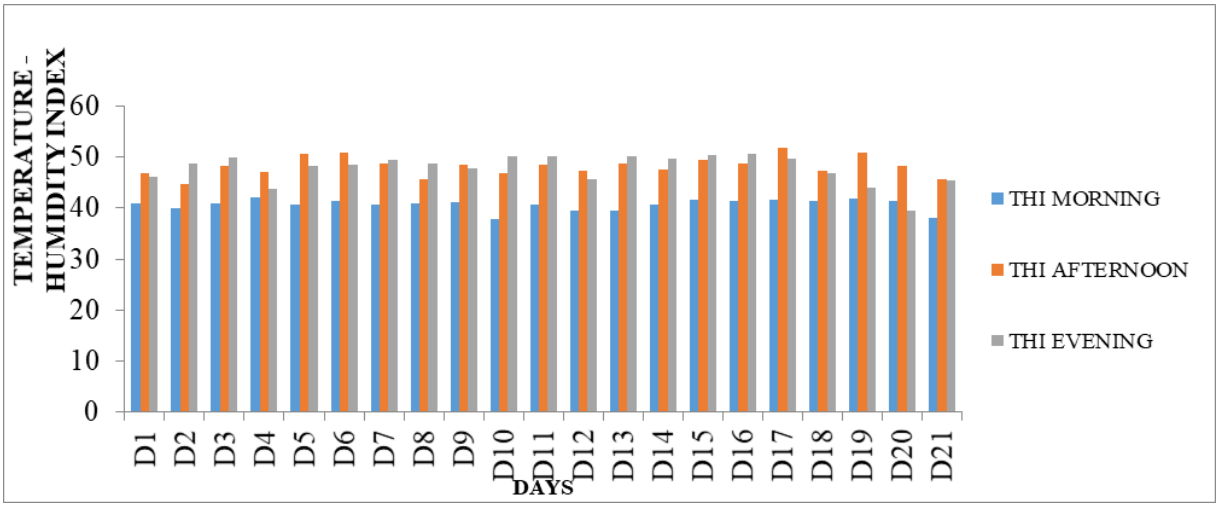
<27.8 = absence of heat stress;
27.8 – 28.9 = moderate heat stress;
29.0 – 30.0 = severe heat stress; and
> 30.0 = very severe heat stress

Data was analysed using General Linear Model of SAS (11) and means were separated using Tukey-Kramer Mean Separation Technique.

Results and Discussion

The main effect of sex on the thermoregulatory response of geese during high temperature – humidity index is shown in Table 1. The **v**alues obtained for the respiratory rate and rectal temperature correspond with the findings of Isidahomen (8) who reported a range of 22 breaths/ minutes respiratory rate for frizzled feathered native chicken and 40.09 – 41.27 ^{o}C rectal temperature in three genotypes of the Nigerian indigenous chickens. There were significant differences ($p<0.05$) in the respiratory rate, rectal temperature and pulse rate among sexes. Females had significantly higher ($p<0.05$) respiratory rate and pulse rate than the males. This could be due to hormonal differences and possibly the egg laying processes the female birds witnessed as compared to their male counterparts since the experiment was carried out during their laying season. However, males had significantly ($p<0.05$) higher rectal temperature than females. 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 (12) reported body weight wise variation in clinically normal birds. The panting rate was not significantly ($p>0.05$) different between the two sexes. This sexual difference was in accordance with the findings of Uzma *et al*. (13) and Sayed and Scott (14).

The main effect of the period on the thermoregulatory response of geese during high Temperature – humidity index is shown in Table 2. The rectal temperature in the morning was significantly ($p< 0.05$) lower than that of the afternoon and evening. This could be due to the significantly ($p<0.05$) lower environmental temperature observed in the morning. Altan *et al*. (15) noted from his study that high ambient temperature and relative humidity increases heat stress and are responsible for the increase in rectal or body temperature of animals. Zahoor *et al*. (16) also observed lower rectal temperature in birds exposed to cooler temperature. Also, their pulse rate in the morning was significantly ($p< 0.05$) higher than that of the afternoon while that of the afternoon was also significantly ($p< 0.05$) higher than in the evening. Reduced environmental temperature and higher humidity may induce increased pulse rate as the heart may have to work harder during the coolest period of the day, mostly in the morning to keep the body warm, thereby increasing pulse rate.



THI = Temperature humidity index, D = Day

Figure 1: Temperature-humidity index of the experimental pen

Table 1: Main effect of sex on the thermoregulatory response of geese during high temperature – humidity index

SEX	RR (breaths/minute)	RT (^{o}C)	PUR (beats/minute)	PR (breaths/minute)	TEMP (^{o}C)	HUM (%)	THI
F	23.65 ± 1.97[a]	0.42±0.15[b]	166.70±11.88[a]	154.94 ± 27.15	32.09±4.59	60.38±18.18	45.67±0.00
M	22.55 ± 1.97[b]	0.57 ±0.30[a]	162.08±16.79[b]	157.59 ± 38.82	32.09±4.59	60.38±18.18	45.67±0.00

[a,b] Means in the same columns with different superscripts are significantly different ($p< 0.05$). RR= Respiratory rate, RT = Rectal temperature, PUR = Pulse rate, PR = Panting rate, Temp = Temperature, HUM = Humidity, THI = Temperature – humidity index, M = Male, F= Female

Table 2: Main effect of period on the thermoregulatory response of geese during high temperature – humidity index

Period of the day	RR (breaths/Min)	RT (^{0}c)	PUR (beats/Min)	PR (breaths/Min)	TEMP (^{0}c)	HUM (%)	THI
Morning	22.51±1.20	40.36±0.22[b]	175.63±5.42[a]	158.85±34.68	26.59±0.00[b]	40.69±0.00[c]	85.65±0.00[a]
Afternoon	23.58±2.23	40.62±0.23[a]	168.56±7.82[b]	154.99±17.79	34.16±0.00[a]	48.25±0.00[a]	46.05±0.00[b]
Evening	23.21±2.38	40.50±0.24[a]	149.54±13.58[c]	147.44±77.58	34.39±3.20[a]	47.84±9.68[b]	46.05±0.00[b]

[a,b,c] Means in the same column with different superscripts are significantly different($p< 0.05$). RR = Respiratory rate, RT = Rectal temperature, PUR = Pulse rate, PR = Panting rate, Temp = Temperature, HUM = Humidity, THI = Temperature – humidity index, Min = minute.

Conclusion and Application

1. The values obtained for the male and female geese thermoregulatory response were similar to those of other avian species.
2. Sex and daytime influenced the thermo-regulatory response of the geese independently.
3. There is an indication that the birds were physiologically normal and were able to maintain homeostasis during the period of high temperature humidity index since their thermoregulatory response values recorded were within the normal range reported for avian specie.

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