



## SCIENCE RESEARCH ANNALS (BIOLOGICAL SCIENCES)

Published by Faculty of Science, Adekunle Ajasin University, Akungba-Akoko (AAUA)

Journal website: <https://sra.com.ng/index.php/sra-biological>



### Research Article

<https://doi.org/10.63112/m20kpc97>

# Effect of Orange-Fleshed Sweet Potato Vine and *Calopogonium mucunoides* on Weight Gain, Thermophysiological, Reproductive and Antioxidant Responses of Rabbit Bucks (*Oryctolagus cuniculus*)

Babatunde H. Ajao<sup>1\*</sup>, G. G. Babaniyi<sup>2</sup>, Kudirat O. Hameed<sup>3</sup>, Afolabi T. Yusuff<sup>1</sup>, Wasiu A. Olaniyi<sup>4</sup>, Kehinde M. Okukpe<sup>1</sup>, & Oluwasayo I. Alli<sup>1</sup>

<sup>1</sup>Department of Animal Production, University of Ilorin, P.M.B.1515, Ilorin, Kwara State, Nigeria.

<sup>2</sup>Department of Agricultural Development and Management, Agricultural and Rural Management Training Institute, P.M.B. 1343, Ilorin, Nigeria.

<sup>3</sup>Agriculture and Natural Resources Department, Ilorin West Local Government Secretariat, P.M.B. 1348, Warrah, Ilorin, Nigeria.

<sup>4</sup>Department of Animal Science, Adekunle Ajasin University, PMB 001, Akungba-Akoko, Ondo State, 342111, Nigeria.

\*Correspondence: Babatunde H. Ajao / [ajao.bh@unilorin.edu.ng](mailto:ajao.bh@unilorin.edu.ng)

### ARTICLE INFORMATION

#### Keywords:

Temperature-humidity index  
Semen  
Antioxidant  
Respiratory-rate  
Rectal temperature

Handling Editor: T.A. Ajayi

**Disclaimer:** All opinions expressed are solely the authors, and do not necessarily represent that of the Journal's Editorial Board, Management, or workers.

**License:** SRA, AAUA, Nigeria.

### ABSTRACT

This study was carried out to investigate the effect of feeding orange-fleshed sweet potato vine (PV) and *Calopogonium mucunoides* (CM) on growth performance, reproductive and antioxidant responses of rabbit buck, *Oryctolagus cuniculus*. Twenty-four rabbit bucks (6 - 8 months old) with average weight of 1.25 kg were allocated to 4 experimental diets comprising of only concentrate (Control), CM, PV and a combination of PV and CM (PVCVM). The ambient temperature (AT), relative humidity (RH) were monitored to determine temperature - humidity index (THI) of the derived Savannah zone of Nigeria. Data on weight, reaction time (RTM), respiratory - rate (RR) and rectal temperature (RT) were obtained. Also, data on semen samples for sperm: motility, liveability, abnormality, concentration and semen volume were evaluated. Parameters on haematology, peripheral levels of testosterone, cortisol, catalase, sodium dismutase and glutathione peroxidase of the bucks were determined. Results of the experiment showed that THI was significantly higher ( $p < 0.05$ ) in the afternoon compared to the morning. RR in animals fed the control (192.83CPM) and CM (192.67CPM) increased significantly ( $p < 0.05$ ) in the afternoon which is contrary to those allotted to PV and PVCVM. RT regardless of the period was not significantly different ( $p > 0.05$ ) among the bucks. Weight gain was significantly lower ( $p < 0.05$ ) in animals fed CM and PVCVM. RTM was significantly longer ( $p < 0.05$ ) in animal allotted to PVCVM compared to other groups. Bucks fed PV had significantly higher sperm's volume, motility and liveability and lowest in abnormality ( $p < 0.05$ ). Glutathione peroxidase and catalase were not significantly affected by experimental treatments while sodium dismutase was highest ( $p < 0.05$ ) in animals fed CM. Testosterone was significantly higher in animals fed with PV while the highest level of cortisol was observed in those fed CM ( $p < 0.05$ ). In conclusion, there was no heat stress during the study; also PV and CM had no lethal effect on rabbit bucks' welfare, performance, semen and antioxidant parameters. Hence both orange-fleshed sweet potato vine and *C. mucunoides* can safely replace or fed along concentrates to rabbit bucks without any negative effects.

### Highlights

- Potato vine improves sperm motility and liveability in rabbit bucks.
- No heat stress was recorded based on temperature-humidity index findings.
- *Calopogonium mucunoides* raised superoxide dismutase levels without harming rabbits.

## 1. Introduction

Environmental factors which include ambient temperature, relative-humidity, wind speed and amount of rainfall regardless of the genetic component of an animal play a major role in its productivity. Understanding the impact of these environmental factors, especially when the lethal effect of climate change is rampant on animals' physiology, is important for animal productivity and reproduction (Cheng *et al.*, 2022). However, ambient temperature and relative - humidity, especially in the tropics, are considered the most important among these factors because their integrative effects cause heat stress (Ajao and Ola, 2021).

One of the ecological zones in Nigeria with rapidly growing rabbit production is the derived - Savannah. The zone is characterised by longer dry season with higher ambient temperature and lower rainfall compared to the rain forest. However, due to the prevailing climatic condition of the derived - Savannah, unfarmed forages that are essential to rabbit nutrition (Abu and Turner, 2017) are fast disappearing because of the longer dry season and human activities (Oluwatimilehin *et al.*, 2021). These may hamper the production of rabbit in the zone because the larger percentage of rabbit farms which constitute small holder backyard enterprises utilize forages in feeding their animals (Ayeeni *et al.*, 2023). Apart from the problem of sparse forages, the characteristic high temperature of the zone may also cause heat stress in the animal due to its largely non-functioning sweat pores (Daader, 2016). Hence, understanding the influence of ambient temperature alone or in combination with relative - humidity on the physiology of the rabbit raised in the zone is critical.

However, crop residues have been reported to be a good substitute to forages and an alternative feed source (Omer *et al.*, 2018) thereby ensuring adequate nutrition for rabbit. There are several studies on various crop residues including potato vines which can replace forages in rabbit nutrition with the focus on rapid weight gain and saving cost on feed (Makinde *et al.*, 2017; Uchegbu and Iyeghe-Erakpotobor, 2015). Additionally, the vine contains considerable amounts of phytochemicals such as alkaloids, flavonoids, phenolic acids, anthocyanins, minerals and vitamins (Abonuusum *et al.*, 2021; Ayeleso *et al.*, 2016) which can act as anti-stress and improve the fertility of rabbit bucks (Nagendra *et al.*, 2014). Besides the phytochemicals, potato vine is high in fibre which is essential for the rabbit that thrives on fibrous materials due to the unique feature of its gastrointestinal tract (Iyeghe-Erakpotobor, 2007).

Nonetheless, there is limited information on temperature - humidity index and its effect on rabbit buck's physiology raised under the derived - Savannah of Nigeria. In addition, there is little information on the effect of potato vine on rabbit buck reproduction, which is key to efficient rabbit production. This study was designed to monitor the ambient temperature and relative-humidity in order to determine the temperature - humidity index of the zone. The study also aimed to compare the biophysical, reproductive and antioxidative responses of rabbit bucks fed orange - fleshed sweet potato vine, a crop residue and *Calopogonium mucunoides*, a common uncultivated forage in the derived - Savannah with those fed only formulated concentrate.

## 2. Materials and Methods

### Study and Ethics

The study was approved by the Ethical Review Committee, (UERC/ASN/2024/2715), of the University of Ilorin, Ilorin, Nigeria; and was carried out for 8 weeks at a rabbit farm in Ganmo, Ifelodun Local Government Area, Kwara State, at latitude 8.41900N and longitude 4.60360E.

### Experimental design

Twenty-four, healthy and matured (~1.25 kg; 6 - 8 months old) rabbit bucks were used. The bucks were individually housed in cages (35 cm x 42 cm x 54 cm) made of wood with the roof covered with corrugated iron sheets and wire - netted floors. Four (4) experimental diets comprising of whole formulated concentrate (150 gram/animal), were fed. The experimental diets comprised of the concentrate feed designated as the control, *C. mucunoides* (CM), orange - fleshed sweet potato vine (PV) and a combination of CM and PV (PVCV). Fresh 10kg of each of the CM and PV were mixed together to compose PVCV. Six bucks were randomised by weight to each of the diets and fed *ad libitum* with clean water. Twenty kilogram of the concentrate feed was fed alongside CM, PV and PVCV. Data on weight gain, reproductive and antioxidant responses were observed and recorded. The control diet (Table 1) was formulated to meet the nutritional requirement (Cunha and Cheeke, 2012) of matured actively reproducing rabbit bucks and pelleted to avoid wastage. Proximate and phytochemical analyses of the control diet and the orange - fleshed sweet potato vine were done and presented on Tables 1 and 2 respectively.

**Table 1: Control experimental diet**

Ingredient	Quantity (kg)
Maize	35.00
Wheat offal	27.00
Groundnut cake	12.00
Soybean meal	13.00
Bone meal	2.00
Lysine	0.35
Methionine	0.35
Premix	0.30
Total	100
<b>Proximate analysis</b>	
Digestible energy (kcal/kg)	2500. 78
Crude protein (%)	17.07
Crude fibre (%)	11.59

**Table 2: Phytochemical components in orange - fleshed sweet potato vine**

Phytochemical	Quantity $\pm$ SE
Saponin (mg DE/g)	8.70 $\pm$ 0.10
Tanin (mg GAE/g)	1.15 $\pm$ 0.01
Cardiac Glycoside (mg DE/g)	14.19 $\pm$ 0.01
Phenolic (mg GAE/g)	0.17 $\pm$ 0.01
Alkaloid (mg AE/g)	10.44 $\pm$ 0.02
Flavonoid (mg QE/g)	5.11 $\pm$ 0.01

### Determination of Temperature - humidity index (THI)

At 3 days intervals, thermohygrometer was used to monitor the rabbit pen's ambient temperature (AT) and relative humidity (RH). Readings were taken at the cool hours of the day (7 am – 9 am) and the hot hours of the day (12 noon – 3 pm) for the entire 8-week research period. THI was calculated and categorized based on the equation of Marai *et al.* (2002) from the recorded ambient temperature and relative-humidity.

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

RH = relative humidity (%), t = temperature (Degree Celsius).

THI values obtained in the experiment were classified for the tropics as follows:

< 27.8 °C=absence of heat stress, 27.8-28.9 °C = moderate heat stress, 28.9-30 °C = severe heat stress and above 30 °C = very severe heat stress.

### Evaluation of biophysical response

A digital thermometer was inserted for sixty seconds (60 s) into the rectum bucks at two days interval for 8 weeks to determine their rectal temperature (RT). The respiratory rate (RR) of the bucks was determined by counting the flank movement of the animals for sixty seconds (60s) simultaneously with the RT.

### Evaluation of weight

Weight of the animals was measured once a week using a weighing balance.

### Determination of Libido

A teaser doe was introduced to 3 bucks in each of the experimental treatments for 3minutes. The time it took a buck to make the first mount on the doe was recorded as the reaction time and a measure of libido. This was carried out at weekly interval throughout the study.

### Collection of Semen and Analysis

Semen samples were collected using improvised artificial vagina maintained at 45°C and teaser does (Ajao and Ola, 2022) from three animals per treatment once in a week for 8 weeks between 08:00am and 10.00am. As the buck mounts and makes a thrust on the teaser doe before intromission, the artificial vagina was applied from the rear to provoke ejaculation. Semen collected was evaluated following IRRG (2005). Semen volume was determined using calibrated collecting tube. Thereafter, a drop of undiluted semen was put on a warmed glass slide (37 °C) and observed under a light microscope at x400 magnification to determine sperm motility. The semen sample was subjectively scored and expressed as percentage motility based on the intensity of the Brownian motion. Sperm viability was determined with a drop of eosin-nigrosin stain and smeared on a glass slide, followed by counting of the number of live cells (unstained) and dead cells (pink) under optical microscopy (x400).

Sperm's morphology was determined by smearing a eosin-nigrosin stained drop of the ejaculate on a glass slide with the use of a cover slip

placed at angle of 45°. The smear was allowed to dry at room temperature within 10 – 15 minute and observed under the microscope (x1000). Sperm concentration was determined using improved Neubauer counter by diluting 10 µL of the semen sample in ratio 1:100 with normal saline solution. Two drops of formalin were added to the normal saline solution before diluting the semen sample in order to kill the sperm cells then charged into the improved Neubauer counter for further counting. The total number of sperm counted was referred to as N. sperm count (SC) and sperm concentration (SCN) was obtained by the following equation:

$$SC = N \times 10000 \times \text{dilution factor/ml of semen}$$

(where: SC = total number of counted sperm cells)

$$SCN = \text{semen volume} \times SC / \text{ejaculate}$$

### Determination of Haematology, Hormone and Enzymes

2ml blood was collected from the ear vein of the bucks at the beginning (1st week) and end (8th week) of the study into EDTA collecting tubes for haematological parameters were determined using the methods described by Ewuola *et al.* (2012) and Jain (1986); and plain tubes to assay the peripheral levels of testosterone and cortisol, catalase, sodium dismutase and glutathione peroxidase using the methods of Jimoh (2019) and Ewuola *et al.* (2012).

### Statistical Analysis

Data observed during the study was analyzed using the factorial analysis of variance of the general linear model for completely randomised design model. Means were separated by Duncan Multiple Range Test with statistical significance determined at p<0.05. In addition, p-values below 0.05 were considered statistically significant. The IBM Statistical Package for the Social Sciences version 21.0 software was used for statistical analysis.

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

$$Y_{ijklm} = \mu + A_i + B_j + C_k + B_n C_{jk} + E_{ijkl}$$

$Y_{ijkl}$  = response variables;  $\mu$  = population mean;  $A_i$  = effect of formulated concentrate;  $B_j$  = effect of orange - fleshed sweet potato vine (PV);  $C_k$  = effect of *C. mucunoides* (CM);  $B_n C_{jk}$  = combined effect of PV and CM;  $E_{ijklm}$  = residual error

## 3. Results

### Air Temperature, Relative - Humidity and Temperature - Humidity Index

Mean values of air temperature (AT), relative - humidity (RH) and temperature - humidity index (THI) observed in the rabbit pen during the study are in presented in Table 3. AT and THI had significantly higher values in the afternoon compared to the morning contrary to the values of RH which was low in the afternoon. Weekly THI monitored during the study is presented in Figure 1. In the mornings (cool hours) and the afternoons (hot hours), THI ranges were 19.25 - 24.84 and 24.60 - 30.79 respectively. THI fluctuated significantly among the weeks with higher values in the afternoon compared to the morning throughout the duration of the experiment.

**Table 3: Mean values of ambient temperature, relative - humidity and temperature - humidity index**

Period	AT (°C)	RH (%)	THI
Morning	23.50±0.36 <sup>a</sup>	40.33±5.19 <sup>a</sup>	21.89±0.39 <sup>a</sup>
Evening	31.39±0.49 <sup>b</sup>	14.71±2.05 <sup>b</sup>	26.90±0.38 <sup>b</sup>

<sup>ab</sup>Means with different superscript within the column differed significantly ( $p < 0.05$ ). AT = Ambient temperature; RH = Relative - humidity; THI = Temperature - humidity index

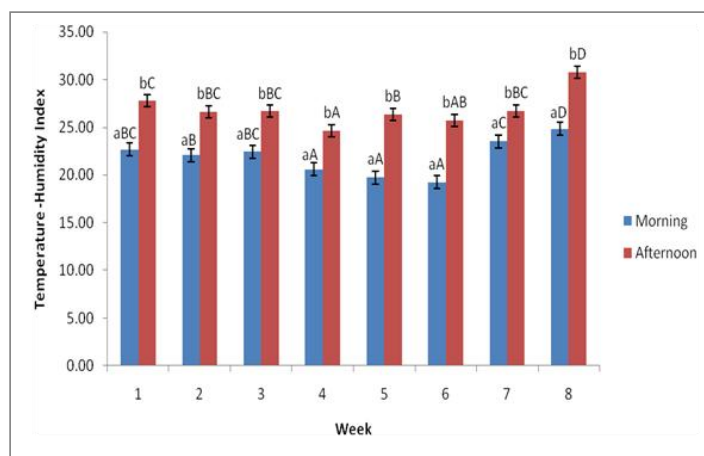


Figure 1: Temperature - Humidity Index (THI) of the rabbit pen during the experiment. Bars with different letters (a - b indicate diurnal difference; A - D indicate weekly differences in the morning and afternoon THI respectively) differs significantly ( $P < 0.05$ )

### Biophysical response

Respiratory rate (RR) and rectal temperature (RT) of the experimental animals were shown in Table 4. RR value was similar in the morning among the animals with the exception of those fed orange - fleshed sweet potato vine (PV) that had significantly higher value of 192.67 CPM. In the afternoon, RR increased significantly in animals fed the control diet and *C.mucunoides* (CM) while it was constant in animals fed OFSP vine and those fed the combination of the PV and CM. Nonetheless, only animals allotted to the combination of PV and CM had significantly lower RR compared to others in the afternoon. RT of was not significantly different among experimental treatments in both the morning and afternoon during the study. However, it was observed that RT in animals fed wholly on concentrate had significantly higher RT in the morning (39.86°C) compared to the afternoon (39.27°C).

### Weight gain

Final weight (2.01 - 2.33 kg), total weight gain (0.76 - 1.10 kg) (Table 5) and average daily weight gain (11.88 - 17.19 g) were significantly different among the treatments with animals allotted to pure concentrate and potato vine having significantly higher values compared to those allotted to *C. mucunoides*

**Table 4: Respiratory rate and rectal temperature of rabbit bucks fed *C. mucunoides* and orange - flesh sweet potato vine**

Parameter	Period	Treatments				±SEM
		C	CM	PV	PVCM	
RR (CPM)	Morning	168.00 <sup>ax</sup>	165.00 <sup>ax</sup>	192.67 <sup>b</sup>	148.08 <sup>a</sup>	8.32
	Afternoon	192.83 <sup>by</sup>	192.67 <sup>by</sup>	192.33 <sup>b</sup>	158.67 <sup>a</sup>	8.32
RT (°C)	Morning	39.86 <sup>y</sup>	39.61	39.36	39.48	0.18
	Afternoon	39.27 <sup>x</sup>	39.44	39.60	39.78	0.18

<sup>abxy</sup>Means with different superscript in the rows and column respectively are significantly different ( $p < 0.05$ ); C = Control; CM = *C. mucunoides*; PV = Orange-Fleshed Sweet Potato vine; PVCM = Combination of CM and PV; CPM = Count per minute, RR = Respiratory Rate; RT = Rectal Temperature

**Table 5: Weight gain of rabbit bucks fed CM and potato vine**

Treatment	Initial Weight (Kg)	Final Weight (Kg)	Total Weight Gain (Kg)	Daily Weight Gain (g)
Control	1.23	2.33 <sup>a</sup>	1.10 <sup>a</sup>	17.19 <sup>a</sup>
CM	1.25	2.01 <sup>b</sup>	0.76 <sup>b</sup>	11.88 <sup>b</sup>
PV	1.20	2.27 <sup>ab</sup>	1.07 <sup>a</sup>	16.72 <sup>a</sup>
PVCM	1.32	2.21 <sup>ab</sup>	0.89 <sup>ab</sup>	13.91 <sup>ab</sup>
PSEM±	0.02	0.08	0.07	1.10

<sup>ab</sup>Means with different superscripts within the column are significantly different ( $p < 0.05$ ), Control; CM = *C. mucunoides*, PV = Potato vine, PVCM = combination of CM and PV

### Libidinal response

Reaction time, which represented the animals' libido, is depicted in Figure 2. Animals fed pure concentrate, *C. mucunoides* (CM) and potato vines (PV) had shorter reaction time ( $< 19.00$  s) contrary to those fed a combination of CM and PV that had significantly ( $p < 0.05$ ) longer reaction time (31.07s).

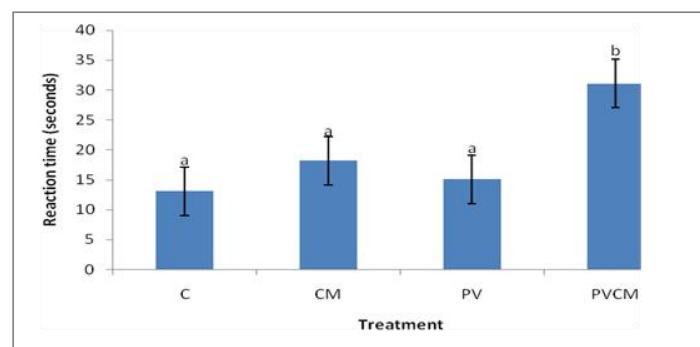


Figure 2: Libido of rabbit bucks feed *C. mucunoides* (CM) and orange - fleshed sweet potato vine (PV). Bars with different letters differs significantly ( $p < 0.05$ )

## Seminal response

The semen characteristics of the studied animals are presented in Table 6. Experimental treatments had significant effect on seminal parameters of rabbit bucks. Seminal volume was highest in animals fed potato vine (PV) and was significantly different from the values observed in other treatments. Sperm motility and livability were lowest in animals fed pure concentrate though with similar values to what was observed in animals fed *C. mucunoides* (CM) and the combination of CM and PV. Nonetheless, animals allotted to PV had significantly higher sperm motility (77.29%) and livability (92.02%). Sperm abnormality (16.96% - 21.83%) was significantly different among experimental animals but was lowest in animals fed PV (16.96%). Treatment had no significant effect on sperm concentration of the rabbit bucks. However, animals fed PV had numerically higher value ( $384.75 \times 10^6$ ).

**Table 6: Seminal parameters of rabbit bucks fed *C. mucunoides* and orange fleshed sweet potato vine**

Treatment	SV(ml)	SM(%)	SL (%)	SAB(%)	SCN( $\times 10^6$ )
C	0.62 $\pm$ 0.08 <sup>a</sup>	66.25 $\pm$ 2.15 <sup>a</sup>	83.77 $\pm$ 2.01 <sup>a</sup>	21.55 $\pm$ 2.18 <sup>b</sup>	255.52 $\pm$ 62.27
CM	0.70 $\pm$ 0.08 <sup>a</sup>	72.81 $\pm$ 2.26 <sup>ab</sup>	85.71 $\pm$ 1.92 <sup>ab</sup>	18.26 $\pm$ 2.30 <sup>a</sup>	200.65 $\pm$ 65.31
PV	1.06 $\pm$ 0.07 <sup>b</sup>	77.29 $\pm$ 1.92 <sup>b</sup>	92.02 $\pm$ 1.64 <sup>b</sup>	16.96 $\pm$ 1.84 <sup>a</sup>	384.75 $\pm$ 55.69
PVCM	0.88 $\pm$ 0.09 <sup>ab</sup>	73.44 $\pm$ 2.26 <sup>ab</sup>	85.26 $\pm$ 1.92 <sup>ab</sup>	21.83 $\pm$ 2.16 <sup>b</sup>	256.06 $\pm$ 65.31
P - value	0.03	0.04	0.03	0.04	0.17

<sup>abc</sup>Means with different superscript within the columns are significantly different ( $P < 0.05$ ). SV = semen volume, SM = sperm motility, SL = sperm livability, SAB = sperm abnormality, SCN = semen concentration C = Control; CM = *C. mucunoides*, PV = Potato vine, PVCM = combination of CM and PV

## Antioxidant enzyme profile

Experimental treatments had no effect on the peripheral level of glutathione peroxidase and catalase of the studied animals (Table 7). Superoxide dismutase varied naturally among the experimental animals at the beginning of the experiment. At the end of the study, experimental treatments had significant effect on the SOD of the animals with animals fed *C. mucunoides* (CM) having the highest value. Nonetheless, SOD values observed in CM was statistically similar to those observed in animals allotted to potato vine (PV) and PVCM. Duration did not affect SOD level in animals fed PV. Nonetheless, SOD was significantly reduced in animals fed the control and PVCM while it increased in animals fed CM at the end of the study.

## Hormonal levels

Blood levels of testosterone and cortisol of experimental animals are shown in Table 7. Cortisol levels increased significantly in all the experimental treatments at the end of the study. However, cortisol level in animals allotted to *C. mucunoides* was higher in comparison to others. Testosterone level was sustained in all the experimental treatments though animals allotted to potato vine had the highest value in both the beginning and the end of the studies.

**Table 7: Blood level of glutathione peroxidase, catalase, superoxide dismutase, cortisol and testosterone of rabbit bucks fed *C. mucunoides* and orange-fleshed sweet potato vine**

Parameter	Period	Treatments				SE
		C	CM	PV	PVCM	
GPX (u/l)	Beginning	41.70	36.34	41.62	47.26	5.99
	End	43.51	33.38	45.01	45.76	5.99
CAT (umol/ml /mins.)	Beginning	10.10	8.53	16.55	4.97	4.14
	End	16.22	8.60	8.35	10.83	4.14
SOD (u/ml)	Beginning	0.87 <sup>bb</sup>	0.20 <sup>aa</sup>	0.84 <sup>b</sup>	1.16 <sup>cb</sup>	0.24
	End	0.30 <sup>aa</sup>	0.61 <sup>bb</sup>	0.55 <sup>ab</sup>	0.51 <sup>abA</sup>	0.24
TEST (ng/ml)	Beginning	5.02 <sup>A</sup>	8.95 <sup>AB</sup>	11.51 <sup>B</sup>	6.53 <sup>AB</sup>	1.91
	End	5.66 <sup>A</sup>	8.45 <sup>AB</sup>	13.14 <sup>B</sup>	6.98 <sup>A</sup>	1.91
CORT (ng/ml)	Beginning	4.95 <sup>A</sup>	5.69 <sup>A</sup>	5.66 <sup>A</sup>	5.69 <sup>A</sup>	0.90
	End	7.81 <sup>ab</sup>	9.03 <sup>bb</sup>	7.51 <sup>ab</sup>	7.14 <sup>ab</sup>	0.90

<sup>abAB</sup>Means with different superscript within the row and column respectively are significantly different ( $P < 0.05$ ). GPX = Glutathione peroxidase, CAT = Catalase, SOD = Superoxide dismutase, CORT = Cortisol, TEST = Testosterone

## 4. Discussion

The diurnal variation of ambient temperature and relative humidity observed in the study were similar to the findings of Boluwaji *et al.* (2019) and Ajao *et al.* (2022) in the rainforest and derived Savannah, respectively. However, while Boluwaji *et al.* (2019) and Ajao *et al.* (2022) observed higher prevalent ambient temperature (AT) and relative humidity (RH), lower values were recorded in this study. The lower values of AT and RH might be attributed to the occurrence of the Harmattan wind during the study. The Temperature - Humidity Index (THI) monitored during the study both in the morning and the afternoon was lower than the values reported by Chintem *et al.* (2018) in semi-arid zone of Nigeria. The THI monitored in both studies for both periods indicated the absence of heat stress based on the categorization of Marai *et al.* (2002). Nonetheless, this result is significantly lower than the values reported by Ajao and Ola (2022) that carried out similar studies in the rainforest Zone of Nigeria during the dry season. This observation might be due to low prevalent relative humidity caused by the harmattan in the derived Savanna.

It is established that nutrition among other managerial practices and environmental factors can mediate stress and thereby influence thermoregulatory responses of rabbits (Zeweil *et al.*, 2016). One of the frontline physiologic reactions to heat stress is rise in rectal temperature and commensurate increased respiratory rate. This will lead to lose body heat in order to achieve thermal balance (Liu *et al.*, 2022). Hence, rise in rectal temperature and increased respiratory rate is a biomarker for heat stress. In this study, despite the experimental diets and period of day having significant effect on respiratory rate (RR) of the studied animals, the ranges of RR observed were lower than 215.94 bpm - 314.25 bpm reported by Jimoh and Ewuola (2016) in heat stressed rabbits studied in the rainforest zone of Nigeria in the dry season. Rectal temperature observed in the morning and the afternoon in this study was not significantly different among treatments similar to the report of Jimoh and Ewuola (2018) but was lesser than the values ( $>42.00^{\circ}\text{C}$ ) reported by Anoh *et al.* (2018). This implies that the animals were not stressed which might be ascribed to the absence of stress either from the environment or the experimental diets.

Rabbit has a unique ability of thriving on plant materials including forages because of its caecum which houses microorganisms that aids in their digestion (Abu and Turner, 2017). In this study, animals fed majorly potato vine had similar weight gain to those placed entirely on formulated feed. This result validates the conclusion that rabbits can be fed majorly with forages or plant residues with a little supplementation of concentrates for optimal growth (Sese *et al.*, 2014). Animals fed *C. mucunoides* had the least weight among the experimental treatments but still had values greater than the weight observed by Adeyemi *et al.* (2020) in rabbits fed only zinc supplemented formulated diets. This implies that potato vine alone or in combination with other forages can replace formulated feed in rabbit nutrition.

Libido regulates sexual vigour and enables animals to mate. Libido is controlled by hormones especially testosterone in rabbit (Nagendra *et al.*, 2014) like in many mammals. Hormonal activity can be affected by heat stress and nutrition (Yangali *et al.*, 2012). *C. mucunoides*, potatoes vines and concentrate did not impair the libido of the studied animals implying that the diets did not hamper testosterone secretion. The beneficial effect of *C. mucunoides* and potatoes vines might be due to phytochemicals in the plants as concluded by Ebeid *et al.* (2022). However, the longer reaction time observed in animals fed the combination of both *C. mucunoides* and potatoes vines may be due to interaction of factors in both materials that prolongs reaction time when combined.

Persistent high temperatures and relative-humidity lead to the rise of severe heat stress. This impair testosterone secretion and decimate spermatogenesis causing infertility in rabbit buck (Yangli *et al.*, 2012). Seminal parameters in the studied animals were within the normal values for rabbits (IIRG, 2005) which might be due to the absence of heat stress during the study. This result is similar to the findings of Ajao and Ola (2022) though it was conducted when heat stress was prevalent. Semen volume, sperm motility and liveability of rabbit bucks were significantly higher in animals fed potatoes vines compared to others. This observation is different from the observations of El-Gindy *et al.* (2020) who recorded non-significant differences in rabbit fed extracts of potato peels. Nonetheless, significant effect of treatments on sperm abnormality were similar to the report of El-Gindy *et al.* (2020) with animals fed potato vine having the least value. In addition, sperm concentration was similar among the treatment groups contrary to the report of Solomon *et al.* (2014) who fed rabbits dump site and non-dumpsite *C. mucunoides*. Better seminal parameters were observed in animals fed potato vine and *C. mucunoides* separately or together compared to those fed concentrate only. This finding may be attributed to the phytochemicals in the crop residue and the forage (Achilonu *et al.*, 2023) which might have reduced lipid peroxidation common in sperm cells and ensured optimal semen parameters.

Glutathione peroxidase (GPX), catalase (CAT) and superoxide dismutases (SOD) are antioxidant enzymes that eradicate reactive oxygen species such as hydrogen peroxide and oxygen ions to prevent cell damage and death (Aziz *et al.*, 2019). Under circumstances of heat stress or poor unbalanced nutrition these enzymes are unable to cope with increased production of oxidative agents. This might lead to termination of physiological process (Li *et al.*, 2017) first of which is reproduction in the rabbit (Liang *et al.*, 2022). In this study, GPX and CAT were not affected by experimental diets. This observation is different from the conclusions of El-Gindy *et al.* (2020) who fed rabbits

extracts of potato peels. However, this finding was similar to the conclusions of Zalejska *et al.* (2012) who fed rats high fat diets. This report shows that both GPX and CAT levels were stable in their activities which might be attributed to the balanced oxidative status of the studied animals (Skowron *et al.*, 2018). SOD is responsible for the first set of reaction in the removal of oxidative agents by reducing them to less harmful elements which are in turn scavenged by GPX and CAT (Sies, 2015). SOD observed at the end of this study was lower than values reported by Jimoh *et al.* (2021) in rabbits raised under conditions of severe heat stress. This implies that the absence of heat stress recorded during this study did not facilitate production of oxidative agents. SOD levels were reduced in all the experimental treatment at the end of the study with the exception of *C. mucunoides*. This result may be attributed to the experimental diets which might have supplied antioxidants which were able to complement the activities of SOD. The reduced levels of SOD at the end of the study might be responsible for the stable levels of GPX and CAT, contrary to the observations of Kolawole (2016) who reported concurrent increase in levels of CAT as SOD levels increased.

Testosterone, the male sex hormone, is produced in the testis. The hormone is responsible for the development of reproductive organs, secondary sexual characteristics, spermatogenesis and sexual behaviour (Ermayanti *et al.*, 2016). Testosterone levels were sustained in each of the experimental treatments throughout the duration of the study. Significant values of testosterone observed among experimental treatments in this study is similar to the report of Ajuogu *et al.* (2018) who fed graded level of *Costusafer* leaves to rabbit bucks. However, the higher level of testosterone recorded in animals fed *Calopogonium* and potato vines might be due to their phytochemical contents as adduced by El-Desoky *et al.* (2017). Cortisol is the key hormone in the physiological response to stress. It prepares animals to respond to external stimuli, and by that facilitate recovery of disturbed homeostasis following acute stressful situations (Bozzo *et al.*, 2018). However, extreme environmental condition and poor management can cause rise in cortisol level and lead to disruption of metabolism and impair reproductive processes including spermatogenesis (Lenis *et al.*, 2015). Hence, the determination of the quantity of cortisol in the body fluids is a stress marker (Bozzo *et al.*, 2022). The rise in cortisol levels observed in this study may not necessarily be attributed to increase in level of stress. This is because no such impact is observed on other physiological parameters observed during the study. Nonetheless, animals fed both *Calopogonium* and potato vine can be considered least disposed to stress because of the lowest level of cortisol recorded in the group. This might be attributed to the synergistic interaction of phytochemicals in both *Calopogonium* and potato vine in confirmation of studies that reported that plant constituents reduced level of cortisol in rabbits (Liu *et al.*, 2010).

## 5. Conclusion

This study revealed on the basis of the Temperature Humidity Index observed during the study that heat stress was absent during the period. Both PV and CM had no lethal effect on rabbit biophysical, antioxidant, hormonal and seminal responses of rabbit bucks though rabbit fed PV showed better physiological indices. It can be recommended that PV can safely replace CM without any negative effect on rabbit welfare, productivity and reproduction in the derived savannah.

## Funding

No external funding was received for this study.

## Competing Interest

The author of this study titled "Effect of orange-fleshed sweet potato vine and *Calopogonium mucunoides* on weight gain thermophysiological, reproductive and antioxidant responses of rabbit bucks (*Oryctolagus cuniculus*)" declares that there are no financial or personal relationships that could be perceived as a conflict of interest in the conduct or publication of this research. All data were gathered in an objective and unbiased manner, and I confirms that the results presented in this paper are based solely on the findings derived from the research.

## Data Availability Statement

Available upon request.

## Ethics Approval

This study did not involve the use of human subjects.

## References

- Abonuusum, A., Gabriel, A., Salifu, A.-R. S., Atinga, C. A., Richard, A., Marcellinus, B. 2021. Analysis of the leaves of five sweet potato varieties for their nutrient, mineral and phytochemical properties. *Journal of Experimental Agriculture International*, 43(3), 133–148. <https://doi.org/10.9734/jeai/2021/v43i330664>
- Abu, O. A., Turner, L. S. 2017. Chemical composition of tropical forages and their acceptability by the domestic rabbit (*Oryctolagus cuniculus*). *Nigerian Journal of Animal Production*, 44(5): 141-147
- Achilonu, M., Shale, K., Arthur, G., Naidoo, K., Mbatha, M. 2018. Phytochemical benefits of agroresidues as alternative nutritive dietary resource for pig and poultry farming. *Journal of Chemistry*: 1-15.
- Adeyemi, A. A., Ibrahim, O. W., Ajayi, O. O., Ayeni, S. T. 2020. Semen indices, growth response and sperm reserve of male rabbits fed zinc supplemented diets. *World Rabbit Science*, 28(4), 199-206.
- Ajao, B. H., Gyasi, D. A., Ibrahim, Y. S., Mukhtar, M. B., Ahmed, M. A., Alimi A. O. 2022. Impact of diurnal temperature - humidity index and sex on the physiological traits of weaner rabbits raised in the derived Savannah. Proceedings of the 27th Annual Conference of Animal Science Association of Nigeria, Bauchi, Nigeria, 84 – 87
- Ajao, B. H., Ola, S. I. 2021. Impact of varying temperature-humidity index on the thermo-physiological, libidinal and seminal characteristics of male rabbits raised in the wet humid tropics. *Nigerian Journal of Animal Science*, 23(2), 83-92.
- Ajao, B. H., Ola, S. I. 2022. Effects of dietary supplementation of ginger, garlic and onion on semen profile, haematological and serum antioxidant status of rabbit bucks raised in the dry season of the humid tropic. *Journal of Agricultural Sciences–Sri Lanka*, 17(1): 228 - 240.
- Ajuogu, P. K., Herbert, U., Ibeh, P. C., Nodu, M. B., Ukpabio, U. H., Onyegbule, C. G., Akintola, A. O. 2018. Semen quality characteristics and testosterone levels of rabbit bucks fed Costusafer leaf. *African Journal of Biotechnology*, 17(2), 24-28.
- Anoh K. U., Atte, P. O., Olayinka O. I., Abdulahi, I. 2018. Effect of transportation stress on the thermoregulatory response of young and adult rabbits. *Nigerian Journal of Animal Science*, 20 (4), 490-495
- Ayeleso, T. B., Ramachela, K., Mukwevho, E. 2016. A review of therapeutic potentials of sweet potato: Pharmacological activities and influence of the cultivar. *Tropical Journal of Pharmaceutical Research*, 15(12), 2751-2761.
- Ayeni, M. D., Adewumi, M. O., Bello, M. A., AdiAdi, K. F., Osungade, A. A. 2023. Effects of rabbit production on income and livelihood of rural households in Nigeria. *Heliyon*, 9(8).
- Aziz, M.A., Diab, A.S., Mohammed, A.A. 2019. Antioxidant categories and mode of action. In *Antioxidants*; Shalaby, E., Ed.; IntechOpen: London, UK, pp. 3–22.
- Boluwaji, O.V., Amusa, R.F., Ola, S.I. 2019. Some factors influencing the physiological parameters of greater grasscutter (*Thryonomys swinderianus*) in the rainforest ecological zone of Nigeria. *Nigerian Journal of Animal Science*, 21 (2): 85-92
- Bozzo, G., Barrasso, R., Marchetti, P., Roma, R., Samoilis, G., Tantillo, G., Ceci, E. 2018. Analysis of stress indicators for evaluation of animal welfare and meat quality in traditional and Jewish slaughtering. *Animals*, 8(4), 1 - 11. <https://doi.org/10.3390/ani8040043>
- Bozzo, G., Dimuccio, M. M., Casalino, G., Ceci, E., D'Amico, F., Petrontino, A., Bonerba, E., Camarda, A., Circella, E. 2022. Preliminary evidence regarding the detection of cortisol and IL-6 to assess animal welfare in various rabbit housing systems. *Agriculture*, 12(10), 1 - 10. <https://doi.org/10.3390/agriculture12101622>
- Cheng, M., McCarl, B., Fei, C. 2022. Climate change and livestock production: a literature review. *Atmosphere*, 13(140), 1 - 20. <https://doi.org/10.3390/atmos13010140>
- Chintem, A.M., Daudu, O.M., Abdulrashid, M. 2018. Physiological and reproductive characteristics of rabbit bucks fed *Cassia tora* leaf meal diets in the Semi – Arid Zone. *Nigerian Journal of Animals Science*, 20(4), 466-474.
- Daader, A. H., Yousef, M. K., Abdel-Samee, A. M., Abd El-Nour, S. A. 2016. Recent trends in rabbit does reproductive management: special reference to hot regions. Proceedings of the 1th World Rabbit Congress: 149-166.
- Ebeid, T.A., Aljabeili, H.S., Al-Homidan, I.H., Volek, Z., Barakat, H. 2023. Ramifications of heat stress on rabbit production and role of nutraceuticals in alleviating its negative impacts: An updated review. *Antioxidants*, 12, 1407: 1 - 29. <https://doi.org/10.3390/antiox12071407>
- El-Gindy, Y.M., Hafsa, S.H.A., Dosoky, W.M. 2020. Effects of potato peel extract on semen quality, sex hormones and immunity of rabbit bucks under intensive breeding system. *Andrologia*. 52:e13869. <https://doi.org/10.1111/and.13869>
- El-Desoky, N. I., Hashem, N. M., Elkomy, A., Abo-Elezz, Z. R. 2017. Physiological response and semen quality of rabbit bucks supplemented with Moringa leaves ethanolic extract during summer season. *Animal: An International Journal of Animal Bioscience*, 11(9), 1549–1557. <https://doi.org/10.1017/S1751731117000088>
- Ermayanti, N. G. A. M., Oka, I. G. L., Mahardika, I. G., Suyadnya, I. P. 2016. Free testosterone level and quality of cauda epididymis sperm of local rabbit that given commercial feed supplemented by cod fish liver oil. *International Research Journal of Engineering, IT and Scientific Research*, 2(3), 1-8.
- Ewuola E.O., Jimoh O.A., Atuma O.V. and Soipe O.D. 2012. Haematological and serum biochemical response of growing

- rabbits fed graded levels of *Moringaoleifera* leaf meal. Proceedings 10th World Rabbit Congress, Sharm El- Sheikh –Egypt: 679 – 683
- International Rabbit Reproduction Group. 2005. Guidelines for the handling of rabbit bucks and semen. *World Rabbit Science*, 13: 71 – 91
- Iyeghe-Erakpotobor, G. T. 2007. Effect of concentrate and forage type on performance and digestibility of growing rabbits under sub-humid tropical conditions. *Asian Journal of Animal and Veterinary Advances*, 2 (3), 125-132
- Jimoh O.A. 2019. Oxidative stress indicators of rabbit breeds in Ibadan, Southwest Nigeria. *Bulletin of the National Research Centre* 43(62): 1-7. <https://doi.org/10.1186/s42269-019-0104-z>
- Jimoh, O. A., Ewuola, E. O. 2016. Thermoregulatory response of exotic rabbit breeds during peak temperature – humidity index of Ibadan. *Trop. Anim. Prod. Invest.* 19 (1): 41-47
- Jimoh, O. A., Ewuola, E. O. 2018. Thermophysiological traits in four exotic breeds of rabbit at least temperature humidity index in humid tropics. *The Journal of Basic and Applied Zoology*, 79(18): 1-6.
- Jimoh, O. A., Ewuola, E. O., Acheneje, P. 2021. Metabolic and oxidative stress markers of rabbit bucks at peak of heat stress in Southwest Nigeria. *Nigerian Journal of Animal Science*, 23(1), 71-79.
- Kolawole, A.K. 2016. Effect of organic turmeric supplemented-diet in rabbits acutely exposed to ultraviolet radiation: oxidative stress in the blood. *Anatomy & Physiology: Current Research*, 6(4), 1 - 4. DOI: 10.4172/2161-0940.1000229
- Lenis, S.Y., Zuluaga, C.A.M., Tarazona, M. A.M. 2015. Adaptive responses to thermal stress in mammals. *Revue de MedecineVeterinaire*, 31:121-135.
- Li, C.Y., Li, J., Kuang, L.D., Mei, X.L., Guo, Z.Q., Lei, M. 2017. Study on blood indicators of meat rabbits at the initial stage of heat stress and their correlation with heat-resistant time. *Chin J AnimHusb.* 53:111–5. doi: 10.19556/j.0258-7033.2017-12-111
- Liang, Z-L., Chen, F., Park, S., Balasubramanian, B., Liu, W-C. 2022. Impacts of heat stress on rabbit immune function, endocrine, blood biochemical changes, antioxidant capacity and production performance, and the potential mitigation strategies of nutritional intervention. *Front. Vet. Sci.* 9:906084. doi: 10.3389/fvets.2022.906084
- Liu, H., Zhang, B., Li, F., Liu, L., Yang, T., Zhang, H., Li, F. 2022. Effects of heat stress on growth performance, carcass traits, serum metabolism, and intestinal microflora of meat rabbits. *Front. Microbiol.*, 13, 998095.
- Liu, H.W., Dong X.F., Tong, J.M., Zhang Q, A. 2010. Comparative study of growth performance and antioxidant status of rabbits when fed with or without chestnut tannins under high ambient temperature. *Anim Feed Sci Technol.*, 164:89–95. doi: 10.1016/j.anifeedsci.2010.09.020
- Makinde, O. J., Sikiru A. B., Ajibade, A. J., Opoola, E., Ibe, E. A., Ibikunle, K. Y. 2017. Effects of different agro industrial by-products on the growth performance, carcass characteristics and blood profiles of growing rabbits. *International Journal of Research in Agriculture and Forestry*, 4(7), 1 - 8.
- Marai, I.F.M, Habeeb, A.A.M., Gad, A.E. 2002. Rabbits productive, reproductive and physiological performance traits as affected by heat stress a review. *Livestock Production Science*, 78: 71 -90.
- Nagendra, S. C., Vikas S., Dixit V. K., Mayank T. 2014. A review on plants used for improvement of sexual performance and virility. Hindawi Publishing Corporation BioMed Research International.
- Oluwatimilehin, I. A., Ayanlade, A. 2021. Agricultural community-based impact assessment and farmers' perception of climate change in selected ecological zones in Nigeria. *Agriculture and Food Security*, 10(3), 3 - 17. <https://doi.org/10.1186/s40066-020-00275-5>
- Omer, H.A.A., El Karamany, M.F, Ahmed, S.M., Abdel-Magid, S.S., El-Naggar, S., Bakry, B.A. 2018. Incorporation field crop residues in rabbit rations. *Bulletin of the National Research Centre*, 42 (27), 1 - 8. <https://doi.org/10.1186/s42269-018-0025-2>.
- Sese, B.T., Okpeku, M. and Igirigi A. 2014. Impact of tropical velvet bean (*MucunaUtilis*) leaf meal on performance, organ weight and haematological indices of young rabbits. *Journal of Animal Science Advances*, 4(4): 777-786
- Sies, H. 2015. Oxidative stress: a concept in redox in biology and medicine. *Redox Biology*, 4, 180 - 183.
- Skowron, M., Zalejska-Fiolka, J., Błaszczyk, U., Chwalińska, E., Owczarek, A., Birkner, E. 2018. Antioxidant enzyme activities in rabbits under oxidative stress induced by high fat diet. *Journal of Veterinary Research*, 62(2), 199.
- Solomon, I.P., Oyebadejo, S.A., Akpan, E.E. 2014. Morphological effect of dumpsite waste forage (*Calopogonium mucunoides*) on the reproductive profile of rabbit (*Oryctolagus cuniculus*). *International Journal of Pharmaceutical Research & Allied Sciences* (4):36-44.
- Uchegbu, E.C., Iyeghe-Erakpotobor, G. T. 2015. Growth performance of rabbits fed sweet potato vine -based diets supplemented with methionine and lysine. *Journal of Animal Production Research*, 27, 131 - 144
- Yangli, P., Yingjie, W., Jie, C., Yinghe, Q. 2012. Effects of chronic heat stress on the reproductive capacity of male Rex Rabbits. *Livestock Science*, 146: 13–21.
- Zalejska-Fiolka, J., Wielkoszyński, T., Kasperczyk, S., Kasperczyk, A., Birkner, E. 2012. Effects of oxidized cooking oil and  $\alpha$ -lipoic acid on blood antioxidants: Enzyme activities and lipid peroxidation in rats fed a high-fat diet. *Biological Trace Element Research*, 145, 217-221. <https://doi.org/10.1007/s12011-011-9186-7>
- Zeweil, H. S., Zahran, S. M., Ahmed, M. H., El-Gindy, Y. M., Khaer, A. Sh. 2016. Effect of organic selenium and ginger supplementation of a diet enriched with linseed oil on performance, carcass, blood lipid profile, with its traits in the meat and antioxidant property of growing rabbits. *Egyptian Poultry Science Journal*, 36 (4): 1147-1161.

## Copyright

Copyright on any article published by SRA-B is retained by the author(s). Authors could also grant permission to third parties freely, as long as adequate reference is made to the original SRA-B article.

**How to Cite:** Ajao, B.H., Babaniyi, G.G., Hammed, K.O., Yusuff, A.T., Olaniyi, W.A., Okukpe, K.M. and Alli, O. I. (2025). Effect of Orange-Fleshed Sweet Potato Vine and *Calopogonium mucunoides* on Weight Gain Thermophysiological, Reproductive and Antioxidant Responses of Rabbit Bucks (*Oryctolagus cuniculus*). *Science Research Annals—Biological Sciences*, 1(1), 13–20. <https://doi.org/10.63112/m20kpc97>