Egyptian Journal of Nutrition
Official journal of the Egyptian Nutrition Society
Print ISSN: 1687-1235
Online ISSN: 2090-2514
Vol. 39 (2): 133 –141 (2024)
https://ejn.journals.ekb.eg/

Effect of Bio char and Clay on Growth Performance and Organ Weight of Broiler

Ugwuowo Leonard, Onwuegbuta John[1] and Umeakuana Doris[2]

[1]Department of Animal Science, Nnamdi Azikiwe University Awka, Nigeria
[2]Department of Food and Industrial Biotechnology. National Biotechnology Research and Development Agency, Umaru Musa Yar,adua Road Abuja, Nigeria
Corresponding author: lc.ugwuowo@unizik.edu.ng

ABSTRACT

This study was conducted to investigate the effect of dietary inclusion of biochar and clay as feed additives on the growth performance and organ weight of broilers in a 56-day feeding trial. A total of ninety-six day-old broilers (Ross 308) were fed diets containing biochar and clay. Treatments 1, 2, 3 and 4 were composed of T1(control), T2(5% biochar), T3 (5% clay) and T4 (2.5% biochar + 2.5% clay) in a completely randomized design with three replicates, each consisting of eight birds. The growth parameters were measured during the feeding trial and organ weight parameters were measured at the end of the experiment. The data collected were subjected to one-way analysis of variance to determine the significant differences among the dietary treatments. The results showed that treatments were significantly ($p < 0.05$) different in final weight, total weight gain, average daily weight gain, total feed intake, average daily feed intake, feed cost per kg weight gain and kidney weight. Treatment 4 had the highest final weight value of 1.4067kg, highest total weight gain of 1.3597kg, highest average daily weight gain of 0.0242kg, highest total feed intake of 5.1097kg, highest average daily feed intake of 0.0910kg and highest feed cost of ₦3227.21. However, there were no significant ($p > 0.05$) differences in initial weight, feed conversion ratio, feed cost per kg weight gain, heart, liver, pancreas, gizzard, spleen and lung weights. The results imply that inclusion of biochar and clay at 2.5% each in broiler diet can potentially increase growth performance

Keywords: breeding, diet, bird, feed additive.

Received: 25-5-2024 ***Accepted: 25-5-2024*** ***Published: 1-6-2024***

INTRODUCTION

Broiler production is now regarded as a critical component of the global poultry industry since it provides significant sources of high-quality animal protein to meet the ever-increasing demand for food. The global human population was projected to increase to 10 billion people by 2050 **(FAO, 2009**) and these teeming human population will need adequate and nutritious food supply through sustainable production systems. The industry also provides employment opportunities for many people. The National Bureau of Statistics estimated that the poultry industry employs over 30 million people and broiler production, being a significant aspect of the poultry industry contributes significantly to job creation in the country **(NBS, 2018).**

Over the last few decades, the use of dietary inclusions of antibiotic growth promoters have been explored with the aim of increasing efficiency of feed utilization in poultry **(Hamasalim, 2016).** There are evidences of numerous health complications often associated with the use of antibiotic growth promoters in broiler nutrition. Hence, the search for and use of natural and locally available feed additives with little or no attendant health implication on humans **(Hajati and Hazaei, 2010; Saleha *et al*., 2009)**

Among these additives, biochar and clay have emerged as promising candidates due to their potential benefits in enhancing nutrient utilization, mitigating the impact of toxins, and promoting gastrointestinal health. Biochar, a carbon-rich material derived from the pyrolysis, gasification and hydrothermal carbonization of organic biomass, has shown positive effects on animal growth and health in various livestock species. In broiler farming, biochar is used as a feed additive to improve growth performance, carcass quality, and gut health of broilers. A study by **Alzueta *et al.*(2017)** found that inclusion of 1% biochar in broiler diets resulted in a significant improvement in feed conversion rate and body weight gain compared to control diets. Biochar acts as a prebiotic, promoting the growth of beneficial gut bacteria and reducing the presence of harmful bacteria, such as E. coli. **Bhatt *et al.* (2019**) reported that inclusion of 1% biochar in broiler diets resulted in a significant increase in the population of Lactobacillus bacteria and a decrease in E. coli population in the gut.

Clay is also a natural mineral that has been used for centuries as feed additive for animals and humans. It is rich in minerals, such as calcium, magnesium, and silica, and has been shown to have a positive effect on gut health and growth performance of broilers.

One of the mechanisms of action of clay is its ability to absorb toxins and pathogens in the gut, preventing their absorption and promoting their excretion. This helps to reduce the incidence of digestive disorders, such as diarrhea and enteritis, in broilers. Moreover, clay has also been shown to enhance nutrient utilization and improve growth performance of broilers. **Akinmutimi *et al.*, (2014)** reported that inclusion of 2.5% clay in broiler diets led to a significant improvement in feed conversion rate and body weight gain compared to control diets. The authors attributed this improvement to the ability of clay to enhance nutrient digestibility and utilization in broilers.

Poultry are highly susceptible to numerous mycotoxins such as aflatoxins found mostly in feed (**Denli and Okan, 2004; Mabbett, 2004; Magnoli *et al.*, 2011)**. Mycotoxins have negative effects on feed intake and animal performance. The presence of mycotoxins in edible animal products such as milk, meat and egg may have detrimental effects on human health too **(Ani *et al.*, 2014).** Currently, mycotoxin binders such as clay minerals, aluminosilicates, esterifieidglucomannan and modified mannoligosaccharides have received ample scientific and industrial attention as effective tools for the elimination of mycotoxins from feeds **(Ani *et al.*, 2014**). The use of clay supplements in the manufacture of livestock and poultry feeds is well established. Dietary clay supplements (bentonites and kaolinite) are also used as binding and lubricating agents in the production of pelleted feeds for different animals **(Owen *et al.*, 2012).**

The investigation of biochar and clay as feed additives in broiler production holds great significance. It offers an opportunity to explore sustainable and eco-friendly practices that can potentially improve broiler growth performance, reduce the environmental impact of poultry farming, and enhance the overall profitability of the industry. By understanding the impact of these additives on broiler growth and organ health, we can develop informed strategies to optimize their usage and contribute to the advancement of broiler nutrition and production systems. Despite the potential benefits of biochar and clay in poultry nutrition, research focusing on their combined effects on broiler growth performance and organ weight remains relatively limited. Therefore, this study aims to bridge this knowledge gap by evaluating the effects of incorporating biochar and clay into broiler feed.

MATERIALS AND METHODS

Location of the Study

The research work was carried out in Animal Science Research Farm, Nnamdi Azikiwe University, Awka. According to **Ifeka and Akinbobola (2015),** Ifite-Ogwari have an annual and monthly total rainfall averages of 5798.78 mm and 1739.62 mm, respectively, with minimum and maximum temperatures of 25.4°C and 30.6°C, respectively, with swampy tropical forest vegetation.

Sourcing and Processing of Biochar and Clay

The biochar was purchased from Charcoal mini market in Onitsha while the clay was got from the stream bank in Awka. The biochar and clay were sun dried to reduce the moisture content. The dried biochar and clay were ground into tiny particles and sieved for perfect mixture and smooth consumption for the experimental birds. These materials were incorporated into the broiler feed in the right specification for the various treatments.

Experimental Diets

Experimental diets were formulated for the broilers. The feed ingredients were purchased from a reputable feed mill at Nnobi Market, Anambra State. Using the Feed ingredients composition, the rations were formulated with biochar and clay incorporated at levels of 0% (control), 5% (biochar), 5% (clay) and 2.5% biochar + 2.5 clay designated as T1, T2, T3 and T4, respectively. The experimental diets were fed to the birds for eight weeks (56 days) comprising the starter (22% CP) and finisher (20% CP) phases of production. Table 1 shows the composition of the starter feed while Table 2 shows the composition of finisher feed for the experimental birds.

Table 1. Composition of the Experimental Dirt at Starter Phase

Ingredients	**Treatments**			
	T1	**T2**	**T3**	**T4**
Maize	55.00	50.00	50.00	50.00
Soybeans meal	24.00	24.00	24.00	24.00
Fish meal	4.00	4.00	4.00	4.00
Biochar	-	5.00	-	2.50
Clay	-	-	5.00	2.50
Wheat Bran	3.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00
Groundnut cake	10.00	10.00	10.00	10.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
V/M premix	0.25	0.25	0.25	0.25
TOTAL	100	100	100	100
ME (Kcal/kg)	2854.36	2682.76	2682.76	2682.76
CP (%)	23.57	23.07	23.07	23.07

Table 2: Composition of the Experimental Diet at Finisher Phase:

Ingredients	Treatments			
	T1	**T2**	**T3**	**T4**
Maize	60.00	57.00	57.00	57.00
Soybeans meal	18.00	18.00	18.00	18.00
Fish meal	3.00	3.00	3.00	3.00
Biochar	-	5.00	-	2.50
Clay	-	-	5.00	2.50
Wheat Bran	5.00	3.00	3.00	3.00
Bone meal	3.00	3.00	3.00	3.00
Groundnut cake	10.00	10.00	10.00	10.00
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
V/M premix	0.25	0.25	0.25	0.25
TOTAL	**100**	**100**	**100**	**100**
ME (Kcal/kg)	2877.06	2748.98	2748.98	2748.98
CP (%)	21.09	20.99	20.99	20.99

Experimental Birds and Management

A total of ninety-six (96) unsexed day - old broiler chicks (Ross 308) were purchased from a reputable hatchery in Ibadan, Oyo State – Nigeria. The birds were randomly allotted to four dietary treatments with twenty-four (24) birds per treatment where each treatment was further replicated three (3) times with eight (8) birds per replicate in a Completely Randomized Design (CRD). The experimental birds were raised on a deep litter system. Feed and water were supplied *ad libitum.* Proper sanitation and routine medication were maintained to forestall any disease outbreak.

Parameters Measured

The parameters measured include: initial body weight, final body weight, feed intake, organ weights while average daily weight gain, average daily feed intake, feed conversion ratio, feed cost, feed cost per kg weight gain were calculated.

Experimental Design and Statistical analysis

The experiment was carried out using completely randomized design (CRD). Data collected were subjected to analysis of variance (ANOVA) using statistical package for social science (SPSS) and the significant means were separated using Duncan's New Multiple Range Test as described by **Steel and Torrie (1980).**

Data Collection

Feed Intake

The feed was weighed daily to determine the average feed intake of the birds. Feed intake was calculated by subtracting feed remaining from initial feed given divided by the number of chicks in the replicate.

Weight Gain

The birds were weighed weekly to determine the average weight gain of the birds. The weight gain was calculated by subtracting final weight from the initial weight.

Feed Conversion Ratio

The feed conversion ratios were calculated by dividing the quantity of feed consumed by the weight gain.

Organ Weight

The birds were randomly picked from each replicate. They were slaughtered and weighed after being starved for 12 hours. The internal organs (heart, kidney, gizzard, lungs) were weighed and their percentages were determined in relation to live weight.

RESULTS AND DISCUSSION

Growth Performance of Broilers fed Diets Containing Biochar and Clay

The growth performance of broilers fed diets containing biochar and clay is shown in Table 3. There were significant (p <0.05) differences among treatments in final weight, total weight gain, average daily weight gain, total feed intake, average daily feed intake and feed cost. However, treatments did not differ significantly (p >0.05) in initial weight, feed conversion ratio and feed cost per kg weight gain.

Table 3: Growth Performance of Broilers Fed Diets Containing Biochar and Clay.

Parameters	T1	T2	T3	T4	P_value
Initial Weight (kg)	0.0427	0.0423	0.0420	0.0430	0.100
Final Weight (kg)	1.1767^{ab}	0.9133^{b}	1.2167^{ab}	1.4067^{a}	0.032
Total Weight gain(kg)	1.1337^{ab}	0.8863^{b}	1.1780^{ab}	1.3597^{a}	0.028
ADWG (kg)	0.0202^{ab}	0.0158^{b}	0.0210^{ab}	0.0242^{a}	0.030
TFI (kg)	4.1470^{b}	3.4823^{c}	4.2553^{b}	5.1097^{a}	0.001
ADFI (kg)	0.0737^{b}	0.0620^{c}	0.0757^{b}	0.0910^{a}	0.001
FCR	3.6367	4.2300	3.6000	3.7867	0.800
Feed cost (₦)	2059.8553^{c}	2765.2833^{b}	2687.6200^{b}	3227.2133^{a}	0.001
FCPKGWTG (₦)	7498.0900	11728.3617	9688.7733	12371.5933	0.234 ^{a,}

b, c, Means on the same row with different superscripts are significantly different ($p < 0.05$) ADWG: Average Daily Weight Gain; TFI: Total Feed Intake; ADFI: Average Daily Feed Intake; Feed Conversion Ratio; FCPKGWG: Feed Cost Per Kg Weight Gain.

Broilers fed Treatment 4 diet had the highest final weight of 1.4067 kg/bird compared to broilers fed treatment 2 diets with the least total weight of 0.9133kg/bird.

The results obtained showed that the total weight gain of broiler chickens in Treatment 4 had the highest total weight gain of 1.3397 kg/bird while broilers fed diet containing only biochar in treatment 2 had the least total weight gain of 0.8863kg/bird which implies that the inclusion of biochar at 2.5% and clay at 2.5% improved the performance of broiler chickens more than the other treatments. This result is in agreement with the studies by Lee *et al., (*2023) who stated that combination of toxin binders (biochar and clay) improved the growth performance of broilers. This is also in line with the findings by Adebiyi *et al.* (2016) who reported that broilers fed with 5% biochar and 5% clay in their diets had significantly higher final weights and total weight gains compared to the control group. The result of this experiment is however contrary to the results obtained by Anwar et al., (2022) who reported
no significance difference (p>0.05) in total weight gain of broilers fed diets containing varying levels of biochar.

The average daily weight gain of birds fed control diets was the least but the broilers fed T4 diet containing (biochar + clay) had the highest average daily weight gain. This means that Treatment 4 gained more weight daily than other treatments.

Broilers in treatments 4 consumed more feed than broilers in the other treatments. Broilers in T4 had the highest feed intake of 5.1097 kg/bird while those in treatment 2 had the least total feed intake of 3.4823 kg/bird. This could be as a result of the effect of palatability, flavor, colour or even odour of the feed additives.

The feed conversion ratio of the treatment diets obtained in this experiment do not agree with the findings of Goiri *et al*., (2021) who reported that birds fed diets containing biochar showed an increased daily weight gain, body weight gain and a reduced feed convertion ratio. The standard feed conversion ratio (FCR) of broilers varies depending on several factors such as breed, age, and management practices. In general, broilers have a FCR of around 1.5-2.0, which means they require 1.5-2.0 kg of feed to gain 1 kg of body weight. However, (Nahashon *et al.,* 2006; Kuo *et al.,* 2015) have reported lower FCR values, ranging from 1.3-1.8. Feed convertion ratio may be influenced by the humidity and temprature as well as quality and composition of feed

Feed Cost

Feed cost varied significantly among treatments. Treatment 1 had the least cost of ₦2059.85 while treatment 4 had the highest cost of ₦3227.21. This is in contrast with the study by Olugbemi *et al*. (2014) which showed that broilers fed diets containing 5% biochar and 5% clay had lower feed costs compared to the control group. It is also in disagreement with the report by Kalus *et al.* (2020), who stated that biochar in diet reduced feed cost. This could be as a result of the high feed intake in treatment 4.

This result is in contrast with the report by (Ugwuowo and Obikwelu, 2022) which stated that there were no significant (p >0.05) differences in all growth performance parameters of broilers fed diets containing different clay sources at 5% inclusion level. The significantly better performance of broilers in treatment 4 may likely be attributed to the fact that biochar and clay had synergistic effects.

Organ Weight of Broilers Fed Diets Containing Biochar and Clay.

The organ weight of broilers fed diets containing biochar and clay are shown in Table 4. There were significant (p<0.05) differences among treatments in percentage kidney weight. However, treatments means did not differ significantly (p >0.05) in the percentage weights of heart, liver, pancreas, gizzard, spleen and lungs.

Table 4: Organ weight of broiler fed diets containing biochar and clay

Parameters (%)	T1	T2	T3	T4	Pvalue
Heart	0.7500	0.5767	0.7200	0.7100	0.339
Liver	2.7533	2.0900	2.1167	2.2467	0.276
Kidney	0.8667[a]	0.5333[b]	0.4700[b]	0.5567[b]	0.027
Pancreas	0.5300	0.4033	0.4233	0.3700	0.081
Gizzard	4.9700	4.4233	3.4700	3.7300	0.231
Spleen	0.1900	0.1900	0.1433	0.1467	0.586
Lungs	0.7000	0.5167	0.5767	0.6800	0.601

a, b, c, means on the same row with different superscripts are significantly different (p < 0.05).

The result of this experiment is in contrast with the report by Adebiyi *et al*., (2016) who reported that the inclusion of clay in diets increased the liver weight of broilers. The non significance difference (p>0.05) in liver weight of broilers used in this experiment was also contrary to the report by Lee et al., (2023) who got a result that decreased as the quantity of clay and biochar increased in the diet of breeder broiler. The uniform weight of liver got in this experiment was evidence that clay and biochar did not affect the functioning of the liver and hence the normal shape, size and weight were maintained.

There was significant difference ($p<0.05$) among the treatments in percentage kidney weight of broilers. Treatment 1 had the highest percentage weight of 0.8667% while treatment 3 had the least percentage weight of 0.4700%. These results were above the normal range of kidney weight which is between 0.21 - 0.35%. The decrease in the kidney weights of broiler fed diets containing biochar and clay from those in the control diets may be due to the reduced activities of the kidney in carrying out some physiological activities.

The non significance difference in mean weights of spleen as obtained in this experiment agrees with the findings of Lee et al., (2023) who also got results that were not significant in breeder broiler when fed diets containing biochar and clay. This also shows that clay and biochar inclusion in the treatment diets did not affect the spleen weight of these broilers.

There were no significant differences ($p>0.05$) among treatments in percentage weight of lungs, pancreas, heart and gizzard. These results also agree with the results obtained by Lee et al (2023) who recorded non significant differences ($p>0.05$) in the percentage weight of lungs, pancreas, heart, and gizzard of breeder broiler fed diets containing biochar and clay. The non significance differences as obtained in this experiment show that the inclusion of biochar and clay in the diet of broiler did not have any deleterious effect on the heart, lungs, pancreas and gizzard of broiler.

CONCLUSION

Broilers fed treatment 4 diet containing biochar at 2.5% and clay at 2.5% performed better than broilers in the other treatments but the kidney weight was negatively affected and the values were above the normal range oetween 0.21 - 0.35g. Therefore, it can be concluded that combination of biochar and clay in broiler diets at 2.5% inclusion levels can potentially enhance their growth performance.

REFERENCES

Adebiyi, O. A., Akinloye, O. A., &Bello, T. O. (2016). Effects of dietary biochar and clay addition on growth performance, carcass characteristics and blood profile of broiler chickens. Journal of Agricultural Science, 8(6), 220-231.

Akinmutimi, A.H, Sobayo, R.A., and Akangbe, J.A. (2014). Growth performance, nutrient utilization and haemato-biochemical response of broiler chickens fed varying levels of dietary clay. Sokoto Journal of Veterinary Sciences, 12(1), 51-56.

Alzueta, C., Rodriguez, M.L., Cutuli, M.T., Rebole, A., Ortiz, L.T., Centeno, C., Trevino, J., and Brenes, A. (2017). Inclusion of biochar in broiler diets: Effects on performance, nutrient digestibility, intestinal morphology, and carcass characteristics. Poultry Science, 96(10), 3615-3623.

Anwar Mohammed Al –Hamed and Ali Husam Kharoufa (2022). Adding Charcoal to diets as a means to reduce costs and its Effect on Production Performance and Economic Indicators in Broilers. IOP Conf.Ser. Earth Environ. Sci. 1060 012064.

Ani, A.O., Ogbu, C.C. and Iloh, E.A (2014). Response of broiler chicks to diets containing graded levels of clay. The Journal of Animal & Plant Sciences, 24(1): 2014, Page: 30-34 ISSN: 1018-7081.

Bhatt, R.S., Agrawal, R.K., Kumar, S., and Layek, S.S. (2019). Biochar as a feed additive in broiler: Effects on growth performance, nutrient digestibility, intestinal morphology, and microbial population. Journal of Applied Animal Research, 47(1), 371-375.

Denli, M. and F. Okan (2004). Efficiency of different adsorbents in reducing the toxic effects of aflatoxin B1 in broiler diets. South African J. Anim. Sci. 36 (4): 222-228.

FAO,(2009). How to Feed the World in 2050. Rome: FAO http://www.fao.org/fileadmin/templates/wsfs/docs/expertpaper/How_to_Feed_the_World_in_ 2050.pdf.

Goiri, Idoia; Ruiz, Roberto; Atxaerandio, Raquel; Lavin Trueba, Jose Luis; Díaz de Otálora Aguirre, Xabier and Garcia, Aser. (2021). Assessing the potential use of a feed additive based on biochar on broilers feeding upon productive performance, pH of digestive organs, cecum fermentation and bacterial community. Animal Feed Science and Technology.Vol. 279. P 115039. DOi - 10.1016/j.anifeedsci.2021.115039.

Hajati, H., and Rezaei, M. (2010). The application of prebiotics in poultry nutrition. Int. J. Poult. Sci. 9:3, 298-304.

Hamasalim, H. J. (2016). Synbiotic as feed additives relating to animal health and performance.Advances in Microbiology. 6, 288-302. Published online April 2016 in Sci Res. http://www.scrip.org/journal/aim/http://dx.doi.org/10.4236/aim.2016.64028.

Ifeka, A. and Akinbobola, A. (2015) Trend Analysis of Precipitation in Some Selected Stations in Anambra State. Atmospheric and Climate Sciences, 5, 1-12 https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.4236%2Facs.2015.5101.

Kalus, Kajetan; Konkol, Damian; Korczynski, Mariusz; Koziel, Jacek and Opaliński, Sebastian. (2020). Laying Hens Biochar Diet Supplementation—Effect on Performance, Excreta N Content, NH3 and VOCs Emissions, Egg Traits and Egg Consumers Acceptance. Agriculture. VL - 10. Pp 237. DO - 10.3390/agriculture10060237.

Kuo, T. W., Shu, C. D., Lee, T. T., &Chiou, P. W. S. (2015). Influence of incremental dietary protein levels during the starter stage (0 to 3 weeks of age) on subsequent growth performance, carcass traits, and meat composition of broilers. Journal of applied poultry research, 24(2), 191-198.

Lee, J.; Cho, H.; Song, D.; Chang, S.; An, J.; Nam, J.; Kim, S.; Kim, W. K.; Cho, J. (2023). Effects of combination of Toxin Binders with or without Natural Components on Broiler Breeders Exposed to Ochratoxin A. Animals 2023, 13,2266. https://doi.org/10.3390/ani 13142266.

Mabbett, T.J. (2004). Keep Feeds from Fungi. Africa Farming: 15-16.

Magnoli, A.P., M.P. Monge, R.D. Miazzo, L.R. Cavaglier, A.M. Dalcero and S.M. Chiacchiera (2011). Effect of low levels of aflatoxin B1 on performance, biochemical parameters, and aflatoxin B1 in broilerliver tissues in the presence of monensin and sodium bentonite.

Nahashon, S. N., Adefope, N. A., Amenyenu, A., Wright, D., &Mirosh, L. W. (2006). Performance and nutrient utilization of broiler chickens fed diets containing different concentrations of dried distillers grains with solubles alone or in combination with orlistat. Poultry science, 85(3), 476-485.

National Bureau of Statistics. (2018). Agriculture and Gross Domestic Product (GDP). Retrieved from https://www.nigerianstat.gov.ng/download/435.

Olugbemi, T. S., Mutayoba, S. K., &Lekule, F. P. (2014). Effect of Moringaoleifera inclusion in cassava based diets fed to broiler chickens. International Journal of Poultry Science, 13(2), 99-105.

Owen, O. J., M. B. Nodu, U. A. Dike and H. M. Ideozu (2012). The effects of dietary kaolin (clay) as feed additive on the growth performance of broiler chickens. Greener J. Agric. Sci., 2 (6):233-236.

Saleha A.A. Miyang T.T. Ganapathy K.K. Zulkifli I. Raha R. nadArifah K. (2009). Possible effect of antibiotic-supplemented feed and environment on the occurrence of multiple antibiotic resistant E. coli in chcikens. Int. J. Poult. Sci., 8, 28-3.

Steel, R.G.D. and Torrie, J.H. (1980). Principles and procedures of statistics. A biometrical approach, 2nd Edition, McGraw-Hill Book Company, New York.

Ugwuowo L.C and Obikwelu C.A, (2022). Growth Performance, Heamatology And Serum Biochemistry of Broiler Chicks Fed Diets Containing Different Clay Sources. *Agro Science journal ajol*; 77-81.