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PERFORMANCE OF GROWING RABBITS FED DIETS CONTAINING VARYING DIETARY LEVELS OF VITAMIN C AND E IN A HOT HUMID TROPICAL ENVIRONMENT

***Okachi, V. C.W., Ben-Chioma, A.E. and Ani, A. O.**

Department of Animal Science, University of Nigeria Nsukka, Nigeria

Abstract: An eight-week study was conducted to determine the response of growing rabbits to varying dietary levels of vitamins C and E under a hot humid tropical environment. Thirty-six hybrid (Chinchilla × New Zealand white) growing rabbits of both sexes with initial average weight of 0.80 kg were randomly divided into nine groups of four rabbits each and assigned to 9 diets a in a 3×3factorial arrangement involving three vitamin C levels (0, 200 and 400mgkg^{-1}diet) and three vitamin E levels (0, 200 and 400mgkg^{-1}diet) in a completely randomized design. Each treatment was replicated 4 times with one rabbit constituting a replicate. Feed and water were supplied to the animals *ad libitum*. Data were collected on performance, cost implication and digestibility. Dietary inclusion of vitamins C and E had significant effect ($p< 0.05$) on final body weight, daily weight gain feed conversion ratio, daily protein intake and it increased the cost of producing one kilogram of feed. Feed cost per kg increased significantly beyond 0mg/kg vitamin E inclusion level. The diet containing 200mg/kg of vitamin C and E (treatment 5) produced the highest dry matter (DM) digestibility coefficient which was similar ($p> 0.05$) to that of the control. It was concluded that a combination of 200mgkg^{-1}diet of vitamin C and 200mgkg^{-1}diet of vitamin E can be successfully added to the diet of growing rabbits during the dry season without having any negative effect on their performance.

Key words: Antioxidants, growing rabbits, digestibility and performance.

Introduction: Low animal protein intake is a major human nutritional problem in Nigeria especially for the non-wage and low income earners (Amaefule, *et al*., 2009). Thus, there is need to encourage the intensive production of micro-livestock like rabbits, especially since rabbits are fast maturing animals with high fecundity and short generation interval. This is because poultry production alone cannot meet the protein needs of the teeming Nigerian populace. Meat obtained from rabbits is usually lean meat that is low in cholesterol, and rich in essential nutrients like proteins and amino acids with high biological value. In recent times, rabbit meat has received attention among

For Correspondence:
vwestleyc@gmail.com.
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humans as one of the preferred meat products with beneficial health promoting effects due to its nutritive and dietetic attributes and high content of polyunsaturated fatty acids (DalleZotte and Szendro, 2011; Petraci and Cavani, 2013). According to Hernandez (2007), rabbit meat has a low content of purines and does not contain uric acid. In addition, the amount of linoleic fatty acid in rabbit meat is about ten times more than is found in beef and lamb and around double the quantity reported for pork meat. Rabbit meat also has about 3% linolenic acid compared to the 1.37, 0.70 and 0.95 % reported for lamb, beef and pork respectively (Enser*et al*., 1996; Hernandez and Gondret, 2006).In tropical and sub- tropical countries, climatic heat is the major constraint on animal productivity. Production and reproduction are impaired as a result of the drastic changes in biological functions caused by heat stress (Marai *et al*., 2002). Heat stress results from a negative balance between the net amount of energy flowing from the animal to its surrounding environment and the amount of heat energy produced by the animal (Farooq *et al.*, 2010). Antioxidants are substances that inhibit oxidation, especially one used to counteract the deterioration of cells in the body. When oxidants generation exceeds the body's antioxidant production capacity, oxidative stress develops (Roth, 2000). The formation of these oxidants is counteracted by natural anti-oxidants. Dietary supplementation with vitamins C and E has been proved to be a simple and convenient strategy to introduce a natural antioxidant that may effectively inhibit the oxidation reactions (Botsoglou *et al.,* 2004). Puron *et al*. (1994) reported that addition of ascorbic acid (200-600mg) in diets, improves growth, feed efficiency, and liveability in heat stress. Vitamin E is a fat soluble vitamin that acts as an antioxidant and free radical scavenger in lipophilic environments. The synergies of vitamin E and vitamin C on the performance indices of rabbits are yet to be substantiated. Against this backdrop, the present study was therefore conducted to determine the response of growing rabbits to varying dietary levels of vitamins C and E under a hot humid tropical environment.

Materials and Method

Experimental Materials: The two antioxidants, vitamins C and E (Hoffman la Roche®) used for the experiment were procured from a pharmaceutical store at the University Market Road, Nsukka. Other ingredients used were obtained from different locations within Nsukka Local Government Area, Enugu State, Nigeria and used to formulate the experimental diets.

Experimental Animals and Management: A total of 36 growing rabbits of about 6 weeks of age and mixed sexes sourced from the Rabbit Farms in Nsukka were used for the study. The rabbits were housed in individual hutches on arrival and fed compounded ration and during the first two weeks of life, the rabbits were allowed to acclimatize with the new environment. Feed and water were served *ad libitum* throughout the experimental period.

The rabbits were treated for coccidiosis by mixing the coccidiosat in their drinking water and administerd to the rabbits for three days. Ivermectin was administered at 0.2ml per rabbit subcutaneously to prevent external and internal parasites.

At about 6 weeks of the experimental period, snuffles were noticed in some rabbits and oxytetracylin (antibiotic) was administered subcutaneously at 0.2ml to all the rabbits to treat the infected rabbits and to prevent the spread to healthy rabbits.

Experimental Procedure: In the experiment 6 weeks old hybrid (Chinchilla × New Zealand white) growing rabbits of both sexes with initial average weight of 0.8 kg were randomly divided into nine groups of four rabbits each. The groups were randomly assigned to nine treatment diets containing 0, 200 and 400mg of vitamin C and E and their combinations. The percentage composition of the experimental diets is presented in Table 1. Each treatment group was repeated four times with a rabbit constituting a replication place in a four-tier rabbit cage that had a total of 12 hutches per tier. The cages were located inside a building equipped with nets and windows for proper ventilation. Each hutch, which accommodated 1 rabbit, was partitioned with metal sheets and wire mesh and fitted with metallic trays (for collection of faecal droppings) and stainless feeders and drinkers.

The rabbits were provided feed and water *ad libitum* for 56 days of the experimental period. The rabbits were weighed at the beginning of the experimental feeding and subsequently on a weekly basis to determine the daily weight gain. Forages like Bermuda grass, elephant grass, alfalfa and glover weed were used to supplement the experimental diet.

Feed intake was determined daily by the weight back technique. Feed conversion ratio was calculated from the weight gain and feed intake values.

Digestibility study: Digestibility study was carried out during the 9th week of the feeding trail. Faecal samples were collected daily for five (5) days from three rabbits per treatment. The samples collected ere bulked for each animal on a daily basis and sundried and later oven dried to achieve complete dryness. At the end of the collection, proximate analysis was carried out on the feed and faecal samples. Data were collected and used to determine the digestibility coefficients.

Chemical and Data Analysis: Experimental diet and faecal samples were assayed for proximate composition by the method of AOAC (1990). Gross energy of experimental diets and faecal samples were determined in a Parr Oxygen adiabatic bomb calorimeter.

Data collected were subjected to a one-way analysis of variance using SAS (1990). Significantly different means were separated using Duncan's New multiple Range test (Duncan, 1955).

Table 1: Gross Composition of Experimental Diets

Vitamin C levels(mgkg^{-1})	0			200			400		
Vitamin E levels(mgkg^{-1})	0	200	400	0	200	400	0	200	400
Ingredients (%)/Diets	1	2	3	4	5	6	7	8	9
Maize	37.35	37.35	37.35	37.35	37.35	37.35	37.35	37.35	37.35
Wheat offal	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00	14.00
Soya bean	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20	11.20
PKC	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Fish meal	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Groundnut cake	20	20	20	20	20	20	20	20	20
Bone meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Iodized salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Vit-mineral mix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Calculated composition									
Crude protein %	15.38	14.81	16.99	15.09	15.80	16.73	15.46	16.45	16.51
Energy (Mj/kg ME)	12.01	12.05	12.07	12.01	12.01	12.06	12.02	12.06	12.06
Crude fibre (%)	5.16	4.51	5.14	5.35	4.86	5.15	5.02	5.41	5.38
Determined composition:									
Dry matter	67.2	66.5	64.8	70.5	72.5	64.6	65.8	68.2	71.3
Crude protein	15.38	14.81	16.9	15.1	16.5	15.5	15.8	16.7	16.5
Crude fibre	5.16	4.51	5.14	5.35	5.41	5.02	4.86	5.15	5.38
Ether extract	8.55	4.22	4.16	3.77	5.66	4.16	3.61	3.06	3.42
Ash	3.58	3.06	2.50	3.31	3.88	2.87	2.94	3.55	3.00
Nitrogen free- extract	46.06	54.9	49.5	54.5	52.1	51.9	51.9	5.71	54.3

*Vit A – 10,000.00 iu, D_3-2,000 iu, B1-0.75g, B_2-5g, Nicotinic acid – 25g, Calcium pantothenate 12.5g, B_12 – 0.015g, K_3-2.5g, E-25g, Biotin – 0.050g, Folic acid – 1g, Manganese 64g, Choline chloride 250g, Cobalt – O.8g, Copper 8g, Manganese 64g, Iron – 32G, Zn-40g, Iodine-0.8g, Flavomycin-100g, Spiramycin 5g, Dl-methionie-50g, Selenium 0.6g, Lysine 120g, BAT-5g.

Results:

Proximate Composition of Experimental Diet:

Table 2 shows the proximate composition of the experimental diet and varying inclusion levels of vitamin C and E

Vitamin C levels(mgkg^{-1})	**0**			**200**			**400**		
Vitamin E levels(mgkg^{-1})	**0**	**200**	**400**	**0**	**200**	**400**	**0**	**200**	**400**
Components (%)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Dry matter	67.16	66.39	64.87	70.55	65.82	68.16	64.67	72.54	71.31
Crude protein	15.38	14.81	16.99	15.09	15.80	16.73	15.46	16.45	16.513
Crude fibre	5.16	4.51	5.14	5.35	4.86	5.15	5.02	5.41	5.38
Ether extract	8.55	4.22	4.16	3.77	3.61	3.06	4.16	5.66	3.42
Ash	3.58	3.06	2.50	3.31	2.94	3.55	2.87	3.88	3.00
Nitrogen free- extract	46.06	54.95	49.27	54.46	51.92	5.712	51.98	52.10	54.33

Growth performance of growing rabbits: Data on the performance of growing rabbits fed diets containing varying levels of vitamins C and E are presented in Table 3. The result showed no significant differences among treatments on protein efficiency ratio (PER) anddaily feed intake (DFI).

Final body weight (FBW) differed significantly ($p<0.05$) among treatments. Rabbits on treatment 4 (diet containing 200mg^{-1}vitamin E and omgkg^{-1}vitamin C) had significantly ($p<0.05$) higher FBW value than those on treatments 6 and 8 but had similar FBW values with those on treatments 1, 2, 3, 5, 7 and 9. Rabbits on treatments 1, 2, 3, 5, 6, 7, 8 and 9 also had similar FBW values. Average daily weight gain of rabbits in treatment 4, 7 and 9 were similar ($p> 0.05$) but were significantly ($p< 0.05$) higher than those obtained on the other treatment groups. However, control group had the least value but was significantly similar ($p> 0.05$) to those obtained in treatment 2, 5, 6 and 8. The feed conversion ratio (FCR) of rabbits on the control, 2 and 5 were similar to those obtained in treatment 6 and 8 but were significantly ($p<0.05$) higher than those obtained in treatment 3,4 and 9 which had comparable values.

Daily protein intake value of rabbits on treatment 2, 3, 4, 5, 6, 7, 8 and 9 were similar ($p>0.05$) but were significantly ($p<0.05$) higher than those obtained on the control.

Cost implication: Table 4 shows data on cost implication of feeding diets containing varying levels of vitamins C and E to growing rabbits. There were significant ($p<0.05$) differences among treatments in cost of daily feed intake, cost of total feed intake and feed cost per kg weight gain. Rabbits on treatment 9 had the highest cost of daily feed intake and cost of total feed intake. Rabbits fed the control diet had similar cost of daily and total feed intake values with those on treatment 2 and these were significantly ($p<0.05$) lower than the values observed in treatments 3 to 9.The feed cost per kg weight gain of rabbits on treatment 8 was significantly ($p<0.05$) higher than the values obtained from rabbits on treatments 1 to 7, but similar to the value observed in treatment 9. Rabbits on treatments 1 to 3 had the least cost per kg weight gain. There were no significant ($p>0.05$) differences among treatments in total feed intake and total weight gain.

Table 3: Performance of growing rabbits fed diets containing varying levels of Vitamins C and E

Vitamin E levels(mgkg^{-1})		0			200			400		
Vitamin C levels(mgkg^{-1})	**0**	**200**	**400**	**0**	**200**	**400**	**0**	**200**	**400**	
Parameters/treatments	1	2	3	4	5	6	7	8	9	**SEM**
Initial body weight (kg)	0.81	0.79	0.78	0.86	0.86	0.77	0.73	0.75	0.77	0.015
Final body weight (kg)	1.40^{abc}	1.39^{abc}	1.41^{abc}	1.67^{a}	1.51^{ab}	1.22^{c}	1.50^{abc}	1.31^{bc}	1.51^{abc}	0.043
Daily weight gain (g)	10.5^{c}	10.7^{bc}	13.6^{ab}	14.5^{a}	11.4^{bc}	11.6^{bc}	14.9^{a}	11.2^{bc}	14.1^{a}	0.58
Daily feed intake (g)	74.9	73.3	74.6	75.6	76.0	74.4	73.5	74.2	75.9	0.93
Feed conversion ratio	7.53^{a}	7.17^{a}	5.46^{b}	5.68^{b}	7.03^{a}	6.38^{ab}	5.11^{b}	6.81^{ab}	5.74^{b}	0.28
Daily protein intake (g)	6.7^{b}	7.2^{a}	7.6^{a}	7.9^{a}	7.0^{a}	7.6^{a}	7.7^{a}	7.4^{a}	7.5^{a}	0.16
Protein efficiency ratio	1.68	1.60	1.64	1.71	1.69	1.63	1.65	1.82	1.68	0.02
Mortality (%)	0	0	0	0	0	0	0	0	0	-

^{abc}means with different superscripts across a given row differ significantly (p<0.05). SEM= standard error of mean

Table 4: Cost implication of feeding diets containing varying levels of vitamins C and E

Vitamin E levels(mgkg^{-1})		0			200			400		
Vitamin C Levels (mgkg^{-1})	0	200	400	0	200	400	0	200	400	
Parameters/treatments	1	2	3	4	5	6	7	8	9	**SEM**
Total feed intake (kg)	4195.0	4050.0	4115.0	4362.5	4425.0	4053.7	4130.0	4157.5	4480.0	**58.5**
Cost daily feed intake (#)	6.83^{f}	8.05^{ef}	9.69^{e}	14.54^{d}	17.22^{c}	16.47^{cd}	27.98^{b}	29.66^{b}	33.55^{a}	**1.59**
Cost total feed intake (#)	383.2^{f}	450.9^{df}	543.1^{d}	817.3^{c}	919.06^{c}	921.62^{c}	1566.7^{b}	1660.6^{b}	1878.9^{a}	**89.19**
Total weight gain (kg)	0.59	0.60	0.76	0.81	0.65	0.65	0.85	0.62	0.79	**0.029**
Feed cost per kg weight gain (#)	687.68^{d}	768.8^{d}	716.9^{d}	1061.4^{cd}	1456.2^{c}	1449.7^{e}	2061.4^{b}	2717.4^{a}	2406.4^{ab}	**128.2**

^{abc} means with different superscripts across a given row differ significantly (p<0.05). SEM= standard error of mean

Nutrient intake: Table 5 shows the data on nutrient intake of growing rabbits fed diets containing varying levels of vitamins C and E. Significant differences (p<0.05) existed among treatments including protein (CP) and nitrogen-free extract (NFE). There were no significant (p>0.05) differences among treatment groups in dry matter (DM), crude ash (CA), ether extract (EE). The crude protein (CP) intake value of rabbits on treatment 5 and 6 had significantly (p<0.05) higher crude protein (CP) intake than rabbits on the other treatments. Nitrogen-free extract (NFE) intake value of rabbits in the control treatment was significantly (p<0.05) higher than NFE intake of rabbits on the other treatments.

Table 5: Nutrient intake of rabbits fed diets containing varying levels of Vitamins C and E

Vitamin E levels(mgkg-1)	0			200			400			
Vitamin C Levels(mgkg-1)	0	200	400	0	200	400	0	200	400	
Components	1	2	3	4	5	6	7	8	9	SEM
Crude protein	17.6^{b}	16.2^{bc}	13.5^{c}	13.5^{c}	18.8^{a}	18.3^{a}	16.9^{bc}	13.5^{c}	14.6^{c}	0.73
Crude fibre	10.6	10.6	9.87	9.67	9.81	9.82	10.5	9.63	9.84	0.14
Crude Ash	9.94	10.65	9.77	9.67	9.81	9.83	10.63	9.68	9.87	0.13
Ether extract	2.87	2.86	3.92	3.85	2.67	2.53	2.93	3.83	3.47	0.18
Nitrogen free-extract	61.1^{a}	54.9^{b}	54.2^{b}	52.6^{b}	56.1^{b}	56.2^{b}	54.8^{b}	54.3^{b}	55.3^{b}	0.78

^{abc}means with different superscripts across a given row differ significantly ($p<0.05$). SEM= standard error of mean

Nutrient Digestibility: Table 6 shows the data on nutrient digestibility % of rabbits fed diets containing varying levels of vitamins C and E. Significant differences ($p<0.05$) existed among treatments in dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE) digestibility coefficients.

The dry matter digestibility % of rabbits on treatment, 1, 2, 3, 4, 5, 8 and 9 were similar but were significantly ($p<0.05$) higher than the values observed in treatment 6 and 7. The crude protein digestibility (CP) % of rabbits on treatment 4 was similar ($p>0.05$) to the values obtained from rabbits on treatments 1, 2, 3, 5, 8 and 9, but significantly ($p<0.05$) higher than the values obtained from rabbits on treatments 6 and 7. The crude fibre digestibility (CF) % of rabbits on treatment 1 and 2 were similar but were significantly ($p>0.05$) higher than those of the other treatment groups. Rabbits on treatment 3, 5 and 6 had similar ($p>0.05$) CF digestibility % but were significantly ($p<0.05$) higher than those in treatment 7, 8, 9 and 4. Rabbits on treatment 9 had the least CF digestibility % value. The ether extract digestibility % (EE) of rabbits on treatments 1, 2, 3, 6 and 9 were similar but were significantly ($p<0.05$) higher than those obtained from rabbits in treatment 4, 5, 7 and 8. Rabbits on treatment 7 had the least ether extract digestibility % value. The Nitrogen-free extract digestibility % (NFE) of rabbits in treatment 1, 3, 4, 6 and 9 were similar to ($p>0.05$) values obtained in treatment 7 and 8 but were significantly ($p<0.05$) higher than the values obtained from rabbits in treatment 2 and 5 which were similar to ($p>0.05$) values obtained in treatment 7 and 8. Rabbits on treatment 2 and 5 had the least NFE digestibility % value, but were similar to ($p>0.05$) those obtained from treatment 7 and 8.

Table 6: Digestibility coefficients of growing rabbits fed varying levels of vitamins C and E

Vitamin E levels(mgkg-1)	0			200			400			
Vitamin C levels(mgkg-1)	0	200	400	0	200	400	0	200	400	
Parameters /treatments	1	2	3	4	5	6	7	8	9	SEM
Dry matter	95.2^{a}	93.8^{a}	94.3^{a}	94.9^{a}	95.6^{a}	85.7^{b}	87.7^{b}	93.9^{a}	94.1^{a}	1.19
Crude protein	95.0^{a}	94.2^{a}	94.0^{a}	96.2^{a}	91.8^{ab}	85.7^{b}	83.7^{b}	93.6^{ab}	90.6^{ab}	1.43
Crude fibre	95.1^{a}	93.1^{a}	81.7^{b}	63.9^{c}	82.8^{b}	86.3^{b}	70.5^{c}	68.9^{cd}	66.0^{d}	3.91
Ether extract	95.4^{a}	92.2^{a}	94.2^{a}	87.4^{bc}	89.6^{bc}	91.5^{a}	81.4^{c}	88.7^{bc}	95.3^{a}	1.49
Nitrogen free-extract	97.3^{a}	90.1^{c}	96.0^{a}	95.1^{a}	90.3^{c}	97.6^{a}	93.9^{ab}	93.2^{ab}	96.1^{a}	0.93

^{abc}means with different superscripts across a given row differ significantly ($p<0.05$). SEM= standard error of mean

Discussion

Growth performance: As shown in table 3, rabbits on treatments 2, 3, 4, 6, 7, and 9 and those on treatment 1 (control) had similar average final body weight values. These results are similar to those reported by Castellini *et al*. (1998, 2001), Oriani *et al*. (2001), Dal Bosco *et al*. (2004) and Botsoglou *et al*. (2004), which showed that the growth promoting action of Vitamin E was not evident in the animals under investigation. Nevertheless, the results contradict the findings reported by Sedki *et al*. (2002), Meshreky and Shaheed (2003) and Corino *et al*. (2007) which showed that vitamin E had growth promoting effects. Also findings from this research are in line with the findings reported by Selim *et al*.(2004) which showed that rabbits fed diets supplemented with vitamin C did not have better growth performance than those on control diet. However the present findings contradict the reported findings of Abdel-Hamid (1994) and Sedki *et al*. (2002) which showed that vitamin C has a growth promoting action on rabbits. According to Selim (2008), such factor as the condition under which the study was performed (environmental condition, dose of the vitamins studied, way of introduction, diet, water, oral or injection) maybe the cause of the differences observed in the rabbits' response to supplemental vitamins C and E.

Rabbits fed diets containing vitamin C and E (Treatment 4, 7 and 9) had similar average daily weight gain (ADWG= 14,49, 14.94, 14.06) but were superior to those fed the control diet(ADWG= 10.49).

Rabbits fed diet containing vitamins C and E (treatment 7) had feed conversion ratio (FCR=5.11) that was superior to those of rabbits fed the control diet (FCR=7.53). This result is in agreement with those reported by Sedki *et al*. (2002), Meshreky and Shaheed (2003) and Corino *et al*. (2007) which showed that feed conversion ratio was improved as growing rabbits were allowed to extra doses of vitamin E. Maria *et al*. (2002) reported that reduction in performance of rabbits raised in the tropics is due to heat stress emanating from the adverse effects of high ambient temperature.

Cost Implication: As shown in Table 4, dietary inclusion of vitamins C and E increased the cost of producing one kilogram of feed. The cost of daily feed intake, and the cost of total feed consumed followed the same trend as the cost of daily feed intake, which was observed to increase as levels of vitamin C and E increased in the diets (Table 4). Also, total weight gain followed the same trend as the daily weight gain. Feed cost per kg increased significantly beyond 0mg/kg vitamin E inclusion level. It is evident from the results obtained in the present study that vitamins C and E should be included in the diet of growing rabbits at 200mg/kg diet in order to prevent oxidative stress and to enhance their performance in a hot tropical country such as Nigeria, especially during the dry season.

Nutrient Intake: Dietary treatments had no significant effect on crude fibre (CF) and crude ash (CA) intakes by rabbits (Table 5). However, treatments had significant effects ($p<0.05$) on the intakes of crude protein (CP), ether extract (EE) and nitrogen free extract (NFE) by rabbits. The results show that the inclusion of vitamin C in the diets enhanced nutrient intake. Halfer *et al*. (1995) and Mest (2003) had shown that high temperature, above the critical threshold is related to reduce feed intake and has deleterious effect on the physiological status of rabbits.

Digestibility: Data on digestibility coefficients of diets as presented in Table 6 showed that treatment had significant effects ($p< 0.05$) on digestibility % of dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE). However, inclusion of vitamin C and E did not enhance digestibility because rabbits on the control group had similar digestibility % with those of other treatment groups.

Conclusion: Results from this study shows that a combination of 200mgkg^{-1}diet of vitamin C and 200mgkg^{-1}diet of vitamin E can be successfully added to the diet of growing rabbits during the dry season, without having any negative effect on their growth performance, carcass yield, relative organ weights and haematological parameters. However, the inclusion of vitamins C and E in the diet of growing rabbits may increase the cost of production but in a long run will enable the growing rabbits perform better both anatomically and physiologically during period of heat stress as is evident in Nigeria where the ambient temperature is relatively high. The inclusion of these antioxidants (vitamin C and E) will reduce the losses associated with the effects of heat stress on growing rabbits in a hot humid tropical environment such as Nigeria.

Reference

- Abdel-Monem U.M. (2001). *Dietary Supplementation with Ascorbic Acid and its Effects on Productive and Reproductive Performance of New Zealand White Rabbits, Under the Summer Condition of Egypt. Proceedings of 2nd International Conference on Animal Production & Health in Semi-Arid Areas*. Al-Arish, North Sinai, Egypt
- Amaefule, K. U., Onwudike, O. C., Ibe, S. N, and Abasiekong, S.F. (2009). *Nutrient utilization and digestibility of growing pigs fed diets of different proportions of palm kernel meal and brewer's dried grain. Pakistan J. of Nutrition*. 8:4, 361-367.
- Azza, M.M. Badr. (2015). *Effect of Feeding Time and Vitamin C Levels on Performance of Rabbit Does During The Mild And Hot Seasons in Egypt*. Regional Center for Food and Feed, Agriculture Research Center, Giza, Egypt.
- Bain, B. S. (1996). *The Role of Vitamin c in Stress Management.*World Poultry, 12(4) 34-41.
- Botsoglou, N., Florou-Paneri, P., Christaki, E., Giannenas, I., Spais, A. (2004).*Performance of Rabbits and oxidative stability of muscle tissues as affected by dietary supplementation with Oregano essential oil. Arch. Animal Nutrition.* 58(3), 209-218.
- Coates, M. E. (1984). *Metabolic Role of Vitamins in Freeman b.m. (editor) Physiological and Biochemistry of the Domestic Fowl*.Academic press, London. 27-36
- DalleZotte, A., Szendro, Z.S. (2011). *The role of rabbit meat as functional food.* Meat Sci., 88:319-331. doi: 10.1016/j. meatsci.2011.02.017.
- Duncan D.B. (1985).*Multiple Range and Multiple Tests*. Biometric 11: 1-42.
- Edgar,H. O (1992). *Secondary prevention with antioxidant or Cardiovascular disease in endstage renal disease*. Lancet, 356: 1213-1218.
- Enser, M., Hallet, K., Hewett, B., Fursey, G. A. J., and Wood, J. D. (1996).*Fatty acid content and composition of English beef, lamb and pig at retail*. Meat Sci. 42, 443-456.
- Farooq U, Samad, H.A, Shehzad F, Qayyum A (2010).Physiological Responses of Cattle to Heat Stress.*World Appl. Sci. J.* 8 (Special Issue of Biotechnology and Genetic Engineering): 38-43.
- Hernandez, P. (2007). Carne de conejo, ideal paradietasbajas en acidourico. Revi stacientifica de nutricion. *N^{o} 8 Septiembre Boletin de cunicultura.154, 33-36.*
- Ingrid S. (2015) Thor Gjermund Eriksen Metrological responsible: Antom Eliassen. *Norwegian Meterological institute and Norwegian Broadcasting Corporation.*
- Leagates, J.E., Farthing, B.R., Casady, R.B. and Barrada, M.S. (1991). Body Temperature and Respiratory Rate of Lactating Dairy Cattle Under Field And Chamber Conditions. *J. Dairy Sci.***74,** 2491-2500.
- Liu H., Dong X., Tong J. and Zhang Q. (2011). A Comparative Study of Growth Performance and Antioxidant Status of Rabbits When Fed With or Without Chestnut Tannins Under High Ambient Temperature. *Animal Feed Sci. and Techno., 164, 89-95.*

- Marai, I.F.M., Ayyat, M.S and Abdel-Monem, U.M. (2002). Growth Performance and Reproductive Traits at First Parity of New Zealand White Female Rabbits as Affected by Heat Stress And Its Alleviation, Under Egyptian Conditions. *Tropical Animal Health and Production 33, 1-12.*
- Mousa-Balabel T.M. (2003). *Effects of Heat Stress On New Zealand White Rabbits' Behaviour and Performance*. Dept. of Hygiene and Preventive Med. Fac.Of Vet.Uni.
- Ofomata *G.E.K, (1975).* Nigeria in Maps Eastern States, Ethiopian Publishing Co. Ltd Benin, Pp 43-45.
- Onifade, A.A.; Abu, O. A.; Obiyan, R.I. and Abanikannda, O.T.F., (1999).*Rabbit Production in Nigeria: Some Aspects of Current Status and Promotional Strategies. World Rabbit Science.* 7(2):51-58.
- Petracci, M., and Cavani, C. (2013).*Rabbit meat processing: historical perspective to future directions. World Rabbit Sci*., 21, 217-226. doi:10.4995/wrs.2013.1329.
- Puron D., Santamaria P., Segura J.C, (1994).Effects of Sodium Bicarbonate, Acetylsalic and Ascorbic acid on Brooder Performance in Tropical Environment.*Journal of Applied Poultry Research, 3:141-145.*
- Richards, S.A. (1976). Evaporative Water Loss in Domestic Fowls and Its Partition in Relation to Ambient Temperature. *J. Agric. Sci*. Cambridge. 87: 527-532.
- Roa M. V and Sharma P.S. (2001).*Reproductive Effect of Vitamin E against Mercury chloride in Reproductive Toxicology in Male Mice. Reproductive toxicology*,15(6) 705-712.
- Roth E. (2000). Oxygen Free Radicals and their Clinical Implications. *Actachirurgica Hungarica, 36, 302-305*.
- SAS 1990.SAS/STAT ® User's Guide: Statistics (Release 6.04 Ed). *SAS Institute Inc.,Cary, NC, USA.*
- Sethi, R. K., Bharadwaj A. and Chopra S.C. (1994). Effect of Heat Stress on Buffaloes Under Different Shelter Strategies. *Indian J. Anim. Sci.***64,** 1282-1285.
- Shafie, M.M., Kamar, G.A.R., Borady, A.H.A. and Hassanien, A.M. (1984). Reproductive Performance of Giza Rabbits Does Under Different Natural And Artificial Environmental Conditions. *Egyptain Journal of Animal Production*, 24 (1-2), 167-174.
- Uzodimma E.O and Ofoefule A. U (2009).Biomass Unit, National Center for Energy Research and Develeopment, University of Nigeria Nsukka.*International Journal of Physical Sciences vol 4, 91-9.*
- Vietmeyer, N.D. (1985). Potential of Microlivestock in Developing Countries.*J. Applied Rabbit Res*., 8: 1581-1586.