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EFFECT OF DIETARY CHOLINE ON THE PRODUCTION PERFORMANCE AND CARCASS CHARACTERISTICS OF COBB 500 CHICKENS

***Abimbola Elizabeth Sokunbi*[1], *John Adesanya Abiona*[2], *Olajide Mark Sogunle*[3], *Ayobami John Owolabi*[4], *Oluwatobi Michael Ogunsola*[5], *Azeez Olanrewaju Yusuf*[6]**

[1] ORCID: 0009-0001-8039-5844
[2] ORCID: 0000-0002-1159-8349
[3] ORCID: 0000-0001-9661-0089
[4] ORCID: 0009-0006-7584-6045
[5] ORCID: 0000-0001-8924-1705
[6] ORCID: 0000-0002-8555-8737
[1–4, 6] Department of Animal Production and Health
Federal University of Agriculture, Abeokuta, Ogun State, Nigeria
[5] McPherson University Farm
McPherson University, Seriki Sotayo, Ogun State, Nigeria

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Abstract

Choline serves several crucial metabolic functions, making it an essential component in poultry diets which include lipid transport, cell signalling, and biosynthesis of methylated compounds. The objective of this study was to evaluate the performance and carcass characteristics of the Cobb 500 chickens fed dietary choline. One hundred- and forty-four-day-old (42.16 ±0.15), unsexed Cobb 500 chickens were randomly assigned to three treatment groups with four replications of twelve (12) chicks each in a Completely Randomized Design. Three levels of choline (0, 1200, 1400 ppm/100 kg of feed) were supplemented in the chick's feed at the starter phase (0–21days), while at the finisher phase (21–49 days) three levels of choline (0, 800, 1000 ppm/100 kg feed) were also supplemented in the chicken's feed. Results showed that different levels of choline had no significant effect ($P > 0.05$) on the weight changes of broiler chickens at the starter and finisher phases. However, the feed conversion ratio was best ($P < 0.05$) for chicks supplemented with 1200 ppm at the starter phase compared to the finisher phase. At the finisher phase, feed intake (3216.93 g/bird) of birds offered 800 ppm choline were significantly ($P < 0.05$) reduced when compared to control diets (3380.11 g/bird). Dressing percentage significantly ($P < 0.05$) increased at 800 ppm while the thigh decreased ($P < 0.05$) with choline increment. In conclusion, choline supplementation in the diets of broiler chickens at 1200 and 800 ppm/100 kg feed impro-

Address: Ayobami J. Owolabi, Federal University of Agriculture, Abeokuta,Ogun State, Nigeria, e-mail: yusufao@funaab.edu.ng

ved the growth performance and carcass characteristics of Cobb 500 broiler strain chickens at starter and finisher phases respectively.

Introduction

The nourishing elements in food that an organism needs to grow and survive are known as nutrients. Micronutrients supply the cofactors required for metabolism to occur, while macronutrients supply the bulk of the energy needed for an organism's metabolic system to work. Both micronutrients and macronutrients can be sourced from the environment.

Choline serves several crucial metabolic functions, making it an essential component in poultry diets which include lipid transport, cell signalling, and biosynthesis of methylated compounds. Choline is required for the formation and maintenance of cell membranes and organelles such as mitochondria and microsomal, as well as the appropriate maturation of the bone cartilage matrix (Arele et al. 2015). Unlike other vitamins, choline can be synthesized through de novo synthesis, but the inability to synthesize enough choline can cause choline deficiency, resulting in growth retardation and perosis in young chicks. According to Lin et al. (2020), choline deficiency is often linked to fatty liver development due to its function in lipid metabolism, and which has been demonstrated in chicken models. Moreover, the bioavailability of choline varies largely and depends on raw material sources and bird related factors such as type, strain, age, feed consumption, dietary crude protein, and methionine (NRC 1994).

Recent studies have shown mixed outcomes regarding the effect of dietary choline supplementation when added above the amount that is naturally present in maize and soybean meal-based diet in broiler growth performance (McDowell and Ward 2008, Norvell and Nesheim 1969). While current choline recommendations may be sufficient to prevent deficiency, they are not necessarily adequate for optimizing the growth performance and carcass yield of broilers. Therefore, the objective of this study was to evaluate growth performance and carcass characteristics of Cobb 500 broiler strain fed on dietary supplementation of choline grown from 0 to 49 days of age.

Materials and Methods

Experimental site

The experiment was carried out at the Poultry Unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta, Ogun State, Nigeria. The farm is located at latitude 7.15°N, longitude 3.26°E. The site is 76 m above sea level in the tropical forest vegetation zone with an average temperature of 30.19°C and relative humidity of 82%.

Experimental design and treatment

A total of one hundred and forty-four day-old unsexed broiler chickens (Cobb 500) were procured from a reputable hatchery in Ibadan, Oyo state Nigeria. On arrival, the chicks were weighed and were randomly assigned to three treatment experimental groups equally with four replications of twelve chicks each in a Completely Randomized Design. Each replicate was raised in a pen measuring $3m^2$ with wood shavings as bedding in a tropical climate. Chicks assigned to Treatment 1 belonged to the control group with no choline supplemented into their feed, those in Treatment 2 had 1200 ppm of choline supplemented into their feed and those in Treatment 3 had 1400 ppm of choline supplemented into their feed at the starter phase (0–21days), while at finisher phase (22–49 days), chicks assigned to treatment 2 had 800 ppm of choline supplemented into their feed and those in treatment 3 had 1000 ppm of choline supplemented with into their feed. The feed was introduced to the day–old chicks on the day of arrival to the last day of the experiments (49 days), they were given fresh clean water *ad libitum* throughout the experiment. The chicks were vaccinated against Newcastle disease and Infectious Bursal disease.

Experimental dietary composition

Choline was procured from a reputable animal feed store in Abeokuta, Ogun State. Three inclusion levels of choline were administered for the starter phases (0, 1200 and 1400) ppm and at finisher phases, three levels of choline were also administered (0, 800 and 1000) ppm for the experimental diets' composition of the broiler chickens as shown in Table 1. The inclusion level was to meet the nutritional composition of broiler chickens at starter and finisher phases.

Table 1

Composition [%] of experimental diets for starter and finisher phases of broiler chickens

Feed ingredients	Starter	Finisher
Maize	52.00	58.40
Soybeans meal	18.00	10.00
Fish meal (72%)	2.20	1.00
Groundnut cake	17.50	14.00
Wheat offal	4.30	10.60
Bone meal	3.00	3.00
Limestone	2.00	2.00
Choline free premix	0.25	0.25
Methionine	0.25	0.25
Lysine	0.25	0.25
Salt (NaCl)	0.25	0.25
Total [%]	100	100
Determined analysis		
Crude protein [%]	22.46	18.15
Crude fibre	3.61	3.51
Ether extracts	4.04	3.88
Metabolisable energy [MJ/kg]	11. 87	12.14

Explanations: choline free premix/vitamins: vitamin A – 8700 IU; vitamin D3 – 2300 IU; vitamin E – 16 IU; vitamin B12 – 31 mg; riboflavin – 6.6 mg; niacin – 28 mg; Ca panthothenate – 35 mg; menadione – 1.50 mg; folic acid – 0.80 mg; thiamine – 3 g; pyridoxine – 2.5 mg; biotin – 30 mg; ethoxyquin – 125 mg; Mn – 80 mg; Zn – 75 mg; Fe – 50 mg; Cu – 10 mg, I – 1 mg

Data collection

Growth performance

Data on body weight (BW) and feed intake (FI) were collected weekly at the starter and finisher phases and were used to calculate average daily gain (ADG) and feed conversion ratio (FCR).

$$\text{Feed intake [g]} = \frac{feed\ of\ ferd\ -\ feed\ leftover}{number\ of\ birds}$$

$$\text{Weight gain per bird [g]} = \frac{final\ weight\ -\ initial\ weight}{number\ of\ birds}$$

$$\text{Feed Conversion Ratio (FCR)} = \frac{total\ feed\ intake}{total\ body\ weight\ gain}.$$

Carcass yield determination

At the end of the experiment (49 days), two broilers were randomly selected per replicate, weighed, slaughtered, de-skinned and eviscerated. The eviscerated carcass was weighed and the head and shank were removed to record the dress weight. The cut-up parts and the organs such as the thigh, drumstick, breast, back, spleen, liver, gizzard, heart, bursa and thymus were weighed with a digital scale. The dress percentage was expressed as a percentage of the live weight.

$$\text{Dress percentage [\%]}\ \frac{\textit{dressed weight}\ [\text{g}]}{\textit{live weight}\ [\text{g}]} \cdot 100$$

Statistical analysis

All data collected during the experimental period were subjected to One Way Analysis of Variance (ANOVA) using a Completely Randomized Design in accordance with SPSS (2009) and Duncan's multiple range tests were used to reveal significant differences at $p < 0.05$ among the treatment means.

Model

$$Y_{ij} = \mu + T_i + \varepsilon_{ij}$$

where:
Y_{ij} – the observed value of j_{th} animal fed i_{th} treatment,
μ – population mean,
T_i – effect of i_{th} treatment,
ε_{ij} – random error.

Results

Growth performance

The growth performance of broiler chickens fed choline is presented in Tables 2 and 3, respectively. At the starter phase, there was a significant ($P < 0.05$) difference in the feed conversion ratio (FCR). The best FCR of 0.91 was obtained in birds on T2 (1200 ppm/100 kg of feed) compared to the value of 0.99 obtained for birds on T3 (1400 ppm/100 kg of feed) and T1 (control). On the 49th day (Table 3), a significant ($P < 0.05$) difference was obtained in the feed intake. Chickens fed with choline at an inclusion level of 800 ppm/100 kg (T2) recorded the lowest feed intake (3216.93 g/birds) while the highest feed intake (3380.11 g/birds) was obtained in chickens fed with 0 ppm/100 kg of feed (T1).

Table 2

Starter phase growth performance of Cobb 500 chickens fed dietary choline

Inclusion levels of choline [ppm]				
Parameters	T1 (0)	T2 (1200)	T3 (1400)	SEM
Initial weight [g/bird]	42.00	42.33	42.15	0.14
Final weight [g/bird]	400.19	448.96	416.67	9.76
Weight gain [g/bird]	358.19	406.62	374.52	9.70
Daily weight gain [g/bird/day]	17.06	19.363	17.84	0.46
Feed intake [g/bird]	370.05	371.06	364.33	6.01
Feed conversion ratio	1.04^{a}	0.91^{b}	0.99^{ab}	0.02

Explanations: *a,b* – means in a row with different superscripts are significantly different ($P < 0.05$); SEM – Standard error of mean

Table 3

Finisher phase growth performance of Cobb 500 chickens fed dietary choline

Inclusion levels of choline [ppm]				
Parameters	0	800	1000	SEM
Initial weight [g/bird]	400.19	448.96	416.67	9.76
Final weight [g/bird]	1587.50	1550.00	1560.00	15.48
Weight gain [g/bird]	1187.31	1101.04	1143.33	22.17
Daily weight gain [g/bird/day]	42.40	39.32	40.83	1.68
Feed intake [g/bird]	3380.11^{a}	3216.93^{b}	3238.74^{ab}	32.78
Feed conversion ratio	2.85	2.92	2.83	0.08

Explanations: ^{a,b} – means in a row with different superscripts are significantly different ($P < 0.05$); SEM – standard error of mean

Carcass characteristics

The result of the carcass yield of Cobb 500 chickens fed diets supplemented with choline is presented in Table 4. There was no significant ($P > 0.05$) difference in the live weight, eviscerated weight and internal organs. However, the chickens reared on T1 (0 ppm choline) and T2 (800 ppm choline) had higher ($P < 0.05$) dressing percentages than those in T3 (1000 ppm choline). The result also revealed that there was decrease in thigh weight ($P < 0.05$) as the choline level increases.

Table 4

Carcass characteristics of Cobb 500 chickens fed dietary choline

Inclusion levels of choline [ppm]				
Parameters	T1(0)	T2(800)	T3(1000)	SEM
Live weight [g]	1587.50	1550.00	1560.00	48.94
Eviscerated weight [g]	1084.75	1045.75	980.25	39.33
Dressing percentage	56.47^{a}	56.57^{a}	51.58^{b}	0.96
Breast [%]	17.27	17.33	16.52	0.32
Back [%]	13.52	13.09	11.94	0.35
Thigh [%]	10.41^{a}	9.12^{b}	8.72^{b}	0.27
Drumstick [%]	9.53	9.80	8.88	0.21
Spleen [%]	0.11	0.12	0.13	0.011
Liver [%]	2.12	2.81	2.24	0.28
Gizzard [%]	2.02	1.80	1.89	0.063
Heart [%]	0.56	0.45	0.48	0.024
Bursa [%]	0.056	0.080	0.090	0.014
Thymus [%]	0.20	0.058	0.29	0.050

Explanations: ^{a,b} – means in a row with different superscripts are significantly different ($P > 0.05$); SEM – standard error of mean

Discussion

The similarity observed in the body weight and daily weight gain is in accordance with the findings of SAARINEN et al. (2000) and RAFEEQ et al. (2011) who reported that dietary supplementation of choline had no significant ($P > 0.05$) effect on the body weight and daily weight gain of broiler chickens in a 28-day experimental period. This also agrees with the study of GREGG et al. (2022), who reported that body weight and BW gain were not impacted by supplemental choline chloride in the diet of broiler chickens fed at different inclusion levels in a 66 days experimental period. In the present study, the weight gain means were comparable, but the feed conversion is best in supplemented groups. This disparity observed might be hinged on several factor like broiler's species used, location, ingredient's composition of the diets etc. Though significantly similar, chickens fed a diet with choline performed better (numerically higher value) at the starter phase as supported by the report of PESTI et al. (1980) and SONBOL (1990) that weight gain of broiler chicks at the starter phase increased as dietary choline elevates to 1900 mg/kg. The similar gain observed at the finisher phase might be that the supplemented choline was used for other physiological functions rather than growth.

The feed conversion ratio of the chicks supplemented with dietary choline was best at starter phase (0–21 days) in the present study. The similar weight gain observed in this study corroborates the earlier report of EMMERT and BAKER (1997) who stated that animals do require choline in feed to maintain body physiological functions rather than growth. The similar feed conversion ratio observed at the finisher phase (22–49 days) agrees with the report of ALAGAWANY et al. (2016) who observed a similar feed conversion ratio during 21–42 days of age of Cobb 500 broiler chickens. The similar feed conversion ratio observed was hinged on the fact that the chloride in the choline chloride might have disturbed the ion balance resulted in lower feed conversion ratio (ALAGAWANY et al. 2016). In contrary to the current result, SUMMER et al. (2013) indicated no positive effects of dietary choline on broiler feed intake during the last three weeks of rearing. Based on weight changes EBAHIMNEZHAD et al. (2011) also reported that dietary choline at different inclusion levels had no significant effect on body weight in poultry in contrast to the feed intake. However, based on the present study, the feed conversion ratio of broiler chickens supplemented with choline at 21–49 days shows that the birds can still maintain the weight gain while reducing feed consumption of broiler chickens if reared for a longer period. This can be made possible because of the choline in various physiological processes like, metabolism (choline is converted to betaine, it is involved in methylation reactions, influencing energy metabolism and nutrient utilization (ALAGAWANY et al. 2022), lipid transport (choline is a precursor to phospholipids which are essential for lipid transport and membrane structure), gene expression (choline affects gene expression and this influences various biological processes such as growth and development) (IGWE et al. 2015, LI et al. 2023) and gut health (choline can influence the gut microbiome, which plays a crucial role in nutrient absorption and utilization) (ABRAMOWICS et al. 2020, GOH et al. 2021).

The prevention of accumulated fat in the hepatocytes or the development of fatty liver is one of the benefits of choline in poultry production (WORKEL 2004). In the present study, the supplementation of choline to the dietary feed of the broiler chickens have no significant effect ($p > 0.05$) on the thigh, drumstick, breast, back, spleen, liver, gizzard, heart, bursa and thymus. This is in accordance with (ALAGAWANY 2015) who reported that the various levels of choline do not show any consistent effect on the carcass and, thigh, drumstick, breast, back, spleen, liver, gizzard, heart, bursa and thymus percentages. These deduce that the different inclusion levels of choline used do not interfere with muscle development and also prevent abnormal accumulation of fat or development of fatty liver. However, the dietary supplementation of choline significantly ($P < 0.05$) influenced the dressing percentage. This result disagrees with DENG and WANG (1997), who observed that the addition of betaine did not affect dressing percentage of broiler chicks. The dietary supplementation of choline in this research showed a slight increase but did not significantly ($P > 0.05$) affect the breast percentage of broiler chickens at 49 days. Similarly, ESTEVE-GARCIA and MACK (2000) reported that the effects of betaine on breast yield were relatively small and non-significant. This agrees with WALDROP and FRITIS (2005) who reported an improvement in breast yield due to choline supplementation (1000 g choline/ton diet) at 42 days of age but not at 49 days of age in broiler chicks. On the contrary, ROSTAGNO and PACK (1996), REMUS (2001) and WALDROUP and FRITTS (2005), reported that the breast meat percentage was increased as diets containing different levels of betaine were fed. The present results are in accordance with the findings of KHOSRAVINIA et al. (2015), who reported an improvement in body weight and FCR but no change in carcass yield percentage when broilers were fed moderate energy diets supplemented with Bio choline, choline chloride and lecithin extract. Also, JAHANIAN and RAHMAN (2008) reported the effects of betaine supplementation to increase dressing and breast meat percentage but no significant effect on thigh and liver weight percentage, compared to a control diet without betaine.

In conclusion, the feed conversion ratio (FCR) of Cobb 500 broiler chickens at the starter phase (day 21) had a significant effect at 1200 ppm/kg of feed dietary supplementation of choline and dietary supplementation of choline at 800 ppm/100 kg of feed, reduced the feed intake of broiler chickens at finisher phase (day 49). Dietary supplementation of choline at 800 ppm significantly influences the carcass yield (dressing percentage and thigh) of broiler chickens.

Based on the present study, it is recommended to use 1200 ppm of choline (T2) as a feed additive in the diet of Cobb 500 broiler chickens at the starter phase, and 800 ppm of choline should be used as a feed additive in the diets of the broiler chickens at finishers phase.

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