Research Article

Influence of Dietary Choline Levels on Growth Performance and Carcass Characteristics of Growing Japanese Quail

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Abstract | This experiment was conducted using 204 day-old Japanese quail chicks to evaluate the effect of different levels of dietary choline on growth performance and carcass characteristics. The experimental diets consisted of 4 levels of choline: 1000, 1500, 2000 and 2500 mg/kg diet. Each dietary treatment was assigned to 3 replicate groups of 17 chicks and the experiment lasted 35 days. Live body weight and body weight gain was significantly (P< 0.01) increased with increasing choline level from 1000 to 2000 mg/kg diet at all different ages, except body weight gain was not affect by dietary choline levels during 21-42 days of age. Feed consumption and feed conversion ratio were affected by the different levels of choline at the different ages (P< 0.05), vs. feed conversion ratio was not significantly affect by dietary choline levels during 21-42 days of age. In conclusion, the obtained results showed that the diet containing 2000 mg/kg choline diet is recommended for feeding growing Japanese quail during the fattening period (7 to 42 days of age).

Keywords | Quails, Choline, Growth performance, Carcass traits.

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INTRODUCTION

Choline is considered as an essential nutrient in poultry diets. Where, choline plays an indispensable role in several biological processes in the body, including building and maintaining cell structure, primarily as a structural component of phospholipids (Summer, 2013). Therefore choline has three important metabolic roles, for instance as a constituent of phospholipids, prevent fatty liver through hepatic lipid metabolism and as a precursor for acetylcholine synthesis as well as prevention of perosis. Acetylcholine is the substance responsible for the transmission of nerve impulses which could not be formed without the presence of choline in the body (Zeisel, 2012). Moreover, choline is very important to the poultry species such as broiler, laying hens, ducks, quails etc. Where, choline gives the methyl groups necessary for the formation of methionine from homo-cysteine through being oxidized to betaine (Zhang et al., 2013). These findings point to the importance of this nutrient in poultry nutrition and production.

It is important for researchers to reinvestigate the use of choline in poultry diets. In the past, several studies have looked at choline and betaine for their methionine sparing effects under ideal conditions (Rafeeq et al., 2011a; Rafeeq et al., 2011b), but it may also be im-

portant to evaluate choline for its primary function of supporting growth and not just as a methionine-sparing molecule. Choline may also have added benefits during heat stress, since bird physiology is altered in this condition.

In this regard, choline requirement was affected by many factors related to birds such as type, strain, age, feed consumption, dietary crude protein and methionine as well as fat type and bioavailability of native choline (NRC, 1994; Ghazalah, 1998; Workel et al., 1999). Choline requirements of quails ranged from 1500 to 2000-mg/kg feed depending on age, type and strain (NRC, 1994). Ghazalah (1998) reported that choline addition at 1250 mg/kg diet resulted in the best broiler growth performance at 28-d old, while choline supplementation at 2500 mg/kg diets resulted in the best growth performance during 1-28 day-old. On the contrary, Saarinen et al. (2000) observed that choline supplementation did not significantly affect growth performance of broiler chicks fed methionine adequate or inadequate diets, their observation agreed with that of Swain and Johri, (2000) nevertheless, 2300 or 3300 mg choline /kg diet enhanced humoral and cellular immune response.

Therefore, the objective of this study was to find an appropriate supplementation level of choline as choline chloride (50%) on the growth performance and carcass characteristic of growing Japanese quail (7 to 42 d of age).

MATERIALS AND METHODS

This study was conducted at Poultry Research Farm, Department of Poultry, Faculty of Agriculture, Zagazig University, Egypt. All the experimental procedures were carried out according to the Local Experimental Animal Care Committee, and approved by the ethics of the institutional committee. Birds were cared for using husbandry guidelines derived from Zagazig University standard operating procedures.

Experimental Design and Diets of Birds

Two hundred and four (n=204), day-old Japanese quail chicks were used at 7th days of age; chicks were randomly divided into four treatment groups equal in number (51 chicks each), with three replications of 17 chicks each. A complete randomized design of four levels of choline (1000, 1500, 2000 and 2500 mg/kg diet) as choline chloride (50%) was used to study the effect of choline levels on growing Japanese quail performance. Chicks were housed in conventional type (50× 50×45 cm) cages with feed and water provided for *ad libitum* consumption. The cages were equipped with a nipple drinker and trough feeders. The bird's house was provided with programmable lighting and adequate ventilation. The Lighting was 23 h light and 1 h darkness. Each experimental diet was formulated to meet the nutrients requirements of growing Japanese quail, according to NRC (1994) recommendations. Experimental diets were isocaloric (3000 kcal of ME/kg) and isonitrogenous (22% CP). The duration of the experiment was 35 days (between 7 and 42d of age). The diets were fed as a mash. The formulation and composition of the experimental diets are shown in table 1.

Performance and Carcass Components

Birds were weighed individually at weekly intervals. Mortality was recorded daily. Total feed intake was measured per pen weekly. Feed consumption (PC) and feed conversion ratio (FCR) (feed intake/weight gain) were adjusted for mortality. Three birds of each group were sampled randomly for carcass evaluations at 35 days of age and slaughtered and weighed. Their feathers were plucked manually, eviscerated by hand. Whole carcass, abdominal fat pad (excluding the gizzard fat), empty gizzard and proventriculus, liver, heart, pancreas and spleen were excised and weighed individually. The carcass yields were calculated as a percentage of the pre-slaughter live body weights of broiler chickens according to Blasco et al. (1993). Carcass and dressed weights studied (dressed weight = carcass weight plus giblets weight)/ live body weight.

Statistical Analysis

Data were statistically analysed using general linear models procedure adapted by SPSS for user's guide with one-way ANOVA. The differences among means were determined using the student Newman keuls test. The Mean values and standard error (SE) are reported. Statements of statistical significance are based on $P < 0.05$.

RESULTS AND DISCUSSION

Quail performance parameters are summarized in table 2. When compared by ANOVA, average body weight was significantly ($P<0.01$) increased with in-

Table 1: Composition and calculated analysis of the experimental diets

	Levels of choline mg / Kg			
	1000	**1500**	**2000**	**2500**
Ingredients %				
Yellow corn	63.64	63.10	63.00	62.88
Soybean meal (44%)	23.00	24.00	24.00	24.00
Corn Gluten (60%)	10.00	9.45	9.45	9.45
Salt	0.30	0.30	0.30	0.30
Premix*	0.30	0.30	0.30	0.30
Di-calcium phosphate	1.60	1.60	1.60	1.60
Limestone	0.85	0.85	0.85	0.85
L- Lysine	0.23	0.21	0.21	0.21
DL- methionine	0.08	0.08	0.08	0.08
Choline chloride 50%	-	0.11	0.21	0.33
Total	100	100	100	100
Calculated analysis**				
Crude protein,%	22.04	22.03	22.07	22.06
ME. K. cal / Kg	3028	3008	3005	3001
Calcium,%	0.80	0.80	0.80	0.80
Available P,%	0.45	0.45	0.45	0.45
Lysine, %	1.15	1.15	1.15	1.15
Methionine + cysteine,%	0.90	0.90	0.90	0.90
Choline mg / kg diet	1000	1500	2000	2500
Price / ton diet L.E., ***	1573	1578	1583	1589

*Grower vit. and Min. Premix: Each 3 Kg consists of : Vit. A 12000.000 IU; Vit. D3, 2000.000 IU, Vit.E 10g; Vit. K3, 2000mg; Vit. B1, 1000 Mg; Vit. B2, 5000 Mg; Vit. B6, 1500Mg, Vit. B12,10Mg; Biotin 50 Mg; Pantothenic acid , 10 g; Niacin, 30 g; Folic acid, 1000Mg; Mn, 60 g; Zn, 50 g; Cu; 10g; I, 1000Mg; Si, 100Mg; Co.100Mg; ** Calculated according to NRC (1994).

creasing dietary choline level from 1000 to 2000 mg/kg diet at 21 and 42 days of age. Where, the 2000 mg/kg of choline level was enough to achieve the heaviest live body weight during the experimental period. Body weight gain followed nearly the same trend observed with live body weight. Since body weight gain was significantly (P< 0.01) improved with increasing dietary choline level in the quail diets up to 2000 mg during 7-21 or 7-42 days of age. While, body weight gain was not statistically affected by dietary choline levels during 21-42 days of age. Similar responses reported by Shrivastav et al. (2004) showed that live body weight and body weight gain significantly (P< 0.05) enhanced with increasing dietary choline levels from 1500 to 2000 mg/kg diet in quail chicks. Moreover, Hassan et al. (2005) observed that different levels of choline supplementation had meaningful effect on average live body weight. Sonbol (1990) noted that body weight gain of broiler chicks at 21 days of age was significantly (P<0.01) increased as a dietary choline increased to 1900 mg/kg diet. Also, Baranova (1991) observed that inclusion of choline to the diet mixture improved growth rate with the inclusion rate of 500-700 mg/kg of diet. The increase in the body weight gain of broiler chicks has been found by many other workers after the addition of dietary choline at an early age, in the absence of methionine supplementation (Pesti et al., 1980; Baker et al. 1983; Harms and Miles, 1984). On the contrary, Rafeeq et al. (2011a) and Swain and Johri, (2000) reported that dietary choline, at different inclusion level, had no significant effect on body weight and body weight change in broiler chicks.

Choline in traditional feedstuffs is not completely available for absorption and utilization, but choline chloride is the common form of supplemental choline considered 100% bioavailability (Emmert and Baker, 1997)

Table 2: Growth performance (Mean+SE) of growing Japanese quails as influenced by choline levels during the experimental periods (7-42 days of age)

Traits	Choline levels (mg /Kg diet)				Sign
	1000	1500	2000	2500	
Average body weight (g) at:					
7d	22.84±0.03	22.85±0.04	22.79±0.15	22.77±0.10	NS
21d	50.18±0.36^{c}	52.32±1.66^{c}	64.60±2.05^{a}	57.45±0.69^{b}	**
42d	141.94±0.68^{b}	138.32±4.14^{b}	159.96±4.29^{a}	147.87±1.56^{b}	**
Body weight gain (g)					
7-21d	1.95±0.02^{c}	2.10±0.12^{c}	2.98±0.14^{a}	2.48±0.03^{b}	**
21-42d	4.36±0.01	4.09±0.11	4.53±0.14	4.29±0.05	NS
7-42d	3.40±0.01^{b}	3.29±0.11^{b}	3.91±0.12^{a}	3.56±0.04^{b}	**
Feed consumption (g)					
7-21d	10.34±0.02^{c}	11.37±0.15^{a}	10.96±0.12^{b}	10.82±0.06^{b}	**
21-42d	17.69±0.17^{b}	18.50±0.32^{b}	19.60±0.36^{a}	18.45±0.30^{b}	*
7-42d	14.75±0.11^{c}	15.64±0.12^{b}	16.41±0.18^{a}	15.39±0.20^{b}	**
Feed conversion (g feed/ g gain)					
7-21d	5.29±0.03^{c}	5.44±0.24^{c}	3.68±0.14^{a}	4.35±0.08^{b}	**
21-42d	4.05±0.03	4.52±0.20	4.32±0.07	4.30±0.12	NS
7-42d	4.33±0.02^{a}	4.76±0.20^{b}	4.12±0.09^{a}	4.31±0.11^{a}	*

Means in the same raw within each classification bearing different letters are significantly different ($P < 0.05$ or 0.01); *$P < 0.05$; ** $P < 0.01$, NS=not significant.

Table 3: Some carcass characteristics of growing Japanese quail as influenced by choline levels during the experimental period (7-42day)

Traits	Choline levels (mg /Kg diet)				Sign
	1000	1500	2000	2500	
Pre-slaughter weight (g)	143.80±1.36^{b}	138.33±4.41^{b}	161.66±7.37^{a}	148.90±1.73^{ab}	*
Carcass %	72.61±1.04	75.40±0.56	73.19±1.25	75.32±0.40	NS
Giblets %	5.83±0.95	5.31±0.24	6.00±0.38	5.51±0.22	NS
Dressing %	78.32±1.02	80.60±0.38	80.85±0.82	80.17±0.18	NS

Means in the same raw within each classification bearing different letters are significantly different ($P < 0.05$ or 0.01); *$P < 0.05$, ** $P < 0.01$, NS=not significant.

and 0.722 g/kg diet is optimal for normal growth (Dilger et al., 2007), but the high levels of choline supplementation as choline chloride (50%) depress growth rate, so the relative contribution of choline and its chloride form need to be more explored, because birds tolerate higher levels of choline as phosphatidylcholine, higher concentrations are usually advised to optimize vitamin store and overcome inefficiencies in absorption or metabolism due to other dietary constituents or physiological state of the bird (Kirk, 1998).

Several studies observed that choline is a very important for the biological performance of birds where, growth retardation and perosis of chicks were induced by choline deficiency in the diets; moreover choline supplementation may be necessary for maintenance of growth and productive performance in

quails (NRC, 1994).

The effect of levels of choline on feed consumption and feed conversion ratio at different ages is shown in table 2. In this study, feed consumption was affected by the dietary choline levels ($P< 0.05$). Quails fed diet containing 2000 mg/kg of choline achieved the largest amount of feed consumption compared to the other levels, during periods 21 to 42 and 7 to 42 days of age. While, the period of 7 to 21 days of age, the largest amount recorded by chicks fed diet containing 1500 mg/kg diet as compared with other treatments.

Feed conversion ratio was affected by the different levels of choline throughout 7-21 and 7-42 days of age ($P< 0.05$). The best values of feed conversion ratio were achieved by diet containing 2000 mg/kg choline vs. the other levels. Meanwhile, the dietary choline levels had no significant effect on feed conversion ratio during 21-42 days of age. These results are in line with findings of Shrivastav et al. (2004) who stated that feed intake and feed efficiency ratio increased significantly with increasing level of choline from 1500 to 2000 mg/kg diet. Sonbol (1990) stated that increasing dietary choline up to 1900 mg/kg diet improved feed conversion by 4.6 and 5.4% when compared with chicks fed on 1400 and 2400 mg choline /kg diet, respectively. In contrast to the results of this research, Waldroup et al. (2006) noted that the supplementation of 1000 mg of choline/kg diet, statistically improved feed conversion ratio over the chicks fed the unsupplemented diets at 35, 42, 49, and 56 d of age. Hassan et al. (2005) found that supplementation of 0.3 g/kg of choline increased feed conversion ratio by 3.3 % compared to control diet. Meanwhile, Swain and Johri, 2000 recorded that choline supplementation alone did not elicit any response in the feed intake and feed utilization of broilers. Their findings was in accordance with the observations of Blair et al. (1986) who found that choline had no effect on the feed consumption of broilers in the presence or absence of addition methionine. In contrast to the finding of our results, Tsiagbe et al. (1987) recorded lower feed consumption on the basal diet.

The current results indicated that the high supplementation rate of choline as choline chloride might have disturbed the ion balance resulted in lower FC and WG. Choline is preferentially used for biosynthesis of acetylcholine and can only supply methyl groups after it has been oxidized to betaine to convert homocysteine to methionine (Garrow, 2007). Fouladi et al. (2008) found that using 500 or 1000 mg/kg of choline chloride supplement to broiler diets significantly increased live body weight and feed intake and improved feed conversion ratio during 22-42 day-old. Harms and Russell (2002) and Ebrahimnezhad et al. (2011) noted that supplementation levels of choline chloride into corn-soy diet have no significant effect on live body weight, body weight gain, feed intake and feed conversion ratio in the fattening period (1-42 d of age). Summer (2013) indicated no positive effects of dietary choline on broiler feed intake during the last three weeks of the experimental study, however, body weight gain and feed conversion did not respond to dietary treatments.

Results of carcass traits as affected by choline levels are presented in table 3. It could be noticed that, various level of choline did not have any consistent effect on dressing, carcass and giblets percentages. While Waldroup 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. Moreover, Waldroup et al. (2006) observed that supplementation of 1000 g of choline/ton to the broiler diets resulted in significant improvements in breast yield at 42, 49 and 56 days of age, also, choline was added at 500 g/ton diet as a methyl donor and clean conditions were used to decrease coccidiosis challenge.

CONCLUSION

In view of our findings, it could be concluded that the diet containing 2000 mg choline/kg diet is recommended for feeding growing Japanese quail during the fattening period (7 to 42 days of age) without any adverse effects on growth performance or feed utilization.

REFERENCES

- Baker DH, Halpin KM, Czarnecki G, Parsons CM (1983). The choline methionine interrelationship for growth of the chick. Poult. Sci. 62(1): 133-137. http://dx.doi.org/10.3382/ps.0620133 PMid:6828405
- Baranova G (1991). Choline in diets for broiler chickens. Ptitsevodstvo. 9:15 -17
- Blasco A, Ouhayoun J Masoero G (1993).

Harmonization of criteria and terminology in rabbit meat research. World Rabbit Sci. 1(1): 1-10.
- Blair ME, Potter LM, Bliss B, Shelton JR (1986). Methionine, choline and sulphate supplementation of practical type diets for young turkey. Poult. Sci. 65(1): 130 -137. http://dx.doi.org/10.3382/ps.0650130
- Dilger RN, Garrow TA, Baker DH (2007). Betaine can partially spare choline in chicks but only when added to diets containing a minimal level of choline. J. Nutr. 137(10): 2224-2228. PMid:17885002
- Ebrahimnezhad Y, Tajaddini MH, Ahmadzadeh AR, Aghdam H, Shahryar J Galekandi G (2011). The effect of additional choline supplement and its effect on Japanese quails (Coturnix coturnix japonica) performance and visceral organs weight in corn and Iranian soybean meal based diet. Ann. Biol. Res. 2(5): 573-577.
- Emmert, Jason L, Baker DH (1997). A chick bioassay approach for determining the bioavailable choline concentration in normal and overheated soybean meal, canola meal and peanut meal. J. Nutr. 127(5): 745-752.
- Fouladi P, Salamat DR, Ahmadzade A (2008). Effect of choline chloride supplement and canola oil on the performance and feed efficiency in broiler chickens. Res. J. Poult. Sci. 2(3): 58-62.
- Garrow TA (2007). Choline. In. J. Zempleni, R. B. Rucker, D. B. McCormick, J. W. Suttie, (eds.). Hand book of vitamins. 4th ed. Boca Raton (FL): CRC Press; p. 459-87.
- Ghazalah AA (1998). The choline requirements of broiler chicks fed fat supplemented diets. Egypt. Poult. Sci. 18: 271-289.
- Hassan RA, Attia YA, El-Ganzory EH (2005). Growth, Carcass Quality and Serum Constituents of Slow Growing Chicks as Affected by Betaine Addition to Diets Containing 1. Different Levels of Choline. Int. J. Poult. Sci. 4(11): 840-850. http://dx.doi.org/10.3923/ijps.2005.840.850
- Harms RH, Miles RD (1984). Effect of supplemental methionine and potassium sulfate on the cholie requirement of the turkey poult. Poult. Sci. 63(7): 1464-1466. http://dx.doi.org/10.3382/ps.0631464 PMid:6473261
- Harms RH, Russell GB (2002). Betaine does not improve performance of laying hens when the diet contains adequate choline. Poult. Sci. 81(1): 99-101. http://dx.doi.org/10.1093/ps/81.1.99 PMid:11885908
- Kirk CK (1998). Comparative Avian Nutrition. Department of Avian Science, College of Agriculture and Environmental Science, University of California.
- NRC (1994). Nutrient Requirement of Poultry. 9th rev. ed. National Academy Press, Washington, DC.
- Pesti GM, Haper AE, Sunde ML (1980). Choline methionine nutrition of starting broiler chicks, three models for estimating the choline requirement with economic considerations. Poult. Sci. 59(5): 1073–1081. http://dx.doi.org/10.3382/ps.0591073 PMid:7393840
- Rafeeq M, Pasha TN, Rashid N, Hilal B, Shahzad I (2011a). Effect of supplementation of methionine, betaine and choline on the performance of broiler chicken in early life fed methionine deficient ration. J. Anim. Plant Sci. 21(4): 778-780.
- Rafeeq M, Pasha TN, Tariq MM, Bajwa MA (2011b). Performance of broiler chicken in early life on methionine deficient feed with added choline and betaine. Int. J. Livest. Prod. 2(9): 142-144.
- Saarinen MT, Kettunen H, Pulliaine K, Peuranen S, Tiihonen K, Remus J (2000). A novel method to analyses betaine in chicken liver: Effect of dietary betaine and choline supplementation on the hepatic betaine concentration in broiler chicks. J. Agri. Food Chem. 49(2): 559-563. http://dx.doi.org/10.1021/jf0006751
- Shrivastav AK, Dash BB, Johri TS (2004). Effect of dietary levels of choline in relation to sulphur amino acid for growth and immune response in quail broilers. Indian J. poult. Sci. 39(1): 9-14.
- Sonbol SM (1990). Interrelationship between methionin and choline levels on the broiler performance and blood constituents. Egypt. J. Appl. Sci. 5 (1):209-219.
- Summers DJ (2013). Effect of choline or betaine supplementation on broilers exposed to different temperature treatments. Thesis Master of Science, The University of Tennessee, Knoxville.
- Swain BK, Johri TS (2000). Effect of supplemental methionin e, choline and their combinations on the performance and immune response of broilers. Central Avian Reaserch Institute, Izatnagar, India. 41: 83-88.
- Tsiagbe VK, Kraus BJ, Benevenga NJ, Haper AE, Sunde ML (1987). Identification of volatile sulfate derivative released from feather of chicks fed diets with various level of sulpher–containing amino acids. J. Nutr. 117(12): 1859–1865. PMid:3681476
- Waldroup PW, Fritis CA (2005). Evaluation of separate and combined effects of choline and betaine in diets for male broilers. Int. J. Poult. Sci. 4(7): 442-448. http://dx.doi.org/10.3923/ijps.2005.442.448
- Waldroup PW, Motl MA, Yan F, Fritts CA (2006). Effects of betaine and choline on response to methionine supplementation to broiler diets formulated to industry standards. J. Appl. Poult. Res. 15: 58–71. http://dx.doi.org/10.1093/japr/15.1.58
- Workel HA, Keller TB, Reeve A, Lauwaerts A (1999).

Choline-The rediscovered vitamin. Poult. Int. April, 1999: 44-47.
- Zeisel SH (2012). A brief history of choline. Ann. Nutr. Metab. 61: 254-258. http://dx.doi.org/10.1159/000343120 PMid:23183298
- Zhang CX, Pan MX, Li B, Wang L, Mo XF, Chen YM, Lin FY, Ho SC (2013). Choline and betaine intake is inversely associated with breast cancer risk: A two stage case control study in china. Cancer Sci. 104(2): 250-258. http://dx.doi.org/10.1111/cas.12064 PMid:23140534