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Thermo physiological traits of Californian, New Zealand white, Havana black and Palomino brown rabbits raised in Humid Tropics

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Abstract

This experiment was conducted to investigate the thermo physiological traits of Californian, New Zealand white, Havana black and Palomino brown rabbits raised in humid tropics. A total number of ninety-six rabbits were used. Rectal temperature, respiratory rate, pulse rate and heat stress index were measured in these temperate breeds during rainy and dry season. Data obtained from the thermo physiological parameters was analyzed using SAS 2010. The analysis of variance showed that the breed of rabbit had a significant effect ($P< 0.05$) on all the thermo physiological parameters studied. Havana black rabbit had the highest mean rectal temperature value (39.32 ± 0.03°C) followed by Palomino brown (38.97 ± 0.03°C), while the least value was recorded for New Zealand white (38.68 ± 0.02). Respiratory rate values followed the same pattern with that of rectal temperature with higher respiratory rate values recorded for Havana rabbits. The pulse rate values ranged from 163.23 ± 0.47 to 184.35 ± 0.78 beats/min. The highest pulse rate value was recorded for Havana black. The lowest heat stress index was obtained for New Zealand white followed by California and Palomino Brown while Havana black rabbit had the highest value. The respiratory rate was significantly lower among males as compared to their female counterparts (63.09 ± 0.58 versus 69.54 ± 1.65breaths per minute). The age of the rabbit also significantly affected ($P< 0.05$) the rectal temperature, respiratory rate, pulse rate and heat stress index. 12 weeks old rabbit had the highest mean values while 4 weeks old rabbit had the least values. The heat stress index value obtained during dry season was higher ($P< 0.05$) than that obtained for rainy season (1.93± 0.02versus 1.80 ± 0.01). Havana black rabbits and Palomino brown were more prone to heat stress than California and New Zealand white rabbits in tropical environment.
Key words: breed, rabbit, heat tolerance, humid tropics

1. Introduction

Rabbit production under tropical conditions is affected by environmental stress mainly from the effect of high ambient temperatures and high humidity, low wind speed and indirect solar radiation. Excessive temperature and humidity induces physiological stress in rabbits (Marai et al 2002).The impact of heat stress on rabbit has been reported by various authors. Lebas (1986) noted that high temperature affects spermatogenesis, reducing the volume and concentration of ejaculates and also affect sperm motility. Ondruska et al (2011) reported that total and daily feed intake, feed conversion ratio, and total and daily gain in body weight for growing rabbits were affected negatively by elevated temperature. Mortality rate as well as haematological and biochemical parameters were also negatively affected by elevated temperatures. In the same vein, Marai and Rashwan (2004) reported that exposure to high ambient temperature induces rabbit doe to produce less number of litters and reduces its reproductive efficiency.

In a thermally stressful environment in which heat production of the animal exceeds heat loss, an increasing amount of heat is stored in the animal body. This results in increased body temperature. Besides rectal temperature, respiratory rate and pulse rate are the major thermo physiological traits indicating heat stress in animals (Butswat *et al.* 2000, Fadare et al. 2012). An animal loses heat by conduction, convention, radiation and evaporation of sweat (Silanikove, 2000). Heat lost by the skin is dependent partly on the temperature gradient between skin, air and solid objects. Non evaporative heat loss declines as ambient temperature rise, making the animal more dependent upon peripheral vasodilation and water evaporation to enhance heat loss).

Heat adaptability is a complex character that depends on the integrity of various systems such as the respiratory, circulatory, excretory, nervous, endocrine systems. The co-ordination of all these system under thermal stress is different not only between species but also between breeds and even between individuals within breeds (Fadare et al, 2012). Some animals may combat heat most efficiently through depressing their energy metabolism to a greater extent than other animals. Other animals may attain the same goal by efficient evaporative or non-evaporative coaling system.

Remedial measures can be successful only when proper evaluation of stress level is possible (Smitha et al 2011). This study is therefore carried out to investigate the heat stress of Californian, New zealand white, Havana black and palomino brown which are all temperate breed when raised in a humid tropical environment.

2. Materials and Method

2.1 Experimental site

The experiment was carried out at the rabbitry unit of the Department of Environmental Biology and Fisheries, Adekunle Ajasin University Akungba-Akoko, Ondo state. Akungba–Akoko is located in Akoko South West Local Government Area of Ondo state, Nigeria. The area lies in the south western region of Nigeria (7º 28ˈ and 5º43ˈ) and has the following environmental condition: ambient temperature of 27^0C and relative humidity of 46mm Hg.

2.2 Experimental animals and management

Ninety-six (96) rabbits which include California white, Palomino brown, New Zealand white and Havana black. Palomino brown rabbits are golden brown and lynx, they are large meaty rabbits. Californian white rabbits are rounded in body and have short smooth coat they are first bred in the 1920's with the intent of creating a better commercial meat rabbit, as a result of crosses between the Himalayan, and the standard Chinchilla. New Zealand white are multipurpose breed because they can be raised for meat, pets and laboratory purpose.

The experimental animals were kept in a wooden cage with each compartment of dimension of lenght× width× height: 80× 50 ×30 cm^3. The cages were constructed of wood and a wire mesh. The hutch was constructed in a way that it allow there waste to drop on the floor easily and has a single roof which covers all cages from rain or sunlight. They were fed with commercial pelleted diet; the diet used contained 15% Crude protein, 7% fat, 10% Crude fibre, 1.0% Calcium, together with available phosphorus of 0.35% and 2550Kcal/kg metabolisable energy. They were also supplied with forages. Clean water was also supplied to the rabbits ad-libitum.

2.3 Data Collection

2.3.1 Rectal temperature

This was taken on each animal using a digital thermometer. The sensory tip was disinfected and inserted into the rectum at the display of L ^oC by the thermometer. This was removed after the sound of the alarm signal. The displayed body temperature was then recorded.

2.3.2 Respiratory rate

This was determined by counting the number of flank movements per minute

2.3.3 Pulse rate

This was determined for each animal by placing the fingertips on the femoral arteries of the hind limb for one minute.

2.3.4 Heat stress index (HIS)

HIS was derived from the relationship between pulse rate and respiratory rate together with their normal average values. The formula is as follows

$$H = (AR/AP) * (NP/NR)$$

H= Heat stress index

AR= Average respiratory rate value

AP= Average pulse rate value

NP = Normal pulse rate value

NR = Normal respiratory rate value. (Oladimeji *et al*., 1996).

The measurements were taken during rainy and dry season.

2.4 Statistical Analysis

Data obtained from the thermo physiological parameters was analyzed using SAS 2007. The linear model is as specified below:

$Y_{ijkl} = \mu + A_i + B_j + P_k + (AB)_{ij} + (AP)_{ik} + (BP)_{jk} + e_{ijkl}$

Y_{ijk} = the parameter of interest

μ = overall mean for the parameter of interest

A_i = fixed effect of ith breed (I = 1-4)

S_j = fixed effect of jth sex (j = 1-2)

P_{k} = fixed effect of kth season (k =1-2)

M_l = fixed effect of lth age (l= 1-3)

$(AS)_{ij}$ = Interaction effect of ith breed and jth sex

$(AP)_{ik}$ = Interaction effect of ith breed and kth season

$(AM)_{il}$ = Interaction effect of ith breed and lth age

$(SP)_{jk}$ = Interaction effect of jth sex and kth season

e_{ijk} = random error associated with each record (normally, independently and identically distributed with zero mean and variance σ^2e).

3. Results and Discussion

Breed of rabbit had a significant effect (P< 0.05) on all the thermophysiological parameters studied as shown on Table 1. Havana black rabbit had the highest mean rectal temperature value (39.32 ± 0.03°C) followed by Palomino brown (38.97 ± 0.03°C) , while the least value was recorded for New Zealand white (38.68 ± 0.02) as shown on Table 2. The high rectal temperature observed for Havana black breed could be a result of the absorption of solar radiation by the dark pigmentation. The light pigmentation of New Zealand white reflects more and absorbs less solar radiation into the body. Rectal temperature increases when physiological mechanisms of body are non productive to counteract the unnecessary heat load (Saddiqi et al. 2011). As cited by Lukefahr and Ruiz-Feria (2004), Baladi white rabbits were more thermo-tolerant than Baladi Black rabbits. These results on light pigmentation agreed with Hansen (2004) that light-coloured and sleek and shiny hair coats reflect a greater pulse proportion of incident solar radiation than dark hair coats. Da Silva et al. (2003) also found that animals with light-coloured hair coats have higher reflectance values than animals with dark-coloured coats. Silanikove (2000) and Keim et al. (2002) reported that the best physiological parameter to objectively monitor animal welfare in hot environment is the rectal temperature. When the physiological mechanism of an animal fails to negate the excessive heat load, rectal temperature increases. Such exposure of animal to heat stress evokes a series of drastic changes in the biological functions, which include a decrease in feed intake, disturbances in water, protein, energy and mineral balances, enzymatic reactions, hormonal secretions and blood metabolism (Marai et al. 2007; Gwatibaya et al. 2007).

Respiratory rate values followed the same pattern with that of rectal temperature with higher respiratory rate values recorded for Havana black rabbits (Table 2). Exposure to high ambient temperature induces rabbits to balance heat load with the environment by using different means to dissipate their latent heat as much as possible. The animals panted in order to increase body cooling by respiratory evaporation since the major evaporatory heat loss mechanism is panting. The pulse rate values ranged from 163.23 ± 0.47 to 184.35 ± 0.78 beats/min. The highest pulse rate value was recorded for Havana black. Heat stress index is commonly used as an indicator of thermal comfort (Kendall and Webster 2009). The index ranged from 1.46 ± 0.01 to1.46 ± 0.01. Havana black rabbit also had the highest estimated value followed by Palomino Brown and California while New Zealand white had the least value.

Sex of rabbit significantly affected the physiological parameters studied (P< 0.05). The rectal temperature for females (39.21 ± 0.02°C) was significantly higher than that observed among males (38.99 ± 0.01°C). The respiratory rate was significantly lower among males as compared to their female counterparts (63.09 ± 0.58 versus 69.54 ± 1.65breaths per minute). Female rabbits equally had the higher beats per minute for pulse rate, while the males had the lower mean value. Marai and Rashwan 2004 observed that does are more susceptible to heat stress than their male counterparts. Sejian et al. (2010) also reported increase in rectal temperature and respiratory rate as a result of heat stress in female sheep, while Stockman (2006) submitted that high respiratory rate is a good indicator of the onset of thermal stress in ewes. Heat stress index was also higher in female rabbits than male rabbits .

The age of the rabbit also significantly affected (P< 0.05) the rectal temperature, respiratory rate, pulse rate and heat stress index. 12 weeks old rabbit had the highest mean values while 4 weeks old rabbit had the least values. Young animals have lower metabolic heat load and are more thermo tolerant than older animals. As shown on Table 3, the rectal temperature and heat stress index increased with age. Dzenda et al. (2011) reported a positive and significant relationship between rectal temperature and heat stress index in African giant rats

Season also significantly (P< 0.05) affected the parameters studied. The mean rectal temperature recorded during the rainy season was significantly lower than the value recorded for the dry season (38.89 ± 0.03°C versus 39.53 ± 0.02°C). Lower mean value of 59.09 ± 0.88 breaths per minute was observed during rainy season, while higher value of 65.94 ± 0.65 breaths per minute of respiratory rate was recorded in dry season. The mean value of pulse rate for rainy season (175.48 ± 2.19 beats per minute) was significantly lower than that for the dry season (188.52 ± 2.46 beats per minute). The heat stress index value obtained during dry season was higher (P< 0.05) than that obtained for rainy season (1.93± 0.02versus 1.80 ± 0.01). The lower rectal temperature, respiratory rate, pulse rate and heat stress index in the wet season might be a result of lower ambient temperature associated with rainy season. The hot climatic condition imposed stress on the rabbits. Rabbits are very sensitive to high temperatures since they have few functional sweat glands limiting their ability in eliminating excess body heat. Higher rectal temperature observed in the late dry season might be due to high ambient temperature and relative humidity associated with this season which could exceed the comfort zone of the animals, resulting in imbalance in the heat energy produced and dissipated. The present study also agreed with the report of Alhidary et al. (2012) and Lallo et al. (2011) where exposure to high ambient temperature resulted in increased rectal temperature and respiratory rate. Shinde et al. (2002) recorded higher respiratory rate, heart rate and rectal temperature in monsoon and summer than in winter for goats on the semi-arid range in India. In a related study on African giant rats, Dzenda et al. (2011) reported that rectal temperature was higher in the hot dry and harmattan seasons than the wet seasons. The interaction effects were not significant on any of the parameter studied.

4. Conclusion and Applications

1. Havana black rabbits and Palomino brown were more prone to heat stress than California and New Zealand white rabbits in the tropical environment.
2. Male rabbits can withstand hot climatic condition better than female rabbit.
3. Heat burden was high on the animals during the dry season than rainy season.
4. Younger rabbits are more thermo tolerant than older rabbits.
5. Special cooling system should be provided for Havana black and Palomino brown rabbits especially during the dry season.

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Table 1: Analysis of variance table for physiological parameters and heat stress index

Source of variation	Degree of freedom	Rectal temp(^oC)	Respiratory rate(breaths/min)	Pulse rate (beats/min)	Heat stress Index
Breed	3	12.59***	17552.23***	6943.78***	0.085***
Sex	1	10.57**	10040.58***	7004.52***	0.005*
Age	2				
Season	1	66.17***	126340.23***	51151.74***	0.013**
Breed x Sex	4	0.56^{ns}	149.64^{ns}	316.30^{ns}	0.0004^{ns}
Breed x Age	4	0.28^{ns}	215.49^{ns}	489.60^{ns}	0.0007^{ns}
Breed X Season	4	0.45^{ns}	123.25^{ns}	363.21^{ns}	0.0003^{ns}
Age x Sex	2	1.66^{ns}	227.61^{ns}	335.96^{ns}	0.0003^{ns}
Season x Sex	1	0.05^{ns}	153.07^{ns}	470.12^{ns}	0.000001^{ns}
Error	2866	0.37	469.94	231.54	0.00008

Table 2: Least square means for physiological parameters as influenced by breed and sex

	Rectal temp(^{o}C)	Respiratory rate(breaths/min)	Pulse rate (beats/min)	Heat stress Index
Breed				
Havana Black	39.32 ± 0.03^{a}	69.09 ± 1.05^{a}	184.35 ± 3.78^{a}	1.95 ± 0.01^{a}
New Zealand white	38.68 ± 0.02^{c}	57.31 ± 0.65^{c}	163.23 ± 1.47^{d}	1.46 ± 0.01^{d}
California	38.65 ± 0.02^{c}	56.82 ± 0.84^{c}	176.09 ± 2.58^{c}	1.65 ± 0.01^{c}
Palomino Brown	38.97 ± 0.03^{b}	62.58 ± 1.08^{b}	172.41 ± 1.68^{b}	1.84 ± 0.01^{b}
Sex				
Female	39.21 ± 0.02^{a}	69.54 ± 1.65^{a}	187.92 ± 1.46^{a}	1.93 ± 0.02^{a}
Male	38.99 ± 0.01^{b}	63.09 ± 0.58^{b}	174.67 ± 2.89^{b}	1.80 ± 0.01^{b}

Means in the same column with the different superscripts are significantly different (P<0.05) for breed and sex

Table 3: Least square means for physiological parameters as influenced by age and season

	Rectal temp(^{o}C)	Respiratory rate(breaths/min)	Pulse rate (beats/min)	Heat stress Index
Age				
4 weeks	38.65 ± 0.02^{c}	69.09 ± 1.05^{a}	184.35 ± 4.78^{a}	1.70 ± 0.01^{c}
8 weeks	38.68 ± 0.02^{b}	58.31 ± 0.65^{c}	163.23 ± 2.47^{c}	1.78 ± 0.01^{b}
12 weeks	39.32 ± 0.03^{a}	57.82 ± 0.84^{c}	176.09 ± 3.58^{b}	1.85 ± 0.01^{a}
Season				
Dry season	39.53 ± 0.02^{a}	65.94 ± 0.65^{a}	188.52 ± 2.46^{a}	1.93 ± 0.02^{a}
Rainy season	38.89 ± 0.03^{b}	59.09 ± 0.88^{b}	175.48 ± 2.19^{b}	1.81 ± 0.19^{b}

Means in the same column with the different superscripts are significantly different (P<0.05) for age and season