Trop. Anim. Prod. Invest. 19 (1): 41-47 (2016)
ISSN: 1115-2540
http://animalsci.agric.ui.edu.ng/TAPI/index.php/tapijournal/index
ORIGINAL RESEARCH ARTICLE

Thermoregulatory Response of Exotic Rabbit Breeds During Peak Temperature – Humidity Index of Ibadan

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ABSTRACT
An experiment was conducted to assess thermoregulatory responses of four exotic breeds of rabbit between February and March (when highest Temperature - humidity index is observed). The breeds included Fauve De Bourgogne (FDB), Chinchilla (CHA), British Spot (BS) and New Zealand White (NZW) rabbits. 10 bucks and 7 Doe per breed housed individually were used for this study. Temperature - humidity index (THI) of the rabbitry microclimate at 08:00h and 14.00h were measured, thermoregulatory indices of rabbit; Respiratory Rate (RR), Heart Rate (HR), Rectal Temperature (RT) and Ear Temperature (ET) were assessed at 08.00 to 10.00h and 16.00h to 18.00h daily for eight weeks. Data were analyzed using ANOVA at $\alpha_{0.05}$. The results obtained showed that the average daily THI obtained in February and March was 29.94 and 28.59, respectively. The average daily RR and HR in Chinchilla and British spot rabbits were significantly ($p<0.05$) higher than in New Zealand white rabbits. Daily ear and rectal temperatures of British spot and New Zealand white rabbits were statistically similar ($p>0.05$) and significantly ($p<0.05$) lower than Chinchilla. It is evident from this study that, British Spot breed of rabbit had the most effective thermoregulatory activities, while New Zealand white had the least susceptibility to heat stress, during highest THI in Ibadan.

Keywords: Thermoregulation; Exotic rabbits; heat stress; Temperature-humidity

INTRODUCTION

Thermoregulation is the means by which animal maintains its body temperature. It involves a balance between heat gain and heat loss. Increased ambient temperature may lead to enhanced heat gain as compared to heat loss from the body and may cause heat stress in animals (Kumar *et al.,* 2011). Rabbit generally use body position, breathing rate and peripheral temperature, especially ear temperature, as core devices to modify heat loss. However, respiration and the ear are the most important dissipation pathways (Shafie *et al*., 1982; Marai *et al*., 2002). Animal is considered to be stressed when it has to alter its physiology and behaviour to adapt to adverse environmental and management conditions. This adaptation involves a series of neuro-endocrinological, physiological, and behavioural responses which act to equilibrate animal functions (Ilori *et al.*, 2012). The maintenance of body temperature within physiological limits is necessary for the animal to remain healthy, survive, and maintain its productivity and longevity (Marai *et al.* 2007). In general, chronic exposure to extremes of heat leads to decomposition of normal physiological and biological mechanisms with a consequent damage of many organs (El-Sobhy, 2000). Thermoregulation in rabbits is rather poor as they have few functional sweet glands (Naqvi *et al.,* 1995).

In rabbits, cooling occurs through nasal mucosa (by air passing over mucous membranes). The ears are also important for cooling as the blood moves to the farthest (coolest) points away from the body core. The rabbit will also stretch its body out as far as possible to cool through radiation/convection. However, due to presence of few functional sweat glands, rabbits lose small amount of moisture through the skin by perspiration (Marai *et al.*, 2001). The rabbit's fur further inhibits the process of evaporation by rabbit for body cooling.. Respiration becomes the main pathway for loss of the latent heat, since most sweat glands in rabbits are not functional and perspiration is not great due to the presence of fur (Marai and Habeeb, 1994 and Marai *et al.*, 2001). The ear plays an important role in thermoregulation of rabbits, since its function is like a radiator. When the ambient temperature is above 25-30^{0}C, the heat load on rabbits increases and the animals stretch and extend their ears to lose as much heat as possible by radiation and convection (Lebas *et al.*, 1986). The increase in rectal temperature of the heat-stressed rabbits may be due to failure of the physiological mechanisms of the animals to balance the excessive heat load caused by exposure to high ambient temperature (Habeeb *et al.,* 1992 and 1998). Skin temperature is directly affected by body temperature and it increases in hot conditions compared to mild conditions, due to the insulation effect of the coat. There is genetic variation among animals for cooling capability, which suggests that more heat tolerant animals can be selected genetically. Four exotic breeds of rabbit: Chinchilla, Fauve de Bourgogne, British spot and New Zealand white, introduced to Ibadan, Nigeria create opportunity for comparative thermoregulatory assessment of these breeds to determine their level of susceptibility or otherwise to the prevailing heat stress in Ibadan.

MATERIALS AND METHODS

This study was carried out in February and March, 2014. Severity of heat stress based on the combination of temperature and humidity (Temperature - Humidity Index) at University of Ibadan, showed that peak heat stress is observed in February and March. 10 bucks and 7 does per breed of similar physiological age and state within sexes, were selected from the rabbitry of the Teaching and Research Farm, University of Ibadan were used for this study. The animals were housed individually in wooden in hutches of 2m^2. Temperature and relative humidity of the rabbitry microclimate was recorded at 08:00 h and 16.00 h daily during the study period using a Thermo-Hygrometer. Daily records of the ambient temperature and relative humidity (RH) were used to compute the temperature humidity index.

Thermoregulatory Assessment

Thermoregulatory indices of rabbit measured include Respiratory Rate (RR), Heart Rate (HR), Rectal Temperature (RT) and Ear Temperature (ET). Measurements were taken at 08.00 to 10.00h and 16.00h to 18.00h of the day. Rectal and Ear Temperatures were measured with a digital thermometer. The ear temperature was taken by placing the digital thermometer in direct contact with the central area of the auricle. The RR was measured visually by counting the flank movement for one minute, while HR was measured using a stethoscope. The temperature-humidity index (THI), an indicator of thermal comfort level for animals in an enclosure was calculated according to Marai *et al*. (2001) and given as:

$$THI = t - [(0.31 – 0.31 \times RH) (t – 14.4)]$$

Where RH = relative humidity /100. t = ambient temperature.

The values of THI obtained for the temperate and tropical region are classified as:

<27.8 ºC = absence of heat stress,
27.8 - 28.9 ºC = moderate heat stress,
28.9 – 30 ºC = severe heat stress and
above 30 ºC = very severe heat stress (Marai *et al*., 2001).

Data analysis

Data obtained were subjected to descriptive statistics and ANOVA of SAS 1999 to detect significant effects at p=0.05. Significant mean differences were separated with Duncan multiple range test.

RESULTS

Temperature - humidity index of rabbit pen during the highest temperature - humidity index of Ibadan is presented in Figure 1. In the morning, THI ranged from 24.86 in February to 26.51 in March. In the evening, THI values obtained in February and March were 35.02 and 30.66, respectively. The average daily THI obtained in February and March were 29.94 and 28.59, respectively.

Thermoregulatory response of exotic breeds of rabbit during the highest THI of Ibadan is shown in Table 1. In the morning, respiratory rate of British Spot rabbits was significantly ($p<0.05$) higher than that of New Zealand White and Fauve de Bourgogne, while respiratory rate of Fauve de Bourgogne rabbits was not significantly ($p>0.05$) different from that of Chinchilla and New Zealand White rabbits. Heart rate of British Spot rabbits was significantly ($p<0.05$) higher than New Zealand White and Fauve de Bourgogne.

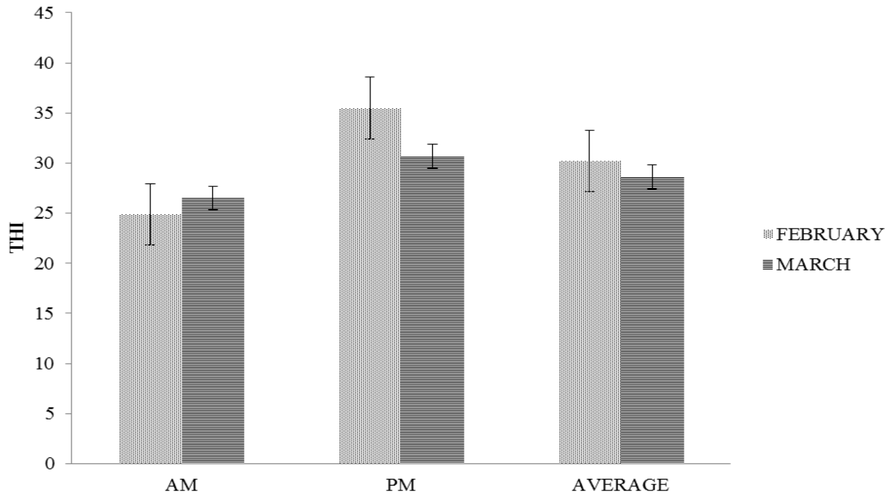

Figure 1: Temperature Humidity Index of Rabbit Pen during High THI of Ibadan

Fauve de Bourgogne rabbits had significantly ($p<0.05$) lower heart rate than chinchilla and British Spot rabbits. The ear temperature of Chinchilla rabbits was significantly ($p<0.05$) higher than that of British Spot rabbits. The rectal temperature of Chinchilla rabbits was significantly ($p<0.05$) higher than that of British Spot and New Zealand White rabbits in the morning. In the afternoon, Fauve de Bourgogne, Chinchilla and British Spot rabbits had similar respiratory rates but were significantly ($p<0.05$) higher than New Zealand White rabbits. Heart rate of Fauve de Bourgogne was not significantly ($p>0.05$) different from other breeds, while that of New Zealand White rabbits was significantly ($p<0.05$) lower than Chinchilla and British Spot rabbits. The ear temperature of Fauve de Bourgogne, British Spot and New Zealand White rabbits was not significantly ($p>0.05$) different from one another but were lower ($p<0.05$) than that of Chinchilla rabbits. Rectal temperature of Fauve de Bourgogne and Chinchilla rabbits were statistically similar but were significantly ($p<0.05$) higher than British Spot and New Zealand White rabbits that had similar rectal temperature. Both in the morning and afternoon, British Spot rabbits had significantly ($p<0.05$) higher respiratory and heart rates but lower rectal temperature compared to other breeds during the highest THI in Ibadan.

Average daily respiratory and pulse rates of four exotic breeds of rabbit during the highest THI are presented in Figure 2. Fauve de Bourgogne, Chinchilla, British Spot and New Zealand White rabbits recorded respiratory rates of 260, 266.91, 266.52 and 250.05 beats per minute, respectively. The pulse rates were 243.41 bpm in Fauve de Bourgogne, 252.82 bpm in Chinchilla, 254.63 bpm in British Spot and 242.85 bpm in New Zealand White rabbits.

The ear and rectal temperature of four exotic breeds of rabbits during highest THI of Ibadan is shown in Figure 3. The ear temperatures of the rabbit breeds were 35.52^0C in Fauve de Bourgogne, 35.91^0C in Chinchilla, 35.55^0C in British Spot and 35.52^0C in New Zealand White rabbits. The rectal temperatures of Fauve de Bourgogne, Chinchilla, British Spot and New Zealand White rabbits were 37.78^0C, 37.99^0C, 37.45^0c and 37.36^0C respectively.

DISCUSSION

Temperature humidity index is an indicator of thermal comfort level for animals in enclosure. It has been reported that exposure to heat stress brings about response by animals to maintain homeostasis. The THI values of 29.94 and 28.59 ºC obtained in February and March, respectively indicate that rabbits were exposed to severe heat stress in February and moderate heat stress in March during the study period. However, diurnal changes significantly affect the severity of heat stress in the study period. The THI values of between 24.82 (morning) and 30.50 ºC (evening) in February and between 26.51 (morning) and 30.66 ºC (evening) in March, indicate that rabbits were not exposed to heat stress in the morning but to very severe heat stress (more than 30.00ºC) in the evening. The result obtained in this study is similar to Akinsola (2012) who reported THI in rabbitry averaged 28.7 ºC during the hot period of the year in Northern Nigeria.

Table 1: Thermoregulatory Response of Exotic Breeds of Rabbit during High THI

Period	Parameters	Fauve de Bourgogne	Chinchilla	British Spot	New Zealand White
AM	Respiratory Rate (bpm)	222.84±4.90[bc]	232.25±5.44[ab]	233.02±5.36[a]	215.94±4.80[c]
	Heart Rate (bpm)	226.16±3.61[c]	242.51±4.00[ab]	247.31±3.95[a]	237.98±3.53[bc]
	Ear Temp. (°C)	34.29±0.11[ab]	34.51±0.12[a]	34.09±0.12[b]	34.27±0.11[ab]
	Rectal Temp (°C)	37.07±0.82[ab]	37.2±0.09[a]	36.98±0.09[bc]	36.70±0.08[c]
PM	Respiratory Rate (bpm)	311.70±3.51[a]	314.25±3.84[a]	313.84±3.87[a]	296.85±3.45[b]
	Heart Rate (bpm)	263.78±3.55[ab]	267.47±3.88[a]	268.33±3.91[a]	256.14±3.49[b]
	Ear Temp (°C)	37.39±0.12[b]	37.75±0.13[a]	37.38±0.13[b]	37.04±0.12[b]
	Rectal Temp (°C)	38.85±0.31[a]	39.00±0.34[a]	37.83±0.34[b]	37.89±0.31[b]

abc: means in the same row with different superscripts are significantly ($P<0.05$) different. Where bpm - breaths per minute, Temp-Temperature

Marai *et al*. (2005) reported a THI value of 28.8ºC for hot period in the subtropical climate of Egypt. The THI obtained in this work is similar to the findings of Marai *et al*., (2005) and Akinsola (2012) of exposure of rabbits to moderate heat stress in the hot period. However, higher THI (34.38) than the findings of this study was reported by Attia *et al*. (2012) in summer of Egypt. Similar THI was earlier obtained by Marai *et al.* (2002). The disparity between the report of this work and that obtained in Egypt could be due to time of measurement of THI, THI was estimated at 8.00h and 16.00h in this study while those of reports in Egypt were carried out at 12.00hr. British Spot rabbit recorded higher respiratory and pulse rate with a concomitant lower core body temperature. This shows effectiveness of the breed's thermoregulatory activities to bring about thermal balance. The effectiveness of the British Spot thermoregulatory apparatus is more pronounced at highest THI because the breed was able to effectively lower its core body temperature to values lower than that reported by Jimoh (2015) at the least THI. However, New Zealand White rabbits had a low core body temperature without a necessary increase in its thermoregulatory apparatus. This suggests that the breed is less susceptible to stress, this could be linked to its white fur colour (white) which absorbs less heat from the environment. Fauve de Bourgogne and Chinchilla rabbits, despite having a higher respiratory and pulse rates and ear temperature than New Zealand White, did not have a lower body temperature.

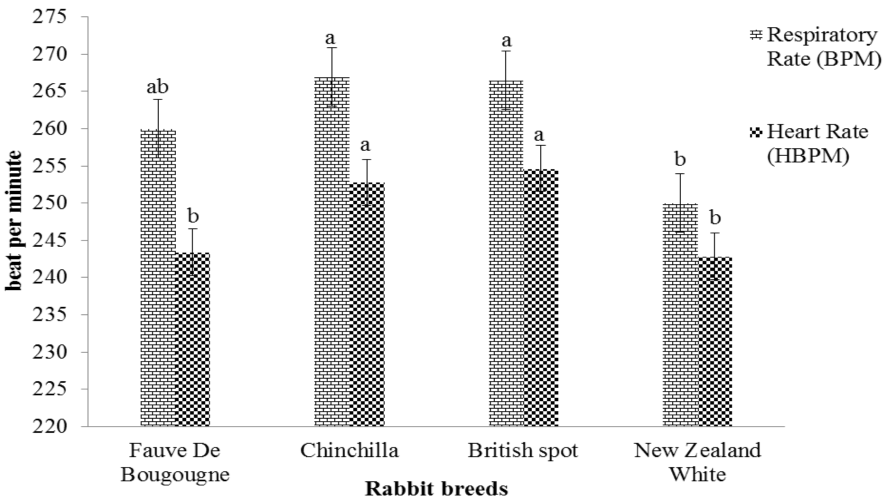

Figure 2: Average Daily respiratory and heart rates of four exotic breeds of rabbit during high THI of Ibadan

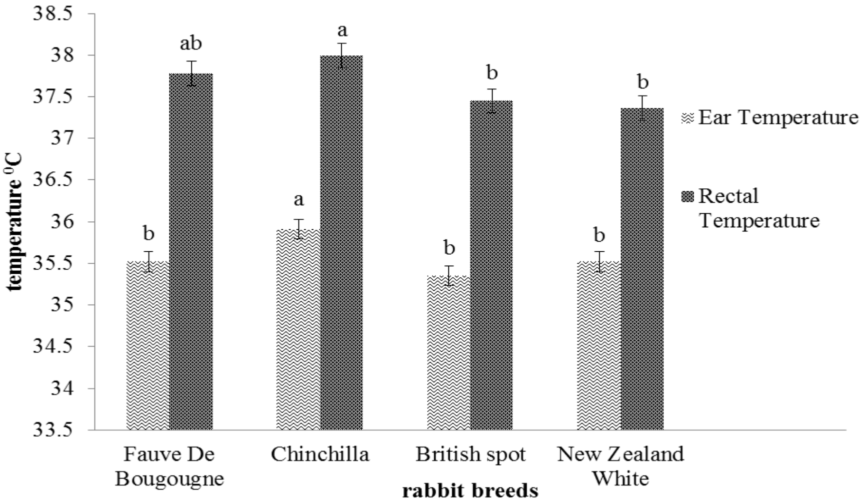

Figure 3: The Ear and Rectal Temperature of four exotic breeds of rabbit during High THI of Ibadan

The values of ear temperature and rectal temperature observed in this study were lower than values recorded by Marai *et al*. (2007) in does (38.3 and 40.1^{0}C ear temperature and rectal temperature, respectively) at THI of 30.1. The results obtained in this study are in line with the increase in thermoregulatory parameters (respiration and temperatures of ear, rectum and skin) due to exposure of New Zealand white rabbits to severe heat stress reported by Marai *et al.* (2007) and were similar to those reported by Rich and Alliston (1970), Shafie *et al.* (1982) and Marai *et al.* (2001). Farghly (2011) reported apparent heat stress in rabbits during the hot period due to failure of thermoregulatory mechanism. This probably suggests that Fauve de Bourgogne and Chinchilla would observe apparent influence of heat stress because of the failure of their thermoregulatory activities to effectively lower heat load.

The result of thermoregulatory response obtained in this study is in line with Akinsola (2012) who observed higher respiratory rate for both grandparent and F_1 progeny Hyla rabbits than the established 35-50. It is, however, contrary to the lower HR values reported by Akinsola (2012) than the range of 130 – 260 beats/min for domestic rabbits (Willmer *et al.* 2000). The values of HR obtained in this study were similar to that of Willman *et al.* (2000). The values of ear temperature obtained in this study are not in agreement with the normal range of Ear Temperature 24 - 30 ºC for domestic rabbits (Willmer *et al*., 2000). However, lower rectal temperature were obtained in this study compared to Rectal Temperature and values 38.6 – 39.5 ºC for domestic rabbits (Willmer *et al*., 2000), except rectal temperature of Fauve de Bourgogne and Chinchilla rabbits in the afternoon, which are within the range. The range of respiratory rate obtained in this study is within the range of values reported for stressed rabbit (40-300) and heart rates of 180-300 hbpm. The result obtained in this work is at variance with values reported by Marai *et al.* (2005) that respiration rate of 134 r.p.m for imported rabbits was observed under the hot conditions of Egypt . This suggests better thermoregulatory activities in the exotic breed of rabbits under investigation in this study.

CONCLUSION

The increase in rectal temperature of the heat-stressed rabbits may be due to failure of the physiological mechanisms of the animals to balance the excessive heat load caused by exposure to high ambient temperature. It was revealed that chinchilla rabbits which had a higher rectal temperature at peak heat stress experiences failure in its thermoregulatory activities to effectively lower its heat load. It is evident in this study that, British Spot breed of rabbit has the most effective thermoregulatory activities during the highest THI in Ibadan because of its inherent ability to effectively lower core body temperature in hot period compared to Fauve de Bourgogne and Chinchilla. New Zealand white Rabbits had the least susceptibility to thermal discomfort.

Conflict of Interest

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

Acknowledgement

The authors are grateful to the management and staff of the Rabbitry unit, Teaching and Research Farm, University of Ibadan, for their assistance in providing animals and housing for this work.

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