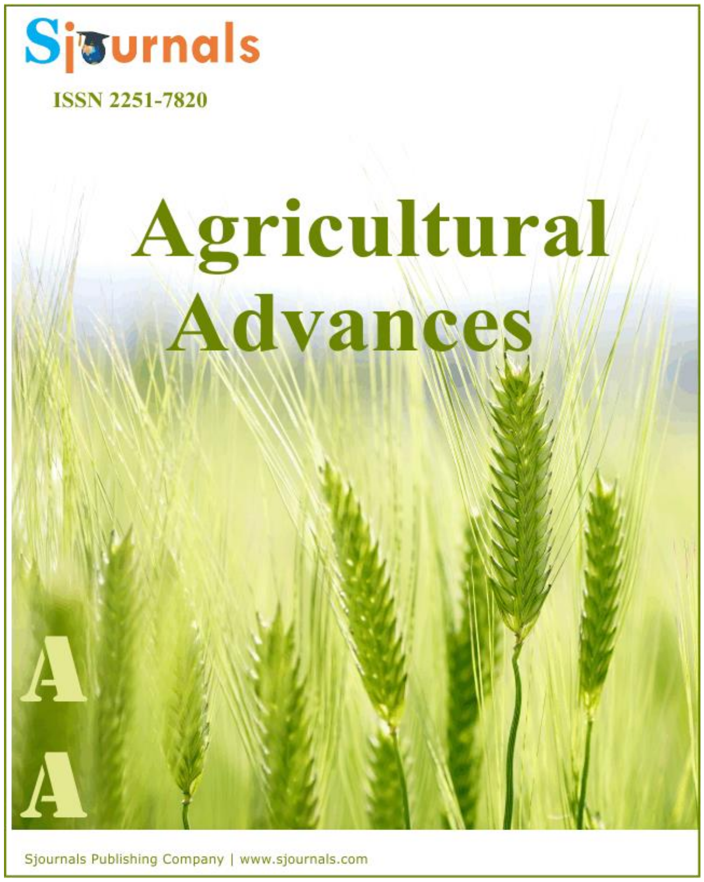
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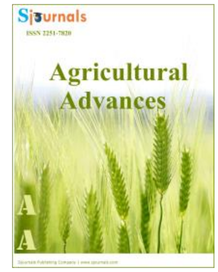


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**Original article**

# Effect of ascorbic acid on the performance and carcass characteristics of broiler birds in semi-arid zone, Sokoto state, Nigeria

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A B S T R A C T

Marshal strain of broiler chicken were used to determine the effect of Ascorbic acid (AA) on the performance and carcass characteristics of broiler birds at starter and finisher phase in Sokoto, Nigeria at different levels of AA inclusion. 225 day-old chicks were housed in a standard open sided tropical house type under deep litter system. The birds were randomly assigned to three treatments (0g, 10g and 20gAA) replicated Five times in completely randomize design (CRD). Feed intake (FI), body weight (BW), body weight gain (BWG) and feed conversion ratio (FCR) were determined. At the end of the experiment, 15 birds were randomly selected from each treatment, fasted, killed and their carcass weight analyzed. The result showed that there is significance difference P<(0.05) between BW and FCR at starter phase. And no significant difference P>(0.05) between FI and BWG. At finisher phase, the result showed that there is significance difference P<(0.05) between BW and BWG and significance difference P>(0.05) does not exist between FI and FCR across all the treatments. Birds fed diet with 0g AA performed better compared to other treatments in terms of FCR at finisher phase. While in the finisher phase those fed with 10g AA performed better compared to other treatments on the remaining parameters and also better in FCR at starter phase. Carcass analysis revealed significance difference P<(0.05) between the treatment means with response to drumstick, legs, neck and gizzard while the other cuts and organs were statistically similar. Birds fed with 10g were superior in most of the parameters mentioned. It's recommended that to include AA in broiler diets at 10g level of AA.



**1. Introduction**

Poultry is a general term for birds of several species such as chicken or domestic fowls, ducks, geese, guinea fowls, pigeons, ostriches and other game birds (Okunnade et al., 2000). In Nigeria, different poultry species contribute significantly to the animal protein supply of the populace in terms of eggs laid (Orumuyi et al., 2007) and meat produced. The general objective of poultry nutrition is to maximize the production performance of birds (Uchegbu et al., 2007). Profitability in the poultry industry depends largely on the biological efficiency of the birds in terms of high egg production, efficiency of feed consumption and life ability. The economic efficiency of chicken meat appears to be dependent on the growth rate of the birds (Adegbola, 1990). Over the years, poultry industry, chicken in particular has been the major source of animal protein in Nigeria. A substantial proportion of Nigeria foreign exchange goes to the importation of livestock, day old chicks and other foreign inputs in order to satisfy the local demand. However, the massive importation of poultry meat cannot provide a lasting solution to the problem of increasing animal poultry demand in Nigeria. Therefore, a planned development of livestock industry and increased poultry production would appear to be a better way of closing the protein gap at both short and long demand. Increase in egg and meat production can be achieved through proper nutrition (Etim and Oguike, 2010). Feed is an important aspect of poultry production (Adenkola et al., 2013). Poultry production especially broiler chicken remains one of the viable way of achieving sustainable and rapid production of high quality animal to meet the increasing demand of the Nigerian teeming population. However, high cost of energy and protein concentrates used in formulation of poultry feeds has remained a significant challenge to the poultry industry, (Apata and Ojo, 2000).

Ascorbic acid (AA) also known as Vitamin C produces anti-stress hormones which help to combat the effect of stress caused on animal body. AA is a water soluble anti-oxidant that is normally produced in adequate quantity by metabolism in birds when not stressed. Butcher and Miles (2003) explained that its use as an anti-stress agent is often considered during periods of heat-stress since AA plays a major role in the biosynthesis of corticosterone, a hormone that enhances energy supply during stress.

Commercial broilers are economic agricultural field production units in which the objective is to maximize field performance. Poultry require supplementary dietary vitamins since common feed ingredients used in poultry production do not provide adequate quantities to meet minimum requirements (Leeson and Summers, 2001). Broilers are in continuous stress due to faster growth rate, pathogens, and the ever-changing environmental conditions in the broiler houses (McCorkle and Glick, 1980). Poultry have the ability to synthesize ascorbic acid, or vitamin C (VC), in their body (McDowell, 2000); hence, no recommended requirement is established by the NRC (National Research Council, 1994). That is why small scale broiler farmers are having difficulty in given the required dosage for the effective management of broilers. However, the study will help poultry farmers of the study area in solving the problems of effective use of supplemented ascorbic acid.

Poultry production has long been recognized as one of the quickest ways for rapid increase in protein supply in the shortest run (Yusuf and Malomo, 2007), the study is carried out in the semi-arid zone, the area is characterized with higher temperature which is one of the constraint in poultry production, Ascorbic acid (AA) also known as Vitamin C produces anti-stress hormones which help to combat the effect of stress caused on animal body, the study will help poultry farmers in the effective use of supplemented ascorbic acid to reduce the effect of heat stress. The main objective of the study is to assess the effect of ascorbic acid on the performance and carcass characteristics of broiler birds in semi-arid zone Sokoto, Nigeria. The specific objectives are:

1. To assess the effect of ascorbic acid on the performance of broiler birds
2. To assess the effect of ascorbic acid on the carcass characteristics of broiler birds
3. To evaluate the performance and carcass characteristic at different level of Ascorbic acid inclusion

## 2. Materials and methods

### 2.1. Description of the study area

The experiment was conducted in the poultry production and research unit of the Department of Animal Science, Faculty of Agriculture, Usmanu Danfodiyo University, Sokoto, at Sokoto State veterinary Centre, Aliyu Jedo road in Sokoto metropolis. Sokoto State is located between latitudes 13$^{o}$05 and 13$^{o}$08'N and longitudes 5$^{o}$15' and 5$^{o}$25'E, within the Sudan savannah zone, in the extreme north western part of Nigeria and at an altitude of 350m above the sea level (Mamman et al., 2000; Aregheore, 2009). It is bordered in the north with Niger Republic, Zamfara state to the east and Kebbi state to the south and west (SSMIYSC, 2010). The annual rainfall ranges between 500mm to 1,300mm. There are two major seasons in the state namely: wet and dry seasons. The dry season starts from October and last up to April, in some part and may extend to May to June in other part. The west season on the other hand begins in most part of the state in May and last up to September or October (SSMISC, 2010).

### 2.2. Experimental birds and their management

Two hundred and twenty-five (225) day old broiler chicks (Marshall) was used for the study. The chicks were housed in a standard open-sided tropical house type under deep litter system. The housing was disinfected and fumigated, as well as thorough cleaning. The drinkers and feeders will also be kept clean, water and feed was provided *ad libitum*. The floor was covered using litter such as wood shavings. Administration of vaccine was accordingly and disease outbreak was managed adequately.

### 2.3. Experimental feed material and their sourcing

Commercial feed was given for 4 days; feed was self-formulated without the test ingredient which was given for 4 days which served as adjustment; afterward the test ingredient (Ascorbic acid) was added to the self-formulated feed which was given for 7 weeks. The feed ingredients which include maize, soya bean, groundnut cake, wheal offal, was sourced from Sokoto State central market. Other ingredients which include; bone meal, limestone, premix, salt, lysine and methionine was obtained from supply store.

### 2.4. Feed formulation

The feed was self-formulated; the process involves in the formulation include;

**Milling/Grinding:** The size of the ingredient was reduced by grinding using a simple grinder which will help in the improvement of the digestibility and result in more uniform feed.

**Weighing of Ingredient:** The grounded ingredient was weighed using weighing scale, some of the ingredients was weighed in grams (g) and others in kilograms (kg).

**Mixing:** Mixing was carried out on a clean floor, proper mixing of the grounded ingredients was ensured by the following step:

- ✓ Assembled ingredients was spread on the cleaned floor one after the other in a distinct layer
- ✓ Smaller ingredient was premixed with wheat-offal or ground grains before spreading
- ✓ Shoveling the feed from one end of the pile to the other to form a cone shaped pile
- ✓ The mixture was shoveled in this manner for five(5) or more times to produce a homogenous mixture
- ✓ The mixed feed was bagged in a dry bag for storage

### 2.5. Experimental design

Total number of birds was 225, Completely Randomize Design (CRD) was used, Three treatments (75 birds each) and five replicates (15 birds each).

Treatment one (T1) served as control with 0% ascorbic acid, Treatment two (T2) was containing 10g of Vitamin C in 10kg feed, Treatment three (T3) was containing 20g of ascorbic acid in 10kg feed.

### 2.6. Data collection

#### 2.6.1. Performance

To assess the performance of the bird the following parameters was measure:

**Feed intake:** feed intake was recorded in daily basis by subtracting the weight of the remnant from weight of the quantity given the previous day
**Body weight gain:** The weight gain was recorded on weekly basis by using a weighing scale
**Feed conversion ratio:** The feed conversion ratio was determined by dividing average feed intake per bird by body weight per bird
**Mortality:** Mortality was recorded on daily basis

### 2.6.2. Carcass characteristics

**Primal cuts:** Birds from different treatment was randomly selected for Primal cut, which was used to assess the carcass characteristics, the primal cut includes: the drumstick, thighs, breast, wings, bark, and neck.
**Organs**: organs to be assess include gizzard, liver, heart, lungs, crop, spleen, head, intestine, bile, abdominal fat.

### 2.6.3. Weight and percentages

The percentage of live weight, killed weight, plucked weight (carcass), and dressed weight was recorded.

### 2.6.4. Data analysis

The data collected was analyzed using descriptive statistics i.e. means percentages, ranges. Some data were analyzed using analysis of variance (ANOVA). Significant means was separated using Least Significant Difference (LSD).

**Table 1**
Gross feed and chemical composition of the starter and finisher diet.

| **Ingredients** | | |
|---|---|---|
| **Feed composition** | **Starter (Kg)** | **Finisher (Kg)** |
| Maize | 50.0 | 49.0 |
| Soya bean meal | 18.0 | 22.0 |
| Groundnut cake | 20.0 | 12.0 |
| Wheal offal | 8.0 | 13.0 |
| Limestone | 1.5 | 0.5 |
| Bone meal | 1.5 | 2.5 |
| Premix | 0.25 | 0.25 |
| Lysine | 0.25 | 0.25 |
| Methionine | 0.25 | 0.25 |
| Salt | 0.25 | 0.25 |
| Total | 100 | 100 |
| **Composition** | **Starter diet (%)** | **Finisher diet (%)** |
| ME ( kcl/kg) | 3054 | 2941 |
| CP | 23.0 | 21.0 |
| Lysine | 0.9 | 1.1 |
| Methionine | 0.6 | 0.6 |
| Ca | 1.0 | 0.9 |
| P | 0.5 | 0.6 |
| Fibre | 6.0 | 5.4 |

## 3. Results and discussion

### 3.1. Performance characteristics at starter phase

The result on the performance characteristics of experimental broiler birds are shown in Table 4.1

**Table 4.1**
The results on performance characteristic of broiler birds at starter phase.

| Parameters | T1(0g) Control | T1(10g) AA | T3(20g) AA | SEM* |
|---|---|---|---|---|
| Total feed intake (TFI) | 14442.18 | 14128.07 | 14111.34 | 176.81806 |
| Average feed intake per bird (AFIB) | 1368.35 | 1284.37 | 1333.99 | 42.49953 |
| Average feed intake per bird per day (AFIBD) | 195.48 | 183.48 | 190.57 | 6.07136 |
| Total body weight (TBW) | 18155.72$^{b}$ | 19092.30$^{a}$ | 19677.67$^{a}$ | 390.21682 |
| Body weight per bird (BWB) | 1717.88 | 1735.66 | 1862.30 | 63.58478 |
| Body weight per bird per day (BWBD) | 245.41 | 247.95 | 266.04 | 9.08354 |
| Body weight gain (BWG) | 7620.75 | 8141.87 | 8257.64 | 303.16305 |
| Body weight gain per bird (BWGB) | 719.30 | 740.17 | 781.80 | 30.66550 |
| Body weight gain per bird per day (BWGBD) | 102.76 | 105.74 | 111.69 | 4.38079 |
| Feed conversion ratio | 1.90$^{b}$ | 1.74$^{a}$ | 1.71$^{a}$ | 0.06042 |

### 3.2. Total feed intake (TFI)

Results of TFI performance are presented in Table 4.1 which shows that T1(control) has the highest mean feed intake of 14442.18g, followed by treatment T2(10g) with mean feed intake of 14128.07g while the last treatment T3 (20g AA) which has the lowest mean feed intake of 14111.34g at starter phase, with SEM of 176.1806. The result indicate that there is no significant difference between the treatments. However the values are statistically the same but slightly differed numerically.

Mean weekly feed intake (MWFI) of the experimental birds as shown in Appendix 1 and Figure 1 increases from week 2 to week 4 in all the treatment, and ranges from the lowest value (3073.03g) recorded in treatment 2 (10gAA) at week 2 to the highest (6648.43g) in treatment 1 (0gAA) at week 4. This shows that with inclusion of AA in the feed of the birds tend to eat less, precisely it shows that birds consumed diets without AA inclusion perform better in terms of feed intake when compared to those with AA inclusion at starter phase. This is in agreement with the findings of Kafri and Cherry (1984), Kutlu and Forbes (1993), who reported that dietary supplemental AA tended to reduce performance of broiler chickens.

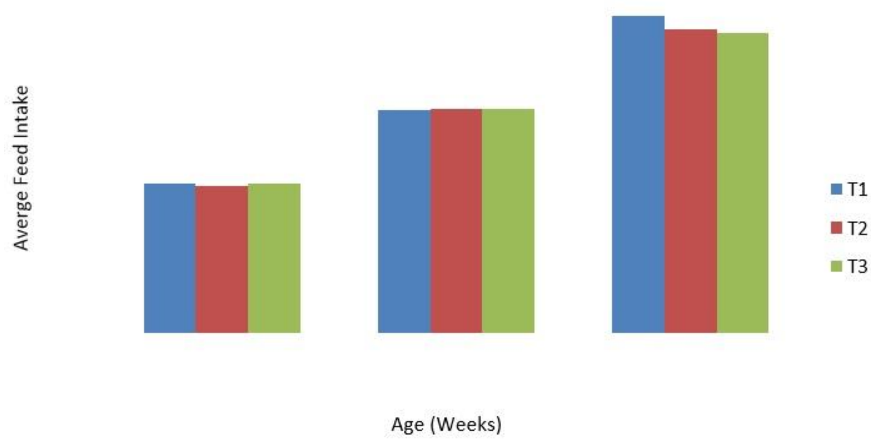


**Fig. 1.** Average feed intake at starter phase.

### 3.3. Average feed intake per bird (AFB)

Results on average feed Intake are presented in Table 4.1 which of the experimental broiler birds showed that $T_2$ was highest with (1368.35) for birds consuming 0gAA then followed by birds in $T_3$ with (1333.99) consuming 20gAA and lowest was (1284.37) for birds in $T_2$ on 10gAA. Results showed that significant difference (p>0.05) does not exist between $T_1$,$T_2$ and $T_3$. SEM recorded under AFB was 42.49953.

### 3.4. Average feed intake per bird per day (AFBD)

Results on Average feed Intake per bird per day of the experimental broiler birds are presented in Table 4.1 which shows that $T_3$ was lowest (183.48) for birds consuming 10gAA and (190.57) for birds in $T_3$ consuming 20gAA the highest being 195.48 for birds in $T_1$ on 0gAA. However, significant difference (p>0.05) does not exist between treatments. SEM recorded under AFBD was 6.07136.

### 3.5. Body weight

#### 3.5.1. Total body weight (TBW)

Results of TBW are presented in Table 4.1. which shows that significant difference (p< 0.05) exist between $T_2$, $T_3$ and $T_1$, while $T_2$ and $T_3$ were statistically similar but they numerically differed. SEM recorded under TBW was (390.21682). Results on total body weight of the experimental broiler birds indicated that TBW (g) was highest (19677.67.) in $T_3$ for birds consuming 20gAA then followed by birds in $T_2$ with (19092.30) consuming 10gAA and lowest was (18155.72) for birds in $T_1$ on 0gAA, which recommend that AA should be included in a feed diet of broiler birds at a level of 20g due to its influence on increase body weight at starter phase. Mckee et al. (1995) also demonstrated that 150 mg AA/kg feed significantly alleviated heat-related reductions in weight gain of birds of the same age, sex, and breed.

Mean weekly body weight of the experimental birds increase at an increasing rate as they aged, as it was shown in Appendix 3 Figure 2 which ranges from the lowest (3347.10g) in treatment 1 (0gAA) at week 2 to the highest (9795.60g) in treatment 3 (20gAA) at week 4.

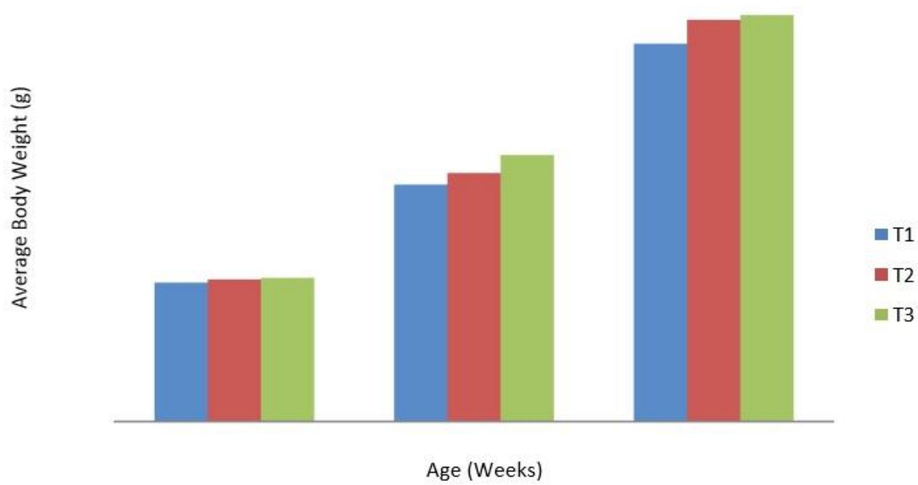


**Fig. 2.** Average weekly body weight at starter phase.

#### 3.5.2. Body weight per bird (BWB)

Results on body weight per bird of the experimental broiler birds are presented in Table 4.1 which shows that BWB (g) was highest (1862.30) in $T_3$ for birds consuming 20gAA, the medium being (1735.66) for birds in $T_2$ consuming 10g-AA and the lowest was 1717.88 for birds in $T_1$ on 0gAA. However, significant difference (p>0.05) does not exist between treatments. SEM recorded under BWB was 63.58478.

#### 3.5.3. Body weight per bird per day (BWBD)

The result of BWBD are presented in Table 4.1 where BWBD values of 245.41, 247.95 and 266.04 were recorded for birds $T_1$,$T_2$ and $T_3$. Results on body weight per bird per day indicated that BWBD (g) was lowest with (245.41) for birds in $T_2$ consuming 0gAA then followed by 247.95 for birds in $T_2$ consuming 10gAA and highest was 266.04 for birds in $T_3$ on 20gAA. However, significant difference does not (p>0.05) exist between $T_1$, $T_2$ and $T_3$. SEM recorded under BWBD was 9.08354.

#### 3.5.4. Body weight gain (BWG)

Results of BWG are presented in Table 4.1. Significant difference (p>0.05) does not exist between the treatments. SEM recorded under BWG was 303.163.5. Results on body weight gain of the experimental broiler birds indicated that BWG (g) was lowest (7620.75) in $T_1$ for birds consuming 0gAA then followed by (8141.87) in $T_2$ for birds consuming 10gAA and highest was 8257.64 for birds in $T_3$ on 20gAA.This indicate that 20gAA has more effect than the other levels of ascorbic acid inclusion (10gAA and 0gAA) which means that T3 perform better than the other treatments in terms of body weight gain at starter phase.

Mean weekly body weight gain of the experimental birds increase at an increasing rate as they age as it was in the feed intake as shown in Appendix 5 and Figure 3.

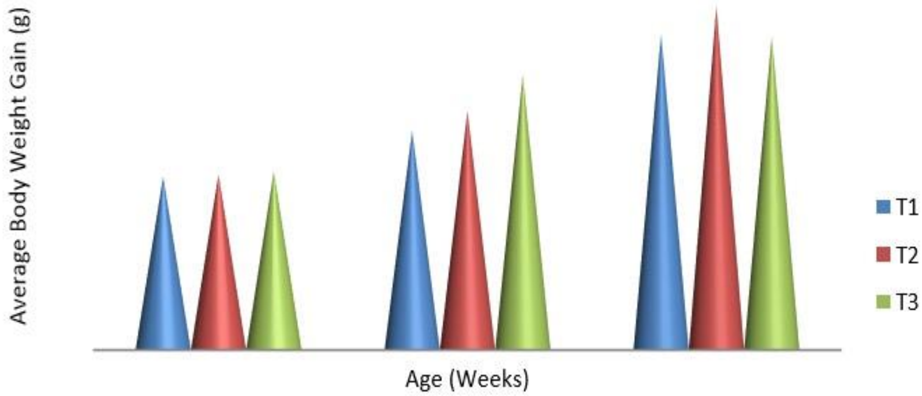


**Fig. 3.** Average weekly body weight gain at starter phase.

### 3.5.5. Body weight gain per bird (BWGB)

Results on body weight gain per bird of the experimental broiler birds are presented in Table 4.1 which shows that BWGB (g) was lowest (719.30) in $T_1$ for birds consuming 0gAA then followed by 740.17 for birds in $T_2$ consuming 10gAA highest was 781.80 for birds in $T_3$ on 20gAA.However, significant difference ($p>0.005$) does not exist between treatments. SEM recorded under BWGB was (30.66550).

### 3.5.6. Body weight gain per bird per day (BWGBD)

Result of BWGBD are presented in Table 4.1 which shows that BWGBD values of 102.76, 105.74 and 111.69 were recorded for birds on $T_1$, $T_2$ and $T_3$. Results on body weight gain per bird per day (BWGBD) indicated that BWGBD (g) was highest (111.69) in $T_3$ for birds consuming 20gAA then followed by (105.74) in $T_2$ for birds consuming 10gAA and lowest was 102.76 for birds in $T_1$ on 0gAA. However, significant difference ($p>0.05$) does not exist between treatment. SEM recorded under BWGBD was 4.38079.

### 3.6. Feed conversion ratio (FCR)

In Table 4.1, the results of FCR recorded SEM of 0.06042. Results on Feed Conversion Ratio of the experimental broiler birds narrated that FCR was highest (1.90) in $T_1$ for birds consuming 0gAA then followed by (1.74) for birds in $T_2$ consuming 10gAA and lowest was 1.71 for birds in $T_3$ on 20gAA. Results showed that FCR means of $T_2$,$T_3$ were statistically similar; but they differed numerically. However, significant difference ($p<0.05$) exist between the treatments $T_2$,$T_3$ and $T_1$, even though the difference is not much.

The mean weekly feed conversion ratio of the experimental birds ranges from the lowest (1.60) the most desirable value in treatment 3 (20gAA) at week 3, to the highest and least desirable value (2.04) in treatment 1 (0gAA) in week 4 as shown in Appendix 7 and Figure 4.

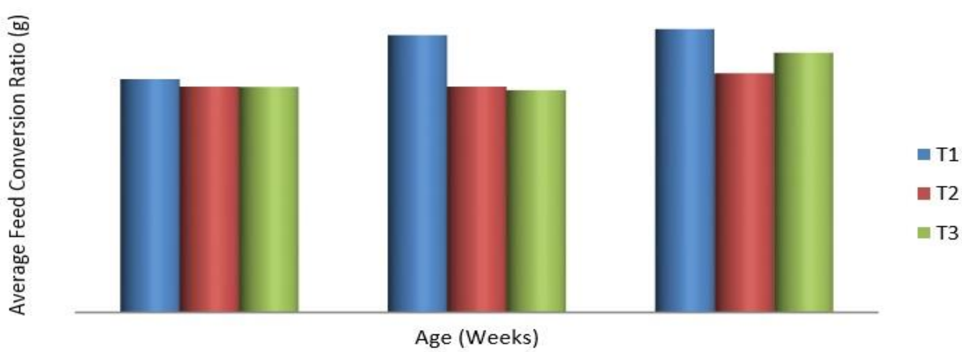


**Fig. 4.** Average weekly feed conversion ratio at starter phase.

### 3.7. Performance characteristics at finisher phase

Results obtained from the experiment at starter phase on performance characteristics of broiler birds are presented in Table 4.2.

**Table 4.2**
The results on performance characteristic of experimental broiler birds at finisher phase.

| Parameters | T1 (0g) Control | T2 (10g) AA | T3 (20g) AA | SEM |
|---|---|---|---|---|
| Total feed intake (TFI) | 31214.32 | 32107.49 | 26430.18 | 2682.63 |
| Average feed intake per bird (AFIB) | 2952.69$^{b}$ | 2918.86$^{b}$ | 3936.81$^{a}$ | 309.30 |
| Average feed intake per bird per day (AFIBD) | 421.81$^{b}$ | 416.98$^{b}$ | 562.40$^{a}$ | 44.19 |
| Total body weight (TBW) | 58814.22$^{ab}$ | 62832.73$^{a}$ | 47692.67$^{b}$ | 5975.56 |
| Body weight per bird (BWB) | 5555.97$^{b}$ | 5712.07$^{b}$ | 6889.8$^{a}$ | 376.40 |
| Body weight per bird per day (BWBD) | 793.71$^{b}$ | 816.01$^{b}$ | 984.26$^{a}$ | 53.77 |
| Body weight gain (BWG) | 14182.96$^{a}$ | 16465.15$^{a}$ | 5527.52$^{b}$ | 2804.77 |
| Body weight gain per bird (BWGB) | 1344.96$^{ab}$ | 1496.83$^{a}$ | 388.09$^{b}$ | 449.36 |
| Bogy weight gain per bird per day (BWGBD) | 192.14$^{ab}$ | 213.83$^{a}$ | 55.44$^{b}$ | 64.19 |
| Feed conversion ratio (FCR) | 2.21 | 1.95 | 3.73 | 1.96 |

#### 3.7.1. Total feed intake (TFI)

Results of TFI performance are showed in Table 4.2 which indicate that T1(control), T2(10g) and T3(20g) had (31214.32g), (32107.49g) and (26430g).18g respectively with SME (2682.63). From the result obtained, T2(10g) had the highest mean value followed by T1(control) for birds consuming (0gAA) and then T3 the lowest for birds consuming (20g AA). The result indicate that there is no significant difference between the treatments. However the means were statistically similar but differed numerically.

Result on weekly mean feed intake of the experimental birds at finisher phase showed that there is increase in feed intake from week 5 to 6 but reduce from week 6$^{th}$ to 7$^{th}$ as shown in Appendix 2 and Figure 5. However, the weekly mean feed intake at finisher phases ranges from highest (12209.33) in $T_2$ (10gAA) at week 6 to the lowest (7354.86) in $T_3$ 20gAA at week 7$^{th}$. However, there is decline from week 6$^{th}$ to week 7$^{th}$ in feed intake and also across treatment. The fluctuation in feed intake across the treatments may be attribute to disease incidence in treatment 3 (20gAA) in the 7$^{th}$ week of the experiment.

Adenyemi et al. (2015) reported on his experiment; Effect of ascorbic acid supplementation on broiler chicken stock at different densities in a humid tropical environment, that The total feed intake of broilers on optimal stocking density was similar (p>0.05) in feed intake of birds on double optimal stocking density supplemented with 300mg AA/litre of water. The least feed intake was however recorded for broilers on double optimal stocking density without AA supplementation.

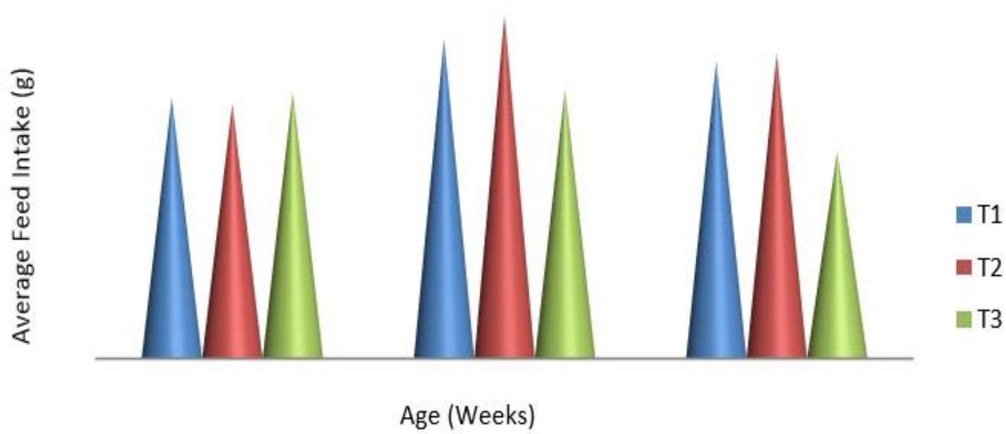


**Fig. 5.** Averge feed intake at finisher phase.

**3.7.2. Average feed intake per bird (AFB)**

Results on average feed Intake per bird of the experimental broiler birds are presented in Table 4.2 which revealed that $T_1$, $T_2$ were statistically similar which shows that significant different ($p>0.05$) exist between ($T_1$,$T_2$) and $T_3$. However $T_3$ has the highest value (3936.81g) for birds consuming 20gAA then followed by birds in $T_1$ with (2952.69g) consuming 0g AA and lowest was 2918.86g for birds in $T_2$ on 10g AA. SEM recorded under AFB was (309.30).

**3.7.3. Average feed intake per bird per day (AFBD)**

Results on average feed Intake per bird per day of the experimental broiler birds are presented in Table 4.2 which revealed that $T_1$, $T_2$ were statistically similar and significant different ($p>0.05$) exist between them and $T_3$. However $T_3$ has the highest value (562.40g) for birds consuming 20gAA then followed by birds in $T_1$ with (421.81g) consuming 0g AA and lowest was( 416.18g) for birds in $T_2$ on 10g AA.. SEM recorded under AFBD was (44.19).

**3.8. Body weight**

**3.8.1. Total body weight (TBW)**

The results of TBW are presented in Table 4.2. Significant difference ($p>0.05$) exist between all the treatments ($T_1$, $T_2$ and $T_3$). SEM recorded under TBW was (5975.56). However, the results on total body weight of the experimental broiler birds indicated that TBW (g) was highest (62832.73g) in $T_2$ for birds consuming 10gAA then followed by birds in $T_1$ with (58814.22g) consuming 0gAA and lowest was (47692.67g) for birds in $T_3$ on 20gAA.This shows that consumed 10gAA performed better compared to those with (20g and 0g) of ascorbic acid inclusion.

In appendix 4 and Figure 6 the result on mean weekly body weight gain of the experimental bird shows that the body weight gain increase as the age of the birds increases. However body weight fluctuate only across the treatment but progressively increases through the weeks. Which indicate an increase from week $5^{th}$ to week $7^{th}$ but decline in all the treatment. The mean ranges from the lowest (1417.0g) in treatment 1 (0gAA) at week 5 to the highest (26144.82g) in treatment 2 (10gAA) at week 7.

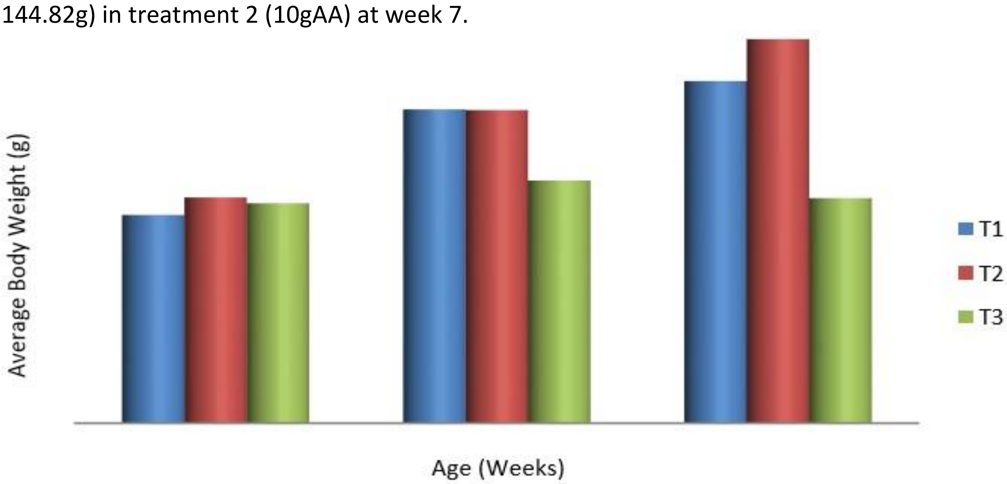


**Fig. 6.** Average weekly body weight at finisher phase.

**3.8.2. Body weight per bird (BWB)**

Results on body weight per bird of the experimental broiler birds are presented in Table 4.2 which shows that body weight per birds (BWB) was highest (6889.8g) in $T_3$ for birds consumed 20gAA, the medium being (5712.07g) for birds in $T_2$ consumed 10gAA and the lowest was 5555.97g for birds in $T_1$ on 0gAA. However, there is significant difference ($p<0.05$) between the treatments, in which $T_2$ and $T_1$ were statistically similar. SEM recorded under BWB was 376.40.

### 3.8.3. Body weight per bird per day (BWBD)

In Table 4.2, the result of body weight per bird per day revealed that BWBD(g) values of (793.71), (816.01) and (984.26) were recorded for birds $T_1$,$T_2$ and $T_3$ respectively. Results on body weight per bird per day indicated that BWBD (g) was lowest with (793.71) for birds in $T_1$ consuming 0gAA then followed by 816.01 for birds in $T_2$ consuming 10gAA which was the moderate and highest was 984.26 for birds in $T_3$ on 20gAA. However, significant difference ($p>0.05$) exist between $T_2$,$T_1$ and $T_3$ in which $T_2$,$T_1$ were statistically similar but differed numerically. SEM recorded under BWBD was (53.77).

### 3.8.4. Body weight gain (BWG)

Results of BWG are presented in Table 4.2 which revealed Significant difference ($p>0.05$) between treatments ($T_1$, $T_2$ and $T_3$) in which $T_2$, $T_1$ were statistically similar. SEM recorded under BWG was 2804.77. Results on body weight gain of the experimental broiler birds indicated that BWG (g) was lowest (5527.52) in $T_3$ for birds consuming 20gAA then followed by (14182.96) in $T_1$ for birds consuming 0gAA which was moderate and highest was (16465.15) for birds in $T_2$ on 10gAA.

Weekly body weight gain of the experimental birds at finisher phase as shown in Appendix 6 and Figure 7 ranges from the lowest (1927.41g) in treatment 1 at week 7 to the highest (7187.71g) at the same treatment at week 6 which indicate that there was decline across treatments and weeks. The fluctuation in body weight gain across the weeks and treatments may be attribute to disease incidence in $T_3$ and $T_2$ at $7^{th}$ week of the experiment.

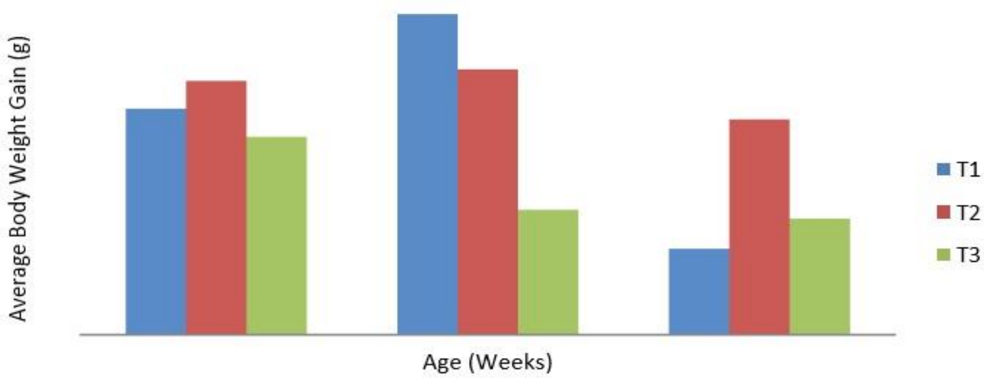


**Fig. 7.** Average weekly body weight gain at finisher phase.

### 3.8.5. Body weight gain per bird (BWGB)

Results on body weight gain per bird of the experimental broiler birds are presented in Table 4.2 which shows that BWGB (g) was lowest (388.09) in $T_3$ for birds consuming 20gAA then followed by (1344.96) for birds in $T_1$ consuming 0gAA highest was (1496.83) for birds in $T_2$ on 10gAA. However, significant difference ($p<0.05$) exist between all the treatments. SEM recorded under BWGB was (449.36).

### 3.8.6. Body weight gain per bird per day (BWGBD)

Results of body weight gain per bird per day are presented in Table 4.2. BWGBD values of (192.14), (213.83) and (55.44) were recorded for birds on $T_1$, $T_2$ and $T_3$ respectively. Results on body weight gain per bird per day (BWGBD) indicated that BWGBD (g) was highest (213.83) in $T_2$ for birds consuming 10gAA then followed by (196.14) in $T_1$ for birds consuming 0gAA and lowest was (55.440 for birds in $T_3$ on 20gAA. However, significant difference ($p>0.05$) exist between all the treatments. SEM recorded under BWGBD was (64.19).

### 3.9. Feed conversion ratio (FCR)

The results of FCR are presented in Table 4.2 which recorded SEM of 1.96.The results on Feed Conversion Ratio of the experimental broiler birds narrated that FCR was highest (3.73) in $T_3$ for birds consuming 20gAA then followed by (2.21) for birds in $T_1$ consuming 0gAA and lowest was 1.95 for birds in $T_2$ on 10gAA. Results showed that FCR means of $T_2$,$T_3$ and $T_3$ are statistically similar; but they differ numerically. However, significant difference ($p>0.05$) does not exist between the treatments.

The weekly feed conversion ratio of the experimental birds ranges from the lowest and most desirable value (1.18g) in treatment 3 (20gAA) at week 7th to the highest and least desirable (5.89g) in treatment 1 at week 7th. Which indicate that there was decline across treatments and weeks. The experimental birds in treatment 3 have the best feed conversion ratio due to the high level of Ascorbic Acid inclusion while for those in treatment 1 with 0 inclusion of Ascorbic Acid have poor feed conversion ratio.

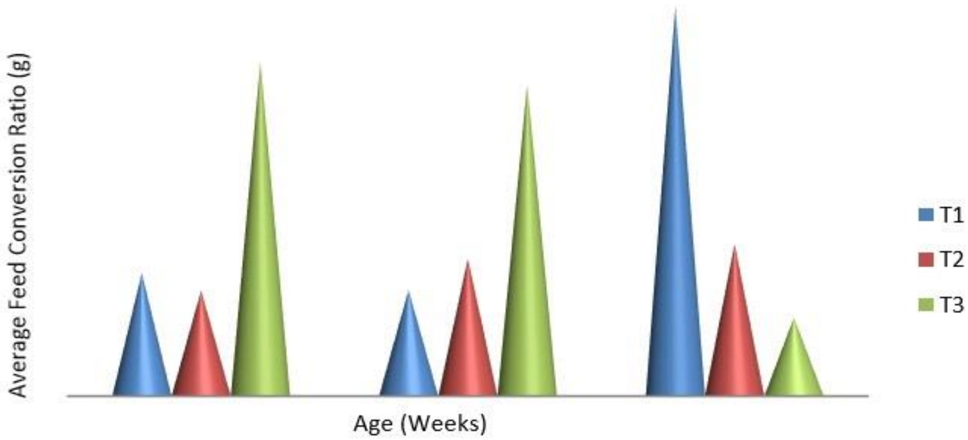


**Fig. 8.** Average weekly feed conversion ratio at finisher phase.

### 3.10. Carcass characteristics of boiler birds

The results of the carcass characteristics obtained from the experimental birds are presented in Table 4.3.

**Table 1.3**
The result of carcass characteristics of broiler birds.

| Parameters | T1(0g) | T2(10g) AA | T3(20g) AA | SEM |
|---|---|---|---|---|
| Drumstick (DRM) | 188.80[b] | 208.35[a] | 212.65[a] | 3.14 |
| Thighs (THI) | 251.80 | 251.50 | 249.60 | 6.33 |
| Breast (BRE) | 718.00 | 663.30 | 650.75 | 31.41 |
| Wing (WNG ) | 166.50 | 165.10 | 162.30 | 4.53 |
| Back (BCK) | 167.70 | 175.35 | 172.05 | 6.71 |
| Neck (NCK) | 70.30[b] | 76.30[a] | 75.75[a] | 2.29 |
| Total primal cuts (TPRM) | 1563.10 | 1539.90 | 1523.10 | 47.83 |
| Gizzard (GZZ) | 49.10[a] | 41.20[b] | 39.20[b] | 3.07 |
| Liver & Bile (L/B) | 49.50 | 50.60 | 48.55 | 2.89 |
| Heart (HRT) | 8.00 | 9.40 | 7.80 | 0.75 |
| Lung (LNG) | 8.30[b] | 9.90[b] | 12.15[a] | 0.78 |
| Crop (CRP) | 10.40 | 21.50 | 14.65 | 5.76 |
| Spleen (SPLN) | 1.70 | 2.05 | 1.60 | 0.38 |
| LEGS | 64.10[b] | 69.50[b] | 74.05[a] | 2.92 |
| HEAD | 43.40 | 44.25 | 45.20 | 1.15 |
| Intestine (INT) | 124.20 | 128.10 | 122.50 | 7.73 |
| Abdominal Fats (ABDF) | 20.40 | 22.85 | 24.05 | 4.09 |
| Total Organs (TORG) | 379.10 | 399.35 | 389.75 | 15.40 |
| Live weight (LW) | 2157.30 | 2168.35 | 2133.00 | 52.07 |
| Kill weight (KW) | 2090.50 | 2092.00 | 2070.15 | 50.52 |
| Pluck weight (PW) | 2017.90 | 2012.45 | 1997.90 | 48.43 |
| Dress weight (DW) | 1661.70 | 1631.70 | 1610.85 | 47.86 |
| Primal cuts as percentage live weight (P/LW) | 72.43 | 71.01 | 71.38 | 0.84 |
| Primal cuts as percentage dress weight (P/DW) | 94.05 | 94.36 | 94.56 | 0.32 |
| Organs cuts as percentage live weight (O/LW) | 17.61 | 18.42 | 18.29 | 0.81 |
| Organs cuts as percentage dress weight (O/DW) | 22.87 | 24.53 | 24.24 | 1.27 |

**Drumstick**

The result of drumstick are presented in Table 4.3 and figure 9. SEM recorded under drumstick weight was 3.14. Results on drumstick weight indicated that drumstick weight (g) was highest (212.65) in $T_3$ followed by $T_2$ (208.35) and lowest was 188.80 for birds in $T_1$. However, significant difference ($p<0.05$) exist between $T_2$,$T_3$ and $T_1$. In which $T_2$ and $T_3$ are statistically similar but differ numerically.

**Thigh**

The result of thigh are presented in Table 4.3 and figure 9. SEM recorded under thigh weight was 6.33. Results on thigh weight indicated that thigh weight (g) was highest (251.80) in $T_1$ followed by $T_1$ with (251.50) and lowest was (249.60) for birds in $T_3$. However, no significant difference ($p>0.05$) exist between $T_1$,$T_2$ and $T_3$.

**Wing**

The result of wing are presented in Table 4.3 and figure 9. Wing weight values of (166.50), 165.10 and (162.300 were recorded for birds on $T_1$,$T_2$ and $T_3$. However, no significant difference ($p>0.05$) exist between $T_1$,$T_2$ and $T_3$. SEM recorded under wing weight was (4.53). Results on wing weight of the experimental broiler birds indicated that wing weight (g) was highest (166.50) in $T_1$ followed by $T_3$ and lowest was 162.30 for birds in $T_3$.

**Back**

The result of back are presented in Table 4.3 and figure 9. Back weight values of (167.70g), (175.35g) and (172.05g) were recorded for birds on $T_1$, $T_2$ and $T_3$. However, no significant difference ($p>0.05$) exist between $T_1$,$T_2$ and $T_3$. SEM recorded under back weight was (6.71). Results on back weight indicated that back weight (g) was highest (175.35g) in $T_2$ and lowest was (167.70g) for birds in $T_1$.

**Neck**

The result of neck are presented in Table 4.3 and figure 9. SEM recorded under neck weight was 2.29. Results on neck weight indicated that neck weight (g) was highest (76.30) in $T_2$ followed by $T_3$ (75.75) and lowest was 70.30 for birds in $T_1$. However, significant difference ($p<0.05$) exist between $T_2$,$T_3$ and $T_1$. In which $T_2$ and $T_3$ are statistically similar but differ numerically.

**Total primal cuts**

The result of total primal cuts are presented in Table 4.3 and figure 9. TPRM values of (1563.10), (1539.90) and (1523.10) were recorded for birds on $T_1$,$T_2$ and $T_3$. However, no significant difference ($p>0.05$) exist between $T_1$,$T_2$ and $T_3$. SEM recorded under TPRM weight was 47.83. Results on TPRM weight of the experimental broiler birds indicated that TPRM weight (g) was highest (1563.10) in $T_1$ followed by $T_2$ with (1539.90) and lowest was (1523.10) for birds in $T_3$.

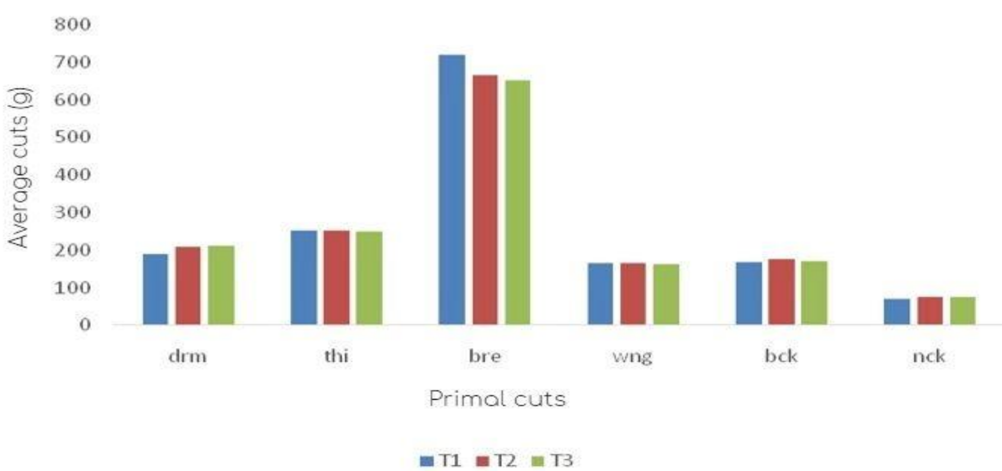


**Fig. 9.** Average primal cuts at finisher.

**Organs**

**Gizzard**

The result of gizzard are presented in Table 4.3 and figure 10. Significant difference ($p<0.05$) exist between $T_2$,$T_{3,}$ and $T_1$ were $T_2$ and $T_3$ are statistically similar. SEM recorded under gizzard weight was 3.07. However, results on Gizzard weight of the experimental broiler birds indicated that gizzard weight (g) was highest (49.10) in for birds in $T_1$ followed by $T_2$ (41.20) and lowest were (39.20) for birds in $T_3$.

**Liver and Bile**

The result of liver and bile are presented in Table 4.3 and figure 10. Results on liver weight of the experimental broiler birds indicated that liver weight (g) was highest (50.60) in $T_2$ followed by birds in $T_1$ with (49.50) and lowest was 48.55 for birds in $T_3$. However, no significant difference ($p>0.05$) exist between the treatments. SEM recorded under liver weight was 2.89.

**Heart**

The result of heart are presented in Table 4.3 and figure 10. Significant difference ($p>0.05$) does exist between $T_1$,$T_2$ and $T_3$. SEM recorded under heart weight was 0.75. However, results on heart weight indicated that heart weight (g) was highest (9.40) in $T_2$ then followed by birds in $T_1$ with (8.00) and lowest was 7.80 for birds in $T_3$.

**Lung**

SEM recorded under lung weight was 0.78. Results on lung weight indicated that lung weight (g) was highest (12.15) for birds in $T_3$ then followed by $T_2$ with (9.90) and lowest was 8.30 for birds in $T_1$. However, significant difference ($p<0.05$) exist between $T_1$ $T_2$ and $T_3$. Where $T_1$ and $T_2$ are statistically similar.

**Crop**

Results on crop weight of the experimental broiler birds are presented in Table 4.3 and figure 10. Crop weight (g) was highest (21.50) for birds in $T_2$ then followed by (14.65) in $T_3$ and lowest was 10.40 for birds in $T_1$. However, significant difference ($p>0.05$) does not exist between $T_{1,}T_2$ and $T_3$. SEM recorded under crop weight was 5.76.

**Spleen**

The result of drumstick are presented in Table 4.3 and figure 10. No significant difference ($p>0.05$) exist between the treatments. SEM recorded under Spleen weight was 0.38. Results on spleen weight of the experimental broiler birds indicated that spleen weight (g) was highest (2.05) for birds in $T_2$ then followed by (1.70) in $T_1$ and lowest was 1.60 for birds in $T_3$.

**Legs**

Results on leg weight of the experimental broiler birds are presented in Table 4.3 and figure 10. Leg weight (g) was highest (74.05) for birds in $T_3$ then followed by birds in $T_2$ with (69.50) and lowest was 64.10 for birds in $T_1$. However, significant difference ($p<0.05$) exist between $T_1$,$T_2$ and $T_3$. Where $T_1$ and $T_2$ are statistically similar. SEM recorded under leg weight was 2.92.

**Head**

The result of head are presented in Table 4.3 and figure 10. SEM recorded under head weight was 1.15. Results on head weight indicated that head weight (g) was highest (45.20) for birds in $T_3$ then followed by $T_2$ with (44.25) and lowest was 43.40 for birds in $T_1$. However, significant difference ($p>0.05$) does not exist between treatments.

**Intestine**

Results on intestine weight are presented in Table 4.3 and figure 10. Intestine weight (g) was highest (128.10) for birds in $T_2$ then followed by bird in $T_1$ with (124.20) and lowest was (122.50) for birds in $T_3$. However, no significant difference ($p>0.05$) exist between the treatments. SEM recorded under Intestine weight was 7.73.

**Abdominal fat**

Results on abdominal fat weight of the experimental broiler birds are presented in Table 4.3 and figure 10. Abdominal fat weight (g) was highest (24.05) in $T_3$ followed by birds in $T_2$ with (22.85) and lowest was (20.40) for birds in $T_1$. However, no significant difference (p>0.05) exist between the treatments. SEM recorded under liver weight was 4.09.

**Total organs**

Results on total organs of the experimental broiler birds are presented in Table 4.3 and figure 10. Total organ values of (379.10), (399.35) and (389.75) were recorded for birds on $T_1$,$T_2$ and $T_3$. However, no significant difference (p>0.05) exist between $T_1$,$T_2$ and $T_3$. SEM recorded under Total organ weight was (915.40). Results on Total organ weight of the experimental broiler birds indicated that Total organ weight (g) was highest (399.35) in $T_2$ followed by $T_3$ with (389.75) and lowest was (379.10) for birds in $T_1$.

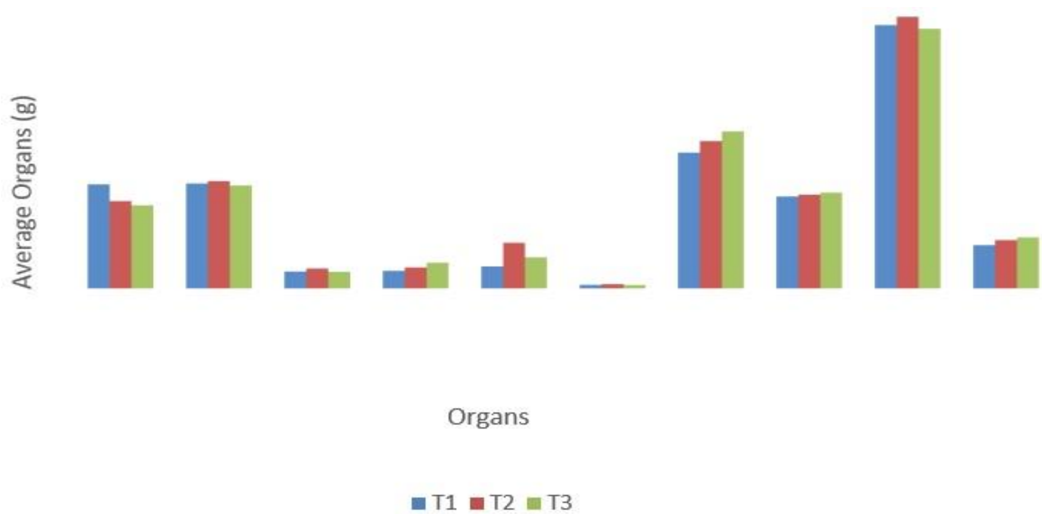


**Fig. 10.** Average carcass organs at finisher phase.

**Percentages**

**Live weight (%)**

The result of live weight are recorded in Table 4.3 and figure 11. Live weight values of (2157.30), (2168.35) and (2133.00) were recorded for birds on $T_1$, $T_2$ and $T_3$. However, no significant difference (p>0.05) exist between $T_1$,$T_2$ and $T_3$. SEM recorded under Live Weight was 52.07 Results on live weight indicated that live weight (g) was highest (2168.35) in $T_2$ then in $T_1$ with (2157.30) and lowest was (2133.00) for birds in $T_3$.

**Killed weight (%)**

The result of kill weight are recorded in Table 4.3 and figure 11. Significant difference (p>0.05) does exist between $T_1$,$T_2$ and $T_3$. SEM recorded under kill weight was 50.52 However, results on kill weight indicated that kill weight (g) was highest (2092.00) in $T_2$ then followed by birds in $T_1$ with (2090.50) and lowest was (2070.15) for birds in $T_3$.

**Plucked weight (%)**

The result of pluck weight are recorded in Table 4.3 and figure 11.SEM recorded under plucked weight was 48.43. Results on plucked weight indicated that plucked weight (g) was highest (2017.90) for birds in $T_1$ then followed by $T_2$ with (2012.45) and lowest was 1997.90 for birds in $T_3$. However, significant difference (p>0.05) does not exist between treatments.

**Dressed weight**

The result of dress weight are recorded in Table 4.3 and figure 11. No significant difference (p>0.05) exist between the treatments. SEM recorded under dressed weight was 47.86. Results on Dressed weight of the experimental broiler birds indicated that dressed weight (g) was highest (1661.70) for birds in $T_1$ followed by (1631.70) for birds in $T_2$ and lowest was (1610.85) for birds in $T_3$.

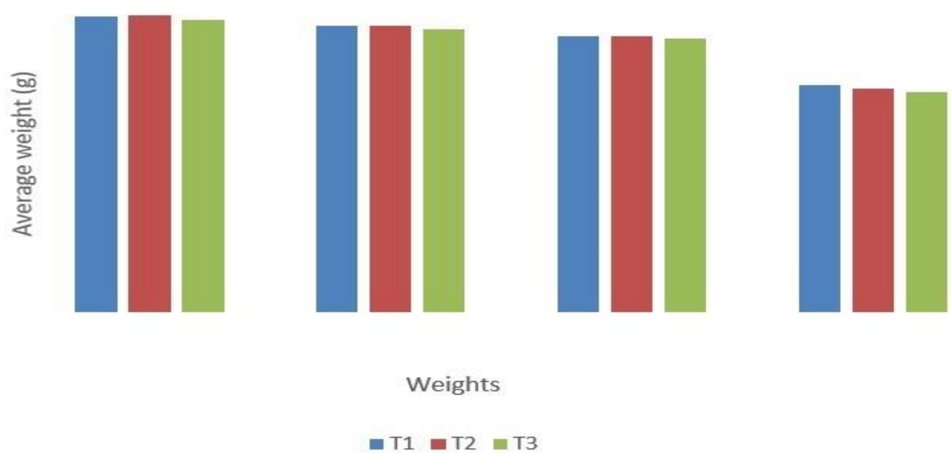


**Fig. 11.** Average weights of experimental birds.

**Primal cord as percentage of live weight P/LW (%)**

The results obtained on percentage as live weight are recorded in Table 4.3, which shows that significant difference (p>0.05) does exist between $T_1$,$T_2$ and $T_3$. SEM recorded under heart weight was 0.84. However, results on primal cord (%) live weight indicated that P/LW weight (g) was highest (72.43) in $T_1$ then followed by birds in $T_3$ with (71.38) and lowest was 71.01 for birds in $T_2$.

**Primal cord as percentage of dressed weight P/DW (%)**

SEM recorded under P/DW was 0.32. Results on head weight indicated that P/DW weight (g) was highest (94.56) for birds in $T_3$ then followed by $T_2$ with (94.36) and lowest was 94.05 for birds in $T_1$. However, significant difference (p>0.05) does not exist between treatments.

**Organs as percentage of live weight O/LW (%)**

Significant difference (p>0.05) does exist between $T_1$,$T_2$ and $T_3$. SEM recorded under O/LW Weight was 0.81. However, results on O/LW weight indicated that O/LW weight (g) was highest (18.42) in $T_2$ then followed by birds in $T_3$ with (18.29) and lowest was (17.61) for birds in $T_1$.

**Organs as percentage dressed weight O/DW (%)**

The result of organs as percentage dress weight are recorded in Table 4.3. Results O/DW values of (22.87), (24.53) and (24.24) were recorded for birds on $T_1$, $T_2$ and $T_3$. However, no significant difference (p>0.05) exist between $T_1$,$T_2$ and $T_3$. SEM recorded under O/DW weight was 1.27. Results on O/DW weight indicated that O/DW weight (g) was highest (24.53) in $T_2$ then in $T_3$ with (24.24) and lowest was (22.87) for birds in $T_1$.

## 4. Conclusion

Base on the result obtained, AA has the positive effect on the performance and carcass characteristics on broiler birds at starter and finisher phase. The research therefore could be concluded that AA be included in the diet of broiler birds at starter and finisher phase at level of 10g in the feed formulation.

**Recommendations**

- ✓ Further research should be conducted on higher levels of AA inclusion to establish the optimum inclusion rates.
- ✓ Also, further research need to be conducted to compare efficiency on other levels of AA inclusion apart from feed. (e.g. in drinking water).
- ✓ Study should be undertaken to determine at with level of inclusion of AA it serve best as anti-stress for the broiler birds in the study area.
- ✓ Research should also be conducted on the broiler birds fed with 0g of AA, that perform even better than of higher levels of AA inclusion.

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