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Impact of varying temperature-humidity index on the thermo-physiological, libidinal and seminal characteristics of male rabbits raised in the wet humid tropics

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***Target Audience:** Animal physiologists, animal scientists and rabbit farmers*

Abstract

The study was conducted to investigate the effect of the wet seasonal Temperature - Humidity Index (THI) at period of high ambient temperature (11am - 2pm) on the thermophysiology, libido and seminal parameters of a composite population of male rabbits. Thirty- three rabbit bucks housed separately in cages were monitored for 8 weeks in the wet season under varying THI. Weekly average of THI (27.61 - 30.36) observed was significantly different ($p<0.05$) and showed that the animals were either severely stressed or very severely stressed. Respiratory rate (142.07 - 328.42 cpm) and rectal temperature (38.58 - 39.73°C) of the bucks were progressively on the rise all through the experiment. Mount and ejaculatory latencies of the animals were significantly shorter ($p<0.05$) at period of high THI compared to lower THI contrary to the number of mounts which was higher at period of high THI. Semen parameters of the bucks were not negatively affected by the prevalent THI during the study. However, percentage semen morphological abnormality (15.82% - 17.71%) was significantly higher ($p<0.05$) at relatively high THI. The results of the study showed that rabbit bucks maintained their normal libidinal and seminal characteristics despite being raised under heat stress of varying intensity.

***Key words:** Heat stress; Libido; Temperature - Humidity Index; Thermophysiology*

Description of Problem

The knowledge of climatic factors and their impact on animal welfare is important to livestock production. Among these factors, air temperature and relative - humidity are of utmost importance especially in the tropics. High ambient temperature and humidity particularly in the wet season is common in the tropics and both induce heat stress which hinder animal wellbeing and militate against animal productivity (1). In order to cope with these environmental stressors, animals regulate their body temperature and make physiological adjustments which include panting and increased rectal temperature (2). However, when animals are exposed to protracted extreme weather conditions, their coping mechanisms tend to fail leading to disturbances in energy metabolism, haematology, enzymatic reactions, hormonal secretions and mineral utilisation (3). Rabbits are more prone to heat stress because their thick fur and largely non-functional sweet glands impairs heat loss (4). Hence, in the wet humid tropic, where high humidity often accompanies high temperature, heat stress is easily facilitated in the rabbit.

Thus, when the animal attempt to

maintain thermal homeostasis especially when the weather is harsh, its body function particularly reproductive performance is disrupted (5).

Therefore, the animal requires a thermo-neutral zone to function properly (6). A thermo - neutral zone is the range of ambient temperatures in which the animals require minimal energetic expenses, which do not compromise body reserves to maintain a constant body temperature (2). Since mitigating heat stress improves animal health, welfare, and production efficiency, thermal comfort indices such as temperature-humidity index (THI) have been developed to assess the impact of the thermal environment on thermoregulatory status of animals (7). Temperature-humidity index (THI) is a single value that depicts the combined effects of air temperature and humidity associated with the level of heat stress (6). THI are species dependent and have been developed for the rabbit as well as other livestock (4).

In order to alleviate the effect of extreme weather conditions which may be exacerbated by climate change, on rabbit productivity, the intricacies of climatic factors and their impact on rabbit welfare and reproduction needs further elucidation.

Therefore, the objectives of this study was to monitor weekly variation of the temperature - humidity index (THI) at the hot hours of the day, when ambient temperature would be high, in the immediate environment of the experimental animals. In addition, thermophysiological, libidinal and seminal responses of the animals to the prevailing THI were evaluated.

Materials and methods

Thirty- three growing rabbit bucks aged between 10 – 12 months with an average body weight of 1kg were studied. The bucks were raised in the Rabbitary Unit of the Teaching and Research Farm, Obafemi Awolowo University, Ile – Ife, Nigeria where the experiment was conducted. The bucks were individually housed in metal cages of the dimension 35cm x 42cm x 54cm.

Forages and rabbit grower ration (feed at 10% body weight) were fed to the animals. Water was provided *ad libitum*. The experiment was conducted for 8 weeks in the wet months of June and July.

The ambient temperature and relative humidity was monitored between 11.00 am to 2.00 pm daily by means of a thermo-hygrometer for the entire duration of the experiment. The daily average of the recorded temperature and relative – humidity values for the period of the study were used to compute THI of the animals using the equation of Marai *et al.* (4):

$THI = t - [(0.31 - 0.31 \times RH)(t - 14.4)]$ where RH = relative humidity, t = temperature THI values observed during the experiment were classified according 4 thus:

<27.8 = absence of heat stress, 27.8–28.9 = moderate heat stress, 28.9–30 = severe heat stress and above 30 = very severe heat stress (4).

Collection of data

A digital thermometer was inserted into the rectum of each of the 33 rabbit bucks twice a week at two days interval for 8 weeks for 1 minute to determine their rectal temperature (RT). The thermometer was read after it emitted a beeping sound and the value was recorded in degree Celsius.

The respiratory rate (RR) of the bucks was determined by counting the flank movement of the animals for 1 minute twice weekly at two days interval simultaneously with the RT. RR was expressed as count/minute (cpm). Evaluation of libidinal parameters was modified from the procedures described by (8).

Libidinal parameters were assessed at two days interval twice in a week for the duration of the experiment between 11am and 1pm. A teaser doe was placed together with a buck in the buck's cage. The time (seconds) interval between the introduction of the doe and the first mount by the buck was determined using a stopwatch and recorded as mount latency (ML). Number of mount (NMT) was determined by counting the number of mounts a buck made on the doe within a period of 3 minutes of pairing. Mating was prevented by repeatedly pulling the buck off the doe. For ejaculatory latency (EL), a doe with a disposable artificial vaginal (AV) (9) was introduced to the buck.

The time (seconds) between the introduction of the doe with AV and ejaculation into the AV by the buck was determined by a stopwatch. Semen parameters which include semen volume (SVL), sperm motility, viability, concentration and abnormality (SM, SV, SCN and SAB) were determined according to the procedures of I.R.R.G. (10) and (11).

Experimental model and statistical analysis

The experimental model below was used to evaluate the animals' responses in the study:

$Y_{ij} = \mu + A_i + E_{ij}$

Y_{ij} = response variables; μ = population mean; A_i = effect of weekly THI; E_{ij} = residual error

The means of the data were computed and analyzed using Multivariate Analysis of Variance of the General Linear Model. Probability value of 5% was considered statistically significant after separation by Duncan Multiple Range Test. Treatment means of parameters were thereafter represented by line charts. SPSS version 21 software was used for statistical analysis.

Results

Air temperature (AT), Relative-humidity (RH) and Temperature -Humidity Index (THI) differed significantly (p<0.05) among the weeks during the study. Apart from the 1st and 2nd week when the AT was below 30°C, it was above 30°C throughout the period of the experiment with a peak of 32.40°C in the 6th week. RH ranged between 62.79% in the 4th week and 66.77% in the 1st week. Similar to AT in the last three weeks of the study, RH fluctuated during the last four weeks of the study.

THI ranged between 27.61 and 30.36 and was consistently on the rise throughout the duration of the study with the exception of the 7th and 8th weeks when it became low and statistically similar to the value observed in the 5th week.

Table 1: Air temperature, Relative-humidity and Temperature -Humidity index during the experiment

	WEEK OF STUDY									
	1	2	3	4	5	6	7	8	SM	SEM
AT(°C)	29.14^a	29.58^a	30.16^b	30.81^c	31.03^c	32.40^e	31.58^d	31.08^{cd}	30.72	0.19
RH (%)	66.77^b	67.39^b	63.30^a	62.79^a	66.06^b	63.48^a	63.12^a	63.24^a	64.52	0.78
THI	27.61^a	28.03^b	28.36^b	28.91^c	29.26^{cd}	30.36^e	29.61^d	29.17^c	28.92	0.15

^{abcd}Means across the rows are significantly different. AT=Air temperature; RH=Relative-humidity; THI=Temperature-Humidity index; SM=Seasonal mean

Respiratory rate (RR) and rectal temperature (RT) (Fig. 1) differed significantly (p<0.05) among the weeks and increased progressevily throughout the duration of the study. From the beginning of the study till the end, RR (142.07 - 328.42cpm) and RT (38.58 - 39.73°C) increased by 186.35cpm and 1.15°C respectively.

Figures 2 and 3 depict the libidinal parameters of the experimental animals. Mount latency (ML), ejaculatory latency (EL) and number of mounts (NMT) varied significantly ($p<0.05$) among the weeks. ML rose significantly ($p<0.05$) from 6.73s in the 1st week to 18.02s in the 3rd week and was regular until it fell back to similar values observed in the beginning of the study. EL was significantly higher ($p<0.05$) in the 1st and 2nd week (>8.09s) of the experiment compared to the remaining period of the study (<4.10s). NMT (Figure 3) unlike ML and EL was significantly lower (<9.50c/m) in the 1st and 2nd week compared to higher values (13.73 - 26.58cpm) in the middle and the end of the study.

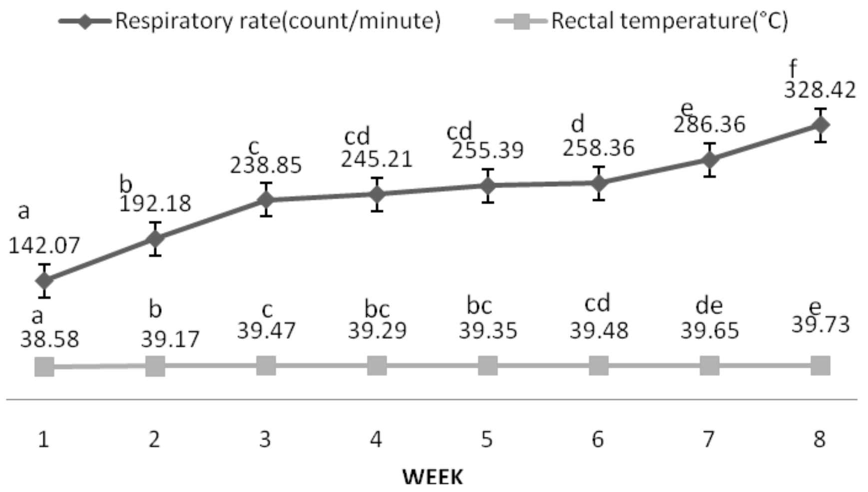

Figure 1: Thermophysiological response of experimental male rabbit.

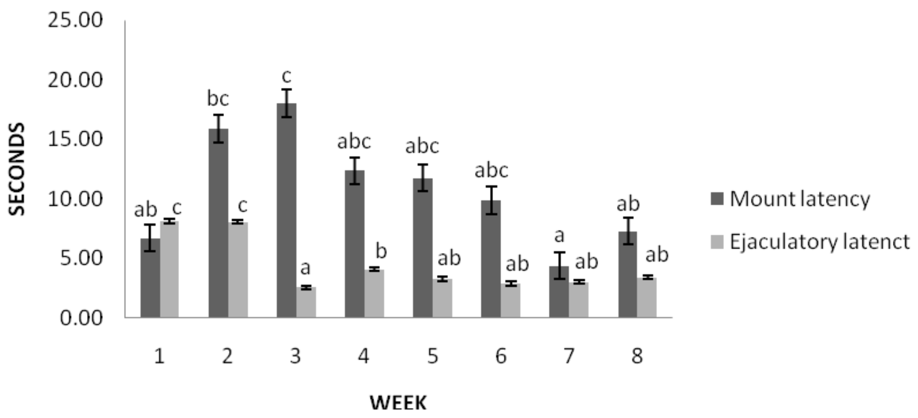

Figure 2: Mount latency and ejaculatory latency of experimental male rabbit.

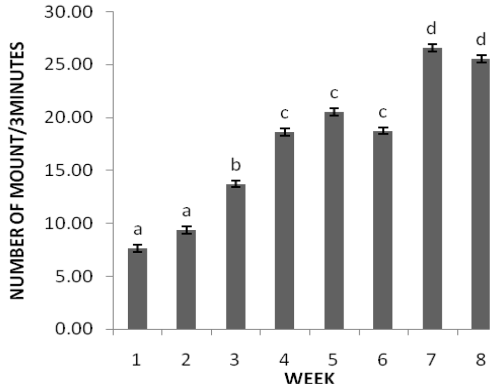

Figure 3: Number of mounts of experimental male rabbits.

Semen volume (Fig. 4) was significantly lower in the 1st and 2nd weeks (<0.55ml) in comparison to subsequent weeks when it was more than 0.60ml while it peaked in the 6th week at 0.77ml.

Sperm concentration (Fig. 5) rose from 139 x 10^6 in the 1st week to 270 x 10^6 the highest value of the study in the 3rd week which was significantly different ($p<0.05$) from the statistically similar values recorded throughout the duration of the study. Sperm motility (73.97 - 97.09 %) and viability (76.97 - 97.04%) (Fig. 6) were both high throughout the study. However, while sperm motility was significantly ($p<0.05$) lower in the 1st week compared to subsequent weeks, sperm viability were statistically similar for the entire period of the study with the exception of the 1st week when it was significantly lower ($p<0.05$) to the values observed in the 7th and 8th week. The percentage of abnormal sperm (6.91 - 10.42%) (Fig. 7) was statistically similar within the first 2 weeks of the study. However, from the 3rd week, abnormal sperm cells were significantly higher ($p<0.05$) peaking at 17.71% in the 7th week.

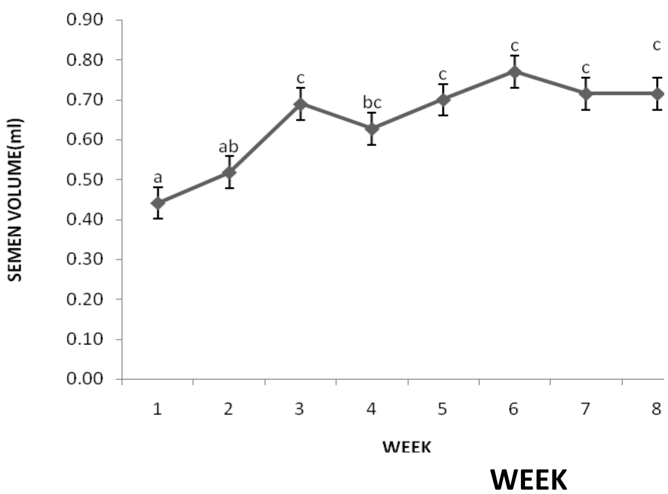

Figure 4: Semen volume of experimental male rabbits.

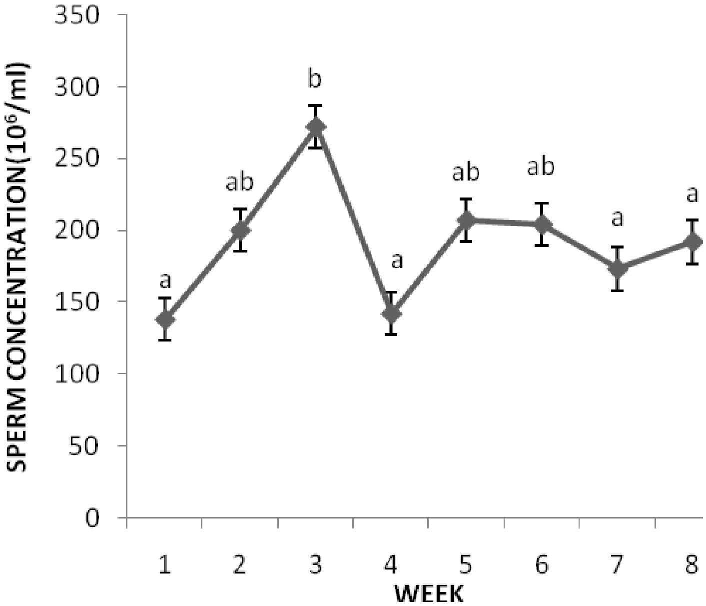

Figure 5: Sperm concentration of experimental male rabbits.

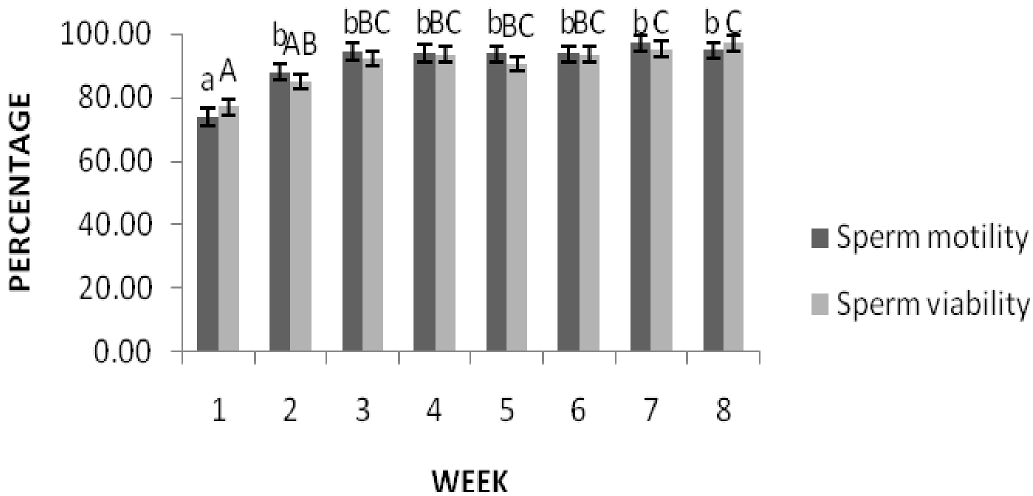

Figure 6: Sperm motility and sperm viability of experimental male rabbits.

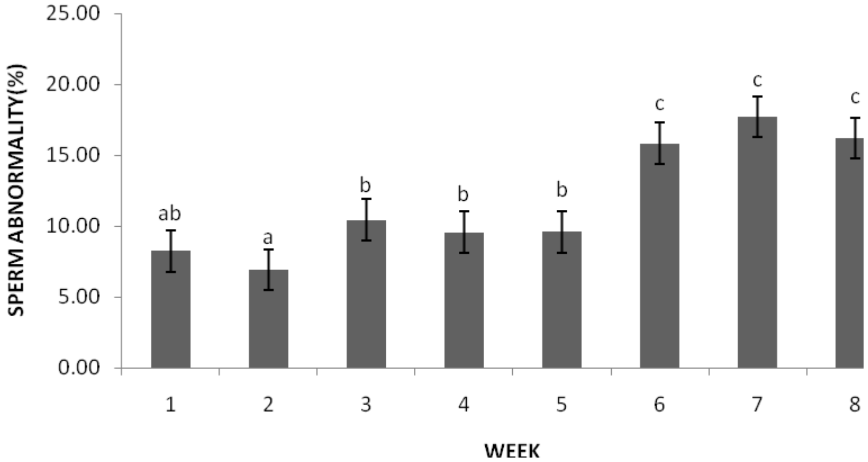

Figure 7: Sperm abnormality of experimental male rabbits.

Discussion

The trend of air temperature (AT) and relative - humidity (RH) was similar to the report of (12) in an earlier research carried out in the same area of study in the wet season. In addition, the fluctuations in AT and RH were within the ranges that are characteristic of the tropics (13). For the first four weeks of the study, the Temperature - Humidity Index (THI) observed indicated that the rabbits were only moderately stressed (4). In subsequent weeks, the animals were under severe stress except for the 6th week when they were very severely stressed. However the resultant effect of the varying THI on the animals during the study was severe heat stress since the mean seasonal THI was 28.92. This result was similar to the observations of (14) for late wet season while it differed with the conclusions of that study for the rest of the year. However, the mean THI monitored in this study was higher than the mean THI reported by (15) in the same season. The dissimilar results of these studies might be due to differing air temperature, humidity and the amount of rainfall in the different period and locations where the studies took place.

Respiratory rate (RR) and rectal temperature (RT) of the male rabbits increased progresively throughout the duration of the study due to the prevalent severe heat stress similar to the conclusions of (16).

In addition, the range of RT (38.58°C - 39.73°C) and RR (142.07 c/m - 328.42 c/m) of the studied animals were higher than 37.29°C - 38.08°C and 208.57c/m - 226.73c/m observed by (15) for RT and RR respectively. This mignt be alluded to the the lower THI observed by (15) (25.05 - 27.66) compared to the prevalent THI (27.61 - 30.36) during this study. This implied that as the core (rectal) temperature of the animals increased due to the prevalent severe heat stress, the animals compensated through increased panting to lose heat to the environment in order to attain thermal homoestasis. However, while the average RT of the experimental animals was higher than the results of (14) it was lower than the reports of (17) although both observed prevalent severe heat stress during their studies. The different results may be due to the diverse breed of rabbits studied which inherent thermoregulatory mechanism may vary in their capabilities in achieveing heat loss under similar THI.

Contrary to expectation, mount latency and ejaculatory latency were shorter while number of mounts were more under high THI compared to lower THI. This implies that libido of the animals in this study was not impacted negatively by severe and very severe heat stress contrary to the conclusions of (18) and (19). The experimental animals might be able to maintain their libido despite the rising air temperature due to their efficient thermoregulatory system shown by increased RR commensurate to rise in RT.

This study revealed that the increasinly progressive THI during most of the wet season did not impact adversly on seminal parameters of the animals in variance to the conclusions of (19) and (20). The only exception was sperm abnormality that was impacted negatively more in the last three weeks of the study which was a period of significantly high THI in agreement to the report of (4). Nonetheless, sperm abnormality observed in this study might not affect the fertility of the rabbit bucks as the value was within the normal benchmark for rabbits (21). Generally, our findings was similar to the report of (22) and (23) and different from the conclusions of (4). In mammals including the rabbit, dissipation of heat is concurrent with rise in rectal temperature and heightened respiratory rate (2). The non lethal effect of significantly progressive THI on the seminal output of the animals during this study might be due to their efficient thermoregulatory system shown by the corresponding rise in respiratory rate to heightened rectal temperaure.

Conclusion and Applications

The results of the study showed that:

1. Growing composite population of male rabbits attempted to loss body heat to the environment under prevalent heat stress as evident in the simultaneous and corresponding increase in both respiratory and rectal temperature.
2. The rabbits were able to maintain their usual libidinal and seminal characteristics despite being raised under heat stress of varying intensity.
3. Raising a composite population of rabbit is recommended under the wet humid tropic because of its inherent capacity to thrive under the attendant adverse condition.

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