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# Growth Performance and Electrolytes Responses of Broiler Chickens Fed Vitamins A, C and E

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**Abstract.** Growth parameters, namely average daily feed intake (ADFI), average daily gain (ADG), feed efficiency (FE) and electrolytes responses in broiler chickens fed vitamins A, C and E, were investigated. Ninety day old chicks were used in the study. Chicks were brooded and similarly reared for 4 weeks to fully pre-condition them to their new environment. At the end of this, animals were weighed to obtain their initial body weights (BW) and randomly assigned to 3 dietary treatments of 30 birds/treatment and 3 replicates of 10 birds/replicate: $T_1$ (control diet, contained vitamins at basal levels of 30mg/kg of diet), $T_2$ (diet 2, contained vitamins A and E at 100mg of vitamin A + 100mg of vitamin E/kg of diet) and $T_3$ (diet 3, contained vitamins C and E at 100mg of vitamin C + 100mg of vitamin E/kg of diet). The animals received their respective diets for 4 weeks. On the last day of study, animals were weighed to obtain their final BW. There were no differences ($P > 0.05$) in the ADFI amongst dietary treatments. ADG showed significant ($P < 0.05$) differences as $T_1$, $T_2$ and $T_3$ groups gained approximately 41g, 68g and 86g/day, respectively. Significant ($P < 0.05$) differences were observed in the FE: $T_1$, $T_2$ and $T_3$ showed FE of 25%, 42% and 53%, respectively. The vitamins had no effects ($P > 0.05$) on the electrolytes studied. It was concluded that dietary vitamins A, C and E improved ADG and FE but had no effect on electrolytes.

**Key words**: Vitamins, A, C and E, Performance, Electrolytes and Broiler Chickens

## Introduction

Broiler chickens are very fast growing species. The fast growing process of the animals justified that the dietary nutrients of broilers should match the nutrient requirements of their growing physiological patterns; nevertheless, their fast growing nature make them highly susceptible to many environmental stressors, including nutrition. This scenario often results in reduced or stunted growth and sometimes even lead to death of the animals, especially at the commercial setting (Hoerr, 1998; NRC, 2012). The attendant effect of the fore-stated challenge no doubt leads to the reduction of the poultry farmer profit margin and in the extreme case results in losses.

In the past, supplementing poultry diets with antibiotics at sub-therapeutic levels had traditionally been employed to improve animal growth rates (Cromwell, 2002). However, at present due to global growing concerns over the resistance of pathogenic bacteria to antibiotics, the use of antibiotics as growth promoters in animal diets, including poultry is limited as a result of public and regulatory pressures. To this point therefore, nutrition becomes the fundamental key in the prevention-modulation reflecting a specific accent in diet as an essential strategy in the preservation of the animal's wholeness. To this extent, nutritional science has to move towards the development of recommendations for optimal dietary ingredients, especially as it relates to micro-nutrients such as the antioxidant vitamins for the maintenance of good health of the fast growing bird for eventual maximum productivity and profitability (NRC, 2012).

Currently, it is now better understood that antioxidant nutrient requirements for the protection of the bird need to be properly established and documented in respect to their

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synergies in terms of growth and the health of the animal (NRC, 2012). Amongst micro-nutrient dietary factors with special emphasis on the health of the animal and consequently better support the growth of the animal, antioxidant vitamins (A, C and E) readily comes to mind because of their involvement in the regulation of the glutathione system of the animal (Harrison & May, 2010). However, there are paucities of information and data on the potentials of the synergies of these vitamins on the growth of broiler chickens thereby necessitated this study. Therefore, the objectives of this study are to evaluate the growth performance and electrolytes responses of broiler chickens to dietary vitamins A, C and E.

## Materials and Methods

### Animals

Ninety (90) *Agrited* day old chicks were acquired from a reputable commercial poultry dealer from Eleme local government area, Rivers State. The animals on arrival at the Rivers State University Teaching and Research Farm were brooded to proper pre-condition them to their new environment. The animals by the third week were observed to have properly adapted to their environment and thus were randomly assigned into three treatment groups of 30 birds/treatment group with 3 replications of 10 birds/replicate. The pens were properly cleaned and disinfected before the birds' arrival. Feeders and drinkers were also properly cleaned to also ensure that the animals' environment were pathogen-free. During the brooding period all protocols, including the necessary medications were provided. Animals were fed similar diets from day one through the end of the 4$^{th}$ week. Water was provided *ad libitum*. In the last 4 weeks of study, animals were fed their respective experimental diets.

### Experimental Diets

A corn/soybean-based diet was used in the study. In other words, the diets fed to the animals during the last four weeks of the experimental period were isocaloric and isonitrogenous except that animals of groups 2 ($T_2$) and 3 ($T_3$) diets contained additional vitamins A/E and C/E, respectively, whereas the control ($T_1$) diet only had vitamins A, C and E at basal levels of 30mg/kg. The $T_2$ diet contained vitamins A and E as: (vitamin A 100mg + vitamin E 100mg/kg of diet) and $T_3$ diet contained vitamins C and E as: (vitamin C 100mg + vitamin E 100mg/kg of diet). The animals were fed these vitamin-based diets for 4weeks.

### Experimental Procedure and Data Collection

Feed intake was strictly monitored as to be able to compute the amount of feed ingested by each animal group. Therefore, at the beginning of each day of the 4 weeks of the experimental period, orts from the previous day was usually collected, air-dried, weighed and recorded. The difference between dry feed delivered and the next day's orts represents the actual feed consumed by the animal for the day. As the animals were weighed at the end of the first 4 weeks of adaptation to obtain their initial body weights (BW) for the study, they were also re-weighed on the last day of trial to obtain their final body weights. The difference between the final and initial BW represents the weight gained during the last 4 weeks of the study period. Average daily feed intake (ADFI) was determined as the difference between the total amount of feed consumed and orts, divided by the number of birds in the pen divided by the number of days of the study period. Average daily gain (ADG) was computed by dividing the weight gain during the study period by the number of days of the study period. Feed efficiency (FE) which is gain/feed was obtained by dividing the ADG by the ADFI. Nine birds from each treatment group were humanely sacrificed and their blood collected.

**Blood Sample Collection**

Three birds were randomly collected from each replicate of the three treatment groups. The blood was collected from each bird into treated tubes with ethylene diamine tetra-acetic acid (EDTA) and immediately snap frozen for later electrolytes analyses. Electrolytes of interest and analyzed for were sodium ($Na^+$), potassium ($K^+$) and chloride ($Cl^-$). Electrolytes were analyzed by the flame photometric and spectrophotometric methods of AOAC, (2000).

**Experimental Design and Statistical Analysis**

The study was carried out as a completely randomized design (CRD). Data were subjected to analysis of variance (ANOVA) using general linear model (GLM) procedure of SAS. Treatment means were compared using Bonferoni's test. Because CRD was used the model was: $Y_{ij} = \mu + X_i + E_{ij}$, where $Y_{ij}$ = individual observation of the treatment, $\mu$ = population mean, $X_i$ = effect of the $i^{th}$ treatment and $E_{ij}$ = the error term. An *α-level* of *0.05* was used for all statistical comparisons to represent significance.

**Results**

The results of the performances of the animals in the $T_1$, $T_2$ and $T_3$ diet groups are shown in Table 1.

**Table 1. Mean Growth Responses of Broiler Chickens Fed Different Vitamins-Based Diets**

| Item | Treatments | | | SEM | *P-value* |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | | |
| ADFI (g) | 162.0 | 161.23 | 160.71 | 0.12 | 0.67 |
| Initial weight (Kg) | 1.10 | 1.11 | 1.10 | 0.11 | 0.97 |
| Final weight (kg) | $2.24^c$ | $3.0^b$ | $3.5^a$ | 0.58 | 0.02 |
| ADG (g) | $40.73^c$ | $67.5^b$ | $85.71^a$ | 2.64 | 0.001 |
| FE (ADG/ADFI) | $0.25^c$ | $0.42^b$ | $0.53^a$ | 0.10 | 0.001 |

Means within each row with different superscript significantly differ ($P < 0.05$)

As shown in Table 1, the ADFI of the animals from all dietary treatment groups were similar as there were no significant ($P > 0.05$) differences between them. However, despite the non-existence of significant differences in the average daily feed intake, there were significant ($P < 0.05$) differences in the rates of weight gain during the study period by the animals of the different dietary treatment groups. To this point, animals in the $T_1$ dietary group demonstrated ADG of 40.73g which was significantly ($P < 0.05$) lower than the rates animals in the $T_2$ dietary treatment group gained weight, that is, 67.5g whereas animals in the $T_3$ dietary treatment group had the best or highest (85.71g) ADG compared with animals with the $T_1$ and $T_2$ treatment groups with the $T_2$ treatment group animals being the intermediate.

The FE mirrored the ADG pattern. There were significant ($P < 0.05$) differences in the FE of the three dietary treatment groups. Just as it was with the ADG, the FE of the $T_1$ group was the lowest (0.25) while that of $T_2$ (0.42) was the intermediate between those of $T_1$ and $T_3$ (0.53) treatment groups. By this again, the FE of the $T_3$ group was significantly ($P < 0.05$) the highest amongst the three dietary treatment groups.

The results of the electrolytes of the animals in the $T_1$, $T_2$ and $T_3$ diet groups are shown in Table 2.

**Table 2. $Na^+$, $K^+$ and $Cl^-$ Serum Contents of Broiler Chickens Fed Different Vitamins-Based Diets**

| Item | Treatments | | | SEM | *P-value* |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | | |
| $Na^+$ (mmol/L) | 145 | 144 | 145 | 0.35 | 0.94 |
| $K^+$ (mmol/L) | 4.9 | 4.7 | 4.8 | 0.18 | 0.88 |
| $Cl^-$ (mmol/L) | 93 | 93 | 92 | 0.38 | 0.98 |

As shown in Table 2, the ingested vitamins-based diets had no effects on the electrolytes as there were no significant ($P > 0.05$) differences amongst the different dietary treatments.

**Discussion**

Antibiotics had been used in the diets of non-ruminant animals, including poultry at sub-therapeutic levels for years to improve growth and reproductive performance (NRC, 2012). At present there are bans of the use of certain antibiotics in non-ruminants' diets, principally due to development of certain strains of pathogenic organisms that are resistant to some antibiotics. From nutrition standpoint, growth physiologically can be used to assess the health status of an animal. Economically, normal growth rate of the animal is a characteristic all animal farmers cherish as it positively affects profit margins in any commercial setting of animal production, including poultry.

Again, with the bans of the use of antibiotics in the diets of animals the animal producers are strategizing for alternatives to antibiotics as to be able to sustain and keep the levels of their animal performance at optimum levels. Nutall *et al.* (1999) and later Salonen *et al.* (2000), respectively, from there result data demonstrated that antioxidant vitamins, particularly vitamins C and E could be used as replacements for antibiotics as to boost the health of the animal and thus better support improved animal performance. These observations were also confirmed in the studies of Lu *et al.* (2014) and Johnson *et al.* (2019) in the pig, especially when the vitamins were given in combinations. In this current study, the effects of vitamins A, C and E were investigated. As shown in Table 1, the results showed that despite the similarity in the ADFI, there were significant differences in the ADG. For instances, while the $T_1$ group of animals had an ADG value of 40.73g, the diets with the added vitamins, that is, the $T_2$ and $T_3$ groups gains were superior to the value of the $T_1$ group. These were 67.5g and 85.71g, respectively. In true economic terms these translated into 66% and over 110% improvements respectively, for the $T_2$ and $T_3$ groups over that of $T_1$ group. Furthermore, the FE of $T_2$ and $T_3$ dietary groups were 68% and 112% superior, respectively over that of $T_1$ group. From the findings of this study, it is clear that fortifying broiler diets with antioxidant vitamins in the combined form as was in this study enabled the vitamins to exert their antioxidant potentials that aided the animals to perform better than the $T_1$ animals whose diet contained only basal level of the vitamins (about 30mg/kg of diet). One of the major theories that might be used to explain at least in part the major findings of this study might not be unrelated to the synergy between antioxidant vitamins in their modus operandi particularly the combinations of vitamins C and E. This is related to the fact that vitamin C always regenerate vitamin E leading to sustained activities of these vitamins in upregulating the animal defense systems, such as the immune and glutathione defense systems of the animal (Salonen *et al.,* 2000). The overall effect of this therefore, would result in better growth performance as observed in this current study. Nevertheless, the ingested antioxidant vitamins had no effects on the electrolytes studied.

## Conclusion

Antioxidant vitamins A, C and E when offered in combinations to broilers better support broiler growth and feed efficiency, especially the dietary combinations of vitamins C and E. However, they had no effects on the sodium, potassium and chloride ions.

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