

EFFECT OF VITAMIN C, E AND SELENIUM SUPPLEMENTATIONS ON GUINEA PIGS (*Cavia porcellus*) THERMOREGULATORY INDICES DURING HOT SEASON OF NORTHERN GUINEA SAVANNA ZONE, NIGERIA

**¹Gaddafi, S., ¹Garba, M.G., ¹Sabo, M. N ²Abdulrashid, M., ²Zahraddeen D., ²Daudou, O.M.,
³Bichi, J.M. and ⁴Salihu, D.Y.**

¹Department of Animal Science, Federal University Dutsin-ma, Nigeria,

²Department of Animal Science, Ahmadu Bello University Zaria, Nigeria,

³Department of Animal Science, Bayaro University Kano

⁴Federal Collage of Animal Health and Production Technology, Vom, Jos, Nigeria.

*corresponding author: sanigaddafi4@gmail.com: GSM: +234(0)7067212353

ABSTRACT

The study was carried out to evaluate the role of vitamin C, E and dietary selenium supplements on thermoregulatory indices of Guinea pigs (*Cavia porcellus*) during hot weather condition of northern guinea savanna zone of Nigeria. A total of 60 adult male guinea pigs of three months of age with an average body weight of 500±20g were randomly allocated into three dietary treatment groups of vitamin C, E and Selenium and each comprised four varying levels with five animals per group in a completely randomized design (CRD). Feed and water was provided *ad-libitum*. The meteorological observation during this study indicated hyperthermy in the month of June with THI average of 31.264 while month of May and July THI values indicated that the guinea pigs were raised in a thermal comfort zone. The thermoregulatory indices evaluated in this study revealed that guinea pigs supplemented with vitamin E and Selenium had a significantly ($P<0.05$) difference on rectal temperature ($^{\circ}\text{C}$) with the range of 35.067-37.067 $^{\circ}\text{C}$ and 36.367 to 37.067 $^{\circ}\text{C}$ for vitamin E and Selenium respectively. Significant ($P<0.05$) difference of pulse rate (177.667-208.000 bpm) was observed in guinea pigs supplemented varying levels of vitamin E while guinea pigs supplemented varying levels of vitamin C had a normalized ($P>0.05$) values of respiratory rate (brpm), rectal temperature ($^{\circ}\text{C}$) and pulse rate (bpm). It could be concluded that supplementation of vitamin E had a positive impact on thermoregulatory indices of adult male guinea pigs raised under hot season of Northern guinea savannah zone, Nigeria.

Key Words: Guinea Pigs, Thermoregulatory, Vitamin C, E and Selenium

INTRODUCTION

The guinea pig is well recognized worldwide for its contributions to science as an experimental or laboratory animal. It is a particularly valuable animal for nutritional research because of its unusually high requirement for certain vitamins and amino acids. They are also used extensively in research laboratories to study medicine, physiology and hereditary (Gaddafi *et al.*, 2019).

The sum of external forces acting on an animal that causes an increase in body temperature and evokes a physiological response is known as heat stress (Dickmen and Hensen, 2009). The problem of heat stress is associated with high air temperatures in conjunction with high relative humidity in the animals' environment (Hill and Wall, 2005). In adverse thermal conditions the animal can dissipate body heat mainly through increased respiration rate, panting, drinking, sweating and reduced feed intake and milk yield. Behavioural coping strategies include increased standing time, shade seeking and decreased activity and movement (Schutz, *et al.*, 2003). Therefore this study was carried out to evaluate the effect of vitamin C, E and Selenium supplementation on adult male guinea pigs reared under hot season condition of Northern Guinea savannah zone, Nigeria.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the teaching and research farm of the Department of Animal Science Ahmadu Bello University, Samaru, Zaria. The farm is located on latitude 11° 9' 45''N and 7° 38' 8'' E at an altitude of 610m above sea level (Ovimap, 2015). Zaria town is part of Northern Guinea Savannah between latitudes 11° and 12°N and between longitude 7° and 8° E at an altitude of 640m above sea level. The climate of the area is sub-humid; rainfall is well distributed during the rainy season, with a mean annual rainfall of 1100mm. the rainy season starts from late April or early mid-October and about 70% of the rain occurs during the months of July and August, followed by the harmattan period of cool and dry weather which usually lasts from October to February. This is then followed by hot-dry weather from March to April, known as pre-rain period. The average ambient temperature and relative humidity during the wet season are 24.7°C and 72% respectively. This is followed by the hot weather when temperatures fluctuate during day from 13 to 36°C with a mean relative humidity of 20-37% (IAR, 2016)

Experimental animals and design

A total of 60 male breeder guinea pigs of three (3) months of age with an average body weight of 500g ± 20g were randomly allocated into three dietary treatment groups of vitamin C, E and Selenium and each comprised four varying levels with five guinea pigs in a completely randomized design (CRD). Feed and water was provided *ad-libitum*.

Experimental diet and management

The diet was formulated to meet the dietary recommendation for guinea pig under tropical condition (NRC, 1995). Twelve different diets were formulated comprising four levels of vitamin C (0mg, 100mg, 200mg and 300mg of AA/kg of diet), vitamin E (0mg, 15mg, 30mg and 45mg/kg) and selenium (0mg, 0.1mg, 0.2mg and 0.3mg/kg).

Table 1: Composition of Experimental Diet (%)

Ingredients (%)	Percentage (%)
Maize	12
SBM	10
GNC	5
G/nut haulm	6
Bracharia	10
Bone meal	1.0
Maize bran	25
Wheat offal	30
Premix	0.25
Salt	0.25
Lysine	0.25
Methionine	0.25
Total	100
Cal. Analysis	
MEKcal/kg	3000
CP (%)	16.50
Fat (%)	5.00
CF (%)	12.50
NFE (%)	48.50
Ash	5.00

Table 2: proximate composition of experimental diet

Composition	%
Metabolizable energy (Kcal/kg)	2734.46
CP	16.57
Fat	4.97
CF	10.57
NFE	58.23
Ash	3.81

Meteorological observations

The ambient temperature and relative humidity of the internal and external environment of the experimental site were recorded in the morning and evening daily and was measured with the aid of digital thermometer and hygrometer (*Kadio RGM®765*) throughout the experimental period. The mean of ambient temperature (Ta) and relative (RH) was recorded during the experimental period. The temperature-humidity index (THI) was computed using the equation described by Marai *et al.*, (2005).

$$THI = T - [(0.31 - 0.31(RH/100))(T - 14.4)]$$

Where,

THI= Temperature-humidity index

T= Dry bulb temperature (°C)

RH= Relative Humidity (%)

THI values will be graded as; 27.8= absence of heat stress; 27.8-28.9=Moderate heat stress; 29.0-30.0= Severe heat stress and 30.0 and above= very severe heat stress levels respectively (Marai, 2005).

Thermoregulatory parameters recorded

Rectal temperature (RT), Respiratory rate (RR) and Pulse rate (PR) was measured early in the morning between 7:00am to 8:00am before sunrise from three (3) guinea pigs each treatment.

Rectal temperature (RT)

The sensory tip of a digital thermometer (*ultramed Mode: GF-MT502®*) was inserted 0.5cm depth into the rectum of guinea pigs at the display of L°C by a thermometer (which was indicated that the thermometer is set for temperature reading). Each guinea pig was restrained gently and calmly and the reading lasted until the thermometer beeped.

Pulse rate (PR)

This was measured using a stethoscope (*Pil pyrochy Dual Head stethoscope®*) and stop watch (*Kadio® Model KD-1069*). The stethoscope were placed on the left region of the thoracic vertebrae of the guinea pig and a stop watch was used to count the number of hearts contractions (rhythms) in one minute.

Respiratory rate (RR)

The respiratory rate was determined while the guinea pig is resting by visually counting the flank movements for one minute using a stop watch (*Kadio® Model KD-1069*).

Statistical Analysis

The data collected from this experiment was subjected to analysis of variance (ANOVA), using the General Linear Model Procedure of SAS (SAS, 2002). The significant differences among the treatment means were separated using the Duncan's Multiple Range Test in the SAS Package.

RESULT**Meteorological Observation**

Meteorological data recorded during study period of three months were presented in table 3. The meteorological data was indicated that there are severe heat stress on second month that is June while May and July THI values obtained from this study shows that there are absences of heat stress which indicate clearly that the guinea pigs are raised on a thermal comfort zone

Table 3: Meteorological observation during experimental period

Months	Temp. (°C)	RH (%)	THI
May	36.5	56	22.364
June	33.2	67	31.264
July	29.7	71	28.323

Table 4: Role of Vitamin C, E and Selenium on Thermoregulatory Indices of Adult Male Guinea Pigs

Parameters	RR (brpm)	RT (°C)	PR (bpm)
Vitamin C			
0mg/kg	107.000	37.333	211.33
100mg/kg	89.667	33.233	186.67
200mg/kg	96.667	36.300	169.00
300mg/kg	93.333	35.433	192.33
SEM	2.929	0.769	6.47
LOS	NS	NS	NS
Vitamin E			
0mg/kg	101.333	37.300 ^a	208.000 ^a
15mg/kg	97.333	36.567 ^a	198.000 ^{ab}
30mg/kg	97.333	35.500 ^b	196.000 ^{ab}
45mg/kg	89.000	35.067 ^b	177.667 ^b
SEM	0.223	0.004	0.049
LOS	NS	**	*
Selenium			
0mg/kg	99.333	37.067	213.000
0.1mg/kg	91.333	37.133	205.667
0.2mg/kg	99.333	36.900	198.000
0.3mg/kg	94.000	36.367	198.667
SEM	3.135	0.105	2.435
LOS	NS	*	NS

^{abc}Mean with different superscripts within columns differed significantly, * significant at P<0.05, NS- Not significant, SEM- Standard error of mean, RR- Respiratory rate, brpm- breath per minute, RT- Rectal temperature, PR- Pulse rate, bpm- beat per minute.

Table 4 shows effect of vitamin C, E and selenium on thermoregulatory indices of adult male Guinea pigs. Respiratory rate (RR) is similar (P>0.05) for all Guinea pigs fed diets supplemented with varying levels of vitamin C, E and Selenium. Rectal Temperature (RT) and Pulse Rate (PR) is similar (P>0.05) in Guinea pigs fed diets supplemented with varying levels of vitamin C and selenium while vitamin E was exceptional (P<0.05). RT values of 37.300 and 36.567°C was higher (P<0.05) in Guinea pigs fed diets supplemented with 0 and 15 mg vitamin E/kg diet respectively. PR values of 208.000 and 198.000 bpm was also higher (P<0.05) in Guinea pigs supplemented with 0 and 15 mg vitamin E/kg diet respectively.

DISCUSSION

No significant difference was observed for respiratory rate, rectal temperature and pulse rate. Still the numerical variation exist for guinea pigs respiratory rate, rectal temperature and pulse rate although the value obtained falls within the normal range of 42-104breaths/minutes, 35.2-39.5°C and 165-380 beats/minutes for RR, RT and PR respectively. The normality of the above parameters indicate that vitamin C play important role in ameliorating guinea pigs thermoregulatory parameters by directly altering the thermal set point thereby decreasing prostaglandin output which has a direct effect on hypothalamic-thermoregulatory zone (Ganong, 2001), since it is generally recognized that environmental factors may cause stress and might alter animals thermoregulatory indices, resistance to diseases or affect metabolism (Amici, *et al.*, 2000).

A significant difference in rectal temperature and pulse rate of adult male guinea pigs fed diets supplemented with vitamin E, while respiratory rate shows non-significant difference. Rectal temperature tends to decrease with increasing dosage of vitamin E. Similar decrease in rectal temperature by vitamin E and C supplementation was reported in goats (Shivkumar and Varshney, 2003) and pigs (Shenglin *et al.*, 2003) under heat stressed conditions.

Vitamin E decreased rectal temperature by directly altering the thermal set point by decreasing prostaglandin output, especially of prostaglandin E series, whose turnover increases during stress which has a direct effect on the hypothalamic thermoregulatory zone (Ganong, 2001). Therefore, these vitamins may have an ameliorating effect on the prostaglandin output.

The significantly high pulse rate of guinea pigs supplemented with vitamin E during this study could be linked to hot dry season of the study period and this agrees with Ganaie *et al.* (2013) who reported that pulse rate increases when environmental temperature increase and reduces as the environmental temperature decreased. Similarly, numerical differences exist for respiratory rate in the hot temperature during this experiment could be linked to high ambient temperature and low ambient relative humidity which induces heat stress, this agrees with Ganaie *et al.* (2013) who reported that respiratory rate increases when ambient temperature increased.

A non-significant increase in respiratory rate and pulse rate of adult male guinea pigs supplemented with varying dosage of dietary selenium was recorded. While a significant decrease in rectal temperature was observed with increased dosage of dietary selenium. This implies that dietary selenium play a vital role in ameliorating rectal temperature of guinea pigs since, dietary selenium seems to have enormous potential with a positive impact on thermoregulation and reproduction in animal production. Hence there is need for further investigation for that since guinea pigs are homeotherms and employ both their somatomotor nervous system (e.g behavioral thermogenesis, shivering thermogenesis) and the sympathetic portion of their autonomic nervous system (e.g non-shivering thermogenesis, changes in vasomotor tone) as thermoregulatory effectors to maintain a stable core temperature (Fewell *et al.*, 1997).

CONCLUSION

It could be concluded that supplementation of vitamin E had a positive impact on thermoregulatory indices of adult male guinea pigs raised under hot season of Northern guinea savannah zone, Nigeria.

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