Growth Performance of Rabbit Bucks Fed Graded Levels of Vitamins C and E in the Guinea Savannah Region of Nigeria

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Abstract
A total of thirty-six (36) rabbit bucks at 12 weeks old were used to study the effects of graded levels of vitamin C and E on the growth performance of crossbred rabbit bucks in the Guinea Savannah Region of Nigeria during the dry season.
Nine diets which contained 0mg vitamins C + 0mg vitamin E (T1), 100mg vitamin C (T2), 200mg vitamin C (T3), 100mg vitamin E (T4), 200mg vitamin E (T5), 100mg vitamin C + 100mg vitamin E (T6), 200mg vitamin C + 200mg vitamin E (T7), 100mg vitamin C + 200mg vitamin E (T8) and 200mg vitamin C + 100mg vitamin E (T9) per kilogram of each diet were formulated. The rabbit bucks were randomly divided into nine dietary groups each had four rabbit bucks, with a rabbit buck making a replicate. The feeding trial and data collection period lasted 12 weeks.
The result obtained showed that the inclusion of vitamins E and C had positive significant effect ($P<0.05$) on all the growth parameters studied namely final weight (FW), average daily weight gain (ADWG), average daily feed intake (ADFI) and feed conversion ratio (FCR). The FW values obtained ranged between 1555.80 g (T1) and 2068.30 g (T3). The mean FCR values obtained was best and least (5.13) in rabbit bucks in T7 but poorest and highest (7.58) in rabbit bucks in T1. It appears that the incorporation of vitamin E and C each up to 200 mg per kilogram diet and a combination of the two improved the growth of the rabbi bucks through various means such as improved digestion, higher utilization and absorption of the digested nutrients and suppression of the action of reactive oxygen species.

Key words: *crossbred rabbits, dry season, feed conversion ratio, final weight*

Introduction

In many countries, high ambient temperatures induce a large economic loss because of mortality and decreased production. Heat stress in livestock reduces feed intake, feed efficiency, production and quality of meat and eggs. In hot environment, livestock exert efforts to maintain their body temperature within a normal range. This challenge is associated with behavioral, physiological, hormonal and molecular reactions to heat stress. The endocrine system plays an integral part in the animal's response to stress (Ayyat et al 2004). High temperatures, as encountered in the tropics and in many other countries in Asia during the summer, is a major constraint factor for rabbit production as it negatively affects production due to heat stress (Fouad 2005).

Rabbits, as a homoeothermic animal, can regulate the heat input and output of their bodies using physical, morphological, biochemical and behavioural processes to maintain a constant body temperature. The thermo-neutral zone of temperature in rabbits is around 18–21 °C (Habeeb et al 1993). Thus, when rabbits are exposed to elevated ambient temperatures, e.g. 32-

43°C imbalances are induced in their body temperature, which adversely affect their growth and reproductive traits. Heat stress stimulates the release of corticosterone and catecholamines and initiates lipid peroxidation in cell membranes (Puthpongsiriporn *et al*., 2001) including membrane of some lymphocytes and there by suppresses antibody production and cell-mediated immunity and also increases heat-stressed dependent mortality. Many attempts have been done to overcome the adverse effects of heat stress by modifying environmental condition through nutritional, managerial, and physiological manipulation of rabbits (Selim *et al.*, 2003). In many instances, proper nutrition decreases the immune suppression associated with the stress response. Antioxidants such as vitamins E and C play an important role in maintaining animal health, productive and reproductive performance (Surai, 2002).

Literature did not reveal sufficient information regarding the role of antioxidants in rabbit reproduction, cell differentiation, blood profile and growth during heat stress, particularly in the tropics.

This study was carried out to investigate the effects of vitamins C and E on the growth performance of rabbit bucks.

Materials and Methods

Experimental Location and Site

The study was carried out at the Rabbitry Section of The Livestock Teaching and Research Farm of the College of Animal Science, University of Agriculture, Makurdi, Benue State. Makurdi is located on latitude 7°43'N and longitude 8°53'E (Microsoft Encarta, 2008). Makurdi lies within the Guinea Savannah region of Nigeria and has two distinct seasons-the wet season which lasts from April to October with an annual rainfall that ranges from 1105 mm to 1600 mm and the dry season which lasts from November to March. The area is warm with an annual temperature range of 22.8°C to 40.0°C and annual relative humidity which ranges between 39.50±2.20% and 64.00±4.8% (TAC, 2009).

Experimental Animals and Design

Fifty-four crossbred (New Zealand White x Dutch) grower rabbit bucks were used for the experiment. The rabbits were sourced from Dagwom rabbit farm in Vom, Plateau State. The rabbit bucks were placed into separate cells in the hutches and allowed to acclimatize to the experimental location for fourteen days. During the adaptation period, the animals were given enrofloxacin, wormazine and enbazin forte (coccidiostat). The rabbit bucks were randomly allocated into nine treatment groups; each group replicated six times using a Completely Randomized Design (CRD).

Experimental Diets

The experimental diets were compounded using conventional feedstuffs, the diets tagged T1, T2, T3, T4, T5, T6, T7, T8 and T9 were given to the experimental animals in treatments 1, 2, 3, 4, 5, 6, 7, 8 and 9 respectively. Treatment 1 served as the reference diet with neither vitamin C nor E, T2 contained 100mg of vitamin C per kg diet, T3 contained 200mg vitamin C per kg diet, T4 contained 100mg of vitamin E per kg diet, T5 contained 200mg of vitamin E per kg diet, T6 was a combination of T2 and T4, T7 was a combination of T3 and T5, T8 was a combination of T2 and T5 while T9 was a combination of T3 and T4. The vitamins E and C used were synthetic types. The experimental diet composition is presented on Table 1 and 2.

Experimental Procedure

The weights of rabbit bucks were taken on the day of commencement of the experiment. During the experimental period, the animals were weighed on a weekly basis to determine the weekly weight gain. Amount of feed was weighed each morning before given to the animals and the

leftover was weighed the next morning; the difference was the previous day amount of feed consumed by each animal. The drinkers and feeders for the rabbits were made of plastics with narrow but blunt mouth to discourage feed wastage and injuries. The parameters taken weekly included feed consumed and weight gain. The experiment lasted for a period of twelve weeks from December to March.

Table 1. Ingredient and nutrient composition of experimental diet

Ingredient	**Quantity (kg per 100kg)**
Maize	31.34
Soybean meal	22.98
Brewers dried grains	17.53
Maize offal	12.44
Rice offal	11.91
Bone ash	3.00
Premix	0.30
Common Salt	0.30
Methionine	0.20
Total	**100.00**
Calculated analysis	
Metabolizable energy (kcal/kg)	2756.95
Crude Protein (%)	16.95
Crude Fibre (%)	11.37
Ether extract (%)	4.14
Calcium (%)	1.16
Phosphorus (%)	0.68

Table 2. Inclusion of Vitamins C and E in rabbit buck diets

Treatment groups	**Experimental diets**
T1	Basal diet (control)
T2	Basal diet + vitamin C 100mg/kg diet
T3	Basal diet + vitamin C 200mg/kg diet
T4	Basal diet + vitamin E 100mg/kg diet
T5	Basal diet + vitamin E 200mg/kg diet
T6	Basal diet + vitamin C 100mg/kg + vitamin E 100mg/kg diet
T7	Basal diet + vitamin C 200mg/kg + vitamin E 200mg/kg diet
T8	Basal diet + vitamin C 100mg/kg + vitamin E 200mg/kg diet
T9	Basal diet + vitamin C 200mg/kg + vitamin E 100mg/kg diet

Growth Performance

The initial body weight of the rabbit bucks was taken at the commencement of the experiment while the final weight of the rabbit bucks were taken with the aid of a precision digital weighing scale. The weight gain was deduced using the difference between the final weight and initial weight. The feed conversion ratio (FCR) was determined by the ratio between total feed consumed and total weight gain.

Statistical analysis

Data collected was subjected to Analysis of Variance (ANOVA) using Minitab Statistical Software (Minitab, 2010). Significant differences among the treatment means were separated using Duncan's New Multiple Range Test as outlined by Steel and Torrie (1980).

Results and Discussion

Growth Performance of Rabbit Bucks Fed Varying Levels of Vitamins C and E

The growth performance of rabbit bucks fed diets containing varying levels of vitamins C and E is presented on Table 3. The initial weight of the rabbit bucks was not significantly different ($P>0.05$) across the treatment levels. The initial weight values ranged from 813g to 820g. The mean value obtained for final weight of the rabbit bucks were significantly affected ($P<0.05$) by the varying inclusion levels of vitamins C and E in the diet. The final weight of the rabbit bucks ranged between 1555.80g and 2068g. The mean values obtained for final weight of the rabbit bucks did not follow a definite pattern across the treatment; however, rabbit bucks in T_1 (0E: 0C) had the least final weight values (1555.80g) while rabbit bucks in T3 had the highest final weight value. The average daily weight gain (ADWG) of the rabbit bucks were statistically different ($P<0.05$) across the dietary treatments. The ADWG values of the rabbit bucks on T3 (0E: 200C), T5 (200E: 0C), T7 (200E: 200C) and T9 (100E: 200C) were similar as the highest values. The mean average daily feed intake (ADFI) values obtained were statistically different ($P<0.05$) across the dietary treatment. The ADFI value obtained for the rabbit bucks was highest (85.7g) in T1 while T8 had the least (64.3g). The feed conversion ratio (FCR) values obtained for the rabbit bucks were significantly affected ($P<0.05$) by the varying inclusion levels of vitamins C and E. The FCR values ranged from 5.13 (T7) to 7.58 (T1).

The FW and ADWG values were significantly different ($P<0.05$) and higher in rabbit bucks fed the test diets. This is an indication that the inclusion of vitamins E and C up to 200 mg per kilogram diet improved weight gains of the rabbit bucks. The positive effect of vitamins E and C on the average daily weight gain of the rabbit bucks was most observed when included at 0 mg vitamin E: 200 mg vitamin C (T3), 200 mg vitamin E: 0 mg vitamin C (T5), 200 mg vitamin E: 200 mg vitamin C (T7) and 100 mg vitamin E: 200 mg vitamin C (T9) per kilogram of the diets. The average daily weight gain values obtained (8.84g to 14.9g) were lower than that reported (19.24 g to 26.78 g) by Selim *et al.* (2008) who fed dietary vitamins E and C to growing rabbit bucks but the values obtained were higher than that reported (-1.75g to 0.67g) by Bisong (2015). The result obtained disagrees with Bisong (2015) who stated that graded levels of vitamin C at 100 mg/kg to 300 mg/kg diet does not improve growth of rabbit bucks during dry season.

Table 3. Growth Performance of Rabbit Bucks Fed Varying Inclusion Levels of Vitamins C and E

Parameters	Inclusion levels of Vitamin C and Vitamin E										
	T1 (control)	**T2 (100VC)**	**T3 (200VC)**	**T4 (100VE)**	**T5 (200VE)**	**T6 (100VC.E)**	**T7 (200VC.E)**	**T8 (100VC.200VE)**	**T9 (200VC.100VE)**	**SEM**	**P-Value**
Initial Weight (g)	814	819	820	819	820	819	816	873	813	8.16	0.78
Final Weight (g)	1556^{c}	1812^{b}	2068^{a}	1710^{bc}	2035^{a}	1746^{b}	2046^{a}	1828^{b}	2047^{a}	20.6	0.00
ADWG (g)	8.84^{c}	11.8^{b}	14.9^{a}	10.6^{bc}	14.5^{a}	11.0^{b}	14.7^{a}	11.4^{b}	14.7^{a}	0.249	0.00
ADFI (g)	85.7^{a}	72.6^{b}	77.6^{b}	70.7^{bc}	77.3^{b}	72.1^{b}	75.1^{b}	64.3^{c}	74.9^{b}	0.898	0.00
FCR	7.58^{a}	6.15^{cd}	5.23^{e}	6.71^{bc}	5.40^{de}	6.54^{c}	5.13^{e}	7.47^{ab}	5.14^{e}	0.104	0.00

^{abc} means with different superscripts are significantly different at $P<0.05$;SEM- Standard Error of Mean; P-Value- Probability value ADWG-Average Daily Weight Gain; ADFI-Average Daily Feed Intake; FCR-Feed Conversion Ratio

The range of values for feed conversion ratio of the rabbit bucks (5.13 to 7.58) were higher and poorer than the range of values (2.75 to 3.68) reported by Selim *et al.* (2008). The range of values obtained for feed conversion ratio of rabbit bucks used in this study was also poorer and higher than that reported (3.02 to 3.52) by Abdel-Khalek *et al.* (2012). The FCR values obtained were similar to the values (4.67 to 6.33) obtained by Makinde (2016). However, the feed conversion ratio values obtained in this study were better for the rabbit bucks fed the test diets especially those in T3, T5, T7 and T9 compared to that obtained for the rabbit bucks in T1. The differences in feed conversion ratio value obtained in this study compared to that reported by Selim *et al.* (2008), Abdel-Khalek *et al.* (2012) and Makinde (2016) could be as result of age, sex, breed and nutrition differences. The average daily feed intake of the rabbit bucks fed the test diets was statistically lesser than those on the control diet (T1) but similar to that reported (64.1g to 69.4g) by Azza *et al.* (2008) who fed different types of organic acids to growing rabbits. The improvement of the average daily weight gain and feed conversion ratio obtained for the rabbit bucks fed the test diets is an indication that the varying inclusion levels of vitamins E and C up to 200 mg per kilogram of diet aided growth of the rabbit bucks. It is also an indication that inclusion of vitamins E and C up to 200 mg per kilogram of diet did not reduce feed intake of the rabbit bucks neither did it pose any palatability issues and toxicity of the feed. The results of the growth performance of rabbit bucks fed the test diets corroborates the findings of Selim *et al.* (2008) who stated that vitamins E and C improves growth rate and feed efficiency of rabbit bucks.

Conclusion

Rabbit bucks in this study were placed in diets that contained nine inclusion levels of vitamins E and C separately and a combination of the two up to 200 mg per kilogram diet and it was concluded that Vitamins E and C each and in combination up to 200 mg per kilogram of the diet improved the growth and nutrient digestion and uptake of the rabbit bucks. Incorporation of vitamins E and C each up to 200 mg per kilogram of diet could have helped suppress the action of reactive oxygen species and the effects of oxidative and thermal stress in rabbit bucks. Inclusion of vitamins C and E up to 200 mg per kilogram diet is therefore recommended for use in rabbit buck production.

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