Kansas Agricultural Experiment Station Research Reports

Volume 8
Issue 11 *Animal Feed and Pet Food Research Report*

Article 5

2022

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Recommended Citation

Beckman, Nelsa M.; Jenkins, Khairy I.; Blomme, Allison K.; Otott, Haley K.; Dunmire, Kara M.; Stark, Charles R.; and Paulk, Chad B. (2022) "Effect of Metabolizable Energy and Crumble Quality of the Diet on Growth Performance of Broilers," *Kansas Agricultural Experiment Station Research Reports*: Vol. 8: Iss. 11. https://doi.org/10.4148/2378-5977.8405

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K-STATE Research and Extension

2022 ANIMAL FEED AND PET FOOD RESEARCH

Effect of Metabolizable Energy and Crumble Quality of the Diet on Growth Performance of Broilers

Nelsa M. Beckman, Khairy I. Jenkins,[1] Allison K. Blomme, Haley K. Otott, Kara M. Dunmire, Charles R. Stark, and Chad B. Paulk

Summary

In order to optimize the growth performance of broilers, diets are formulated to a recommended ME concentration. In addition, broilers (chicks) are often fed diets in the form of crumbles in early production to improve growth performance. Thus, the objective of this study was to determine the effect of ME concentration in diets and if removal of crumble fines influenced the growth performance response of broilers. At hatch, a total of 300 one-day-old male broilers (Cobb 500, initial BW 0.093 lb) were used in an 18-day study. Broilers were housed in 3 Petersime batteries with *ad libitum* access to feed and water. Treatments were randomly assigned to 60 cages balanced by location, resulting in 10 cages per treatment with 5 broilers per cage. Treatments were arranged in a 2 × 3 factorial of ME content (1,376 and 1,346 ME, kcal/lb) and crumbled diets with or without fines (removed particles < 1,532 µm or < 864 µm). Crumble treatments were fed with no sifting (NS) or sifted using either a screen with 0.06-in. openings (removed particles < 1,532 µm) or a screen with 0.03-in. openings (removed particles < 864 µm). Data were analyzed as a completely randomized design using the GLIMMIX procedure of SAS (v. 9.4, SAS Institute, Inc., Cary, NC). There was no evidence of an interaction between crumble fines removal and ME or main effect of ME. Body weight gain (BWG) and total feed intake (TFI) increased ($P < 0.05$) when broilers were fed crumbles sifted with a 0.06-in. screen compared to NS and crumbles sifted with a 0.03-in. screen. Broiler feed conversion ratio (FCR) improved ($P < 0.001$) when broilers were fed crumbles sifted with a 0.06-in. screen compared to those fed NS and sifted with a 0.03-in. screen. In conclusion, broilers fed crumbles with particles < 1,532 µm removed had an improved FCR and an increased BWG and TFI regardless of the ME content of the diet. Increasing ME from 1,346 to 1,376 kcal/lb did not influence growth performance of broilers from d 0 to 18 d of age.

Introduction

Poultry diets are commonly pelleted to improve nutrient utilization, growth performance, feed handling characteristics and bulk density. Most of the improvement in poultry feed efficiency due to pelleting can be attributed to a decrease in feed wastage or broiler energy usage while feeding. Grower and finisher broilers are often fed diets in the form of pellets; however, starter broiler diets are often crumbled to accommodate

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for the size of the young bird. In the crumbling process, pellets are moved through a single pair roller to break up pellets into smaller sizes. In addition to small, fragmented pellets, this process also creates fines. Feeding crumbles has been shown to reduce selective feeding and increase feed intake of broilers compared to those fed mash diets.[2] However, little research has been conducted to determine the influence of percentage fines in crumbled diets on the broilers' growth performance response.

In addition to pelleting and crumbling the diets to improve performance, increasing the ME content of the diet has also been shown to improve body weight gain (BWG) of broilers.[3] Hypothetically, if a broiler expends more energy eating because of an increased proportion of fines in the crumbles, then increasing the ME content of the diet may provide a greater improvement in BWG of broilers. In contrast, removing fines from a crumble diet could potentially increase growth performance, if the broiler must exert less energy to consume the same amount of feed or if it allows the broiler to consume more feed. Therefore, the objective of this study was to determine if dietary ME content and crumble quality influenced broiler growth performance.

Materials and Methods

The Institutional Animal Care and Use Committee at Kansas State University (Manhattan, KS) reviewed and approved the protocols. At hatch, 300 one-day-old male broilers (Cobb 500, Cobb-Vantress, Siloam Springs, AR; initial BW 0.093 lb) were used in an 18-day study. Broilers were housed in 3 Petersime batteries with *ad libitum* access to feed and water. Treatments were randomly assigned to 60 cages balanced by location, resulting in 10 cages per treatment with 5 broilers per cage. Birds and feeders were weighed on days 0, 7, and 18 to calculate total feed intake (TFI), BWG, and feed conversion ratio (FCR).

Treatments were arranged in a 2 × 3 factorial of ME content (1,376 and 1,346 ME, kcal/lb) and crumbled diet treatments (not sifted [NS], sifted with a 0.06-in. screen, and sifted with a 0.03-in. screen). The ME of the diet was increased by increasing soy oil from 0.55 to 1.81%. Diets were balanced by digestible lysine, amino acid ratios, available P, and Ca. Both ME diets were mixed using a 1,000-lb Scott twin shaft ribbon/paddle combination mixer (Scott Equipment Company, New Prague, MN) mixer and were mixed for 60 s dry and 120 s wet. Diets were steam conditioned (10 × 55 in. length Wenger twin staff pre-conditioner, Model 150) to a target conditioning temperature of 175°F for approximately 30 s and pelleted on a 1-ton 30-horsepower pellet mill (1012-2 HD Master Model, California Pellet Mill) equipped with a 3⁄16 × 1 ¼ in. pellet die (L:D 6.67). The feeder was set at a constant rate to achieve approximately 27 lb/min. Cooled pellets were then crumbled using a single pair crumble roll (Colorado Mill Equipment model EcoRoll 7, Canon City, CO). Each diet was sifted using a 0.06-in. screen, a 0.03-in. screen, or no screen to create the different treatments.

[2] Xu, Y., C.R. Stark, P.R. Ferket, C.M. Williams, J. Brake. 2015. Effects of feed form and dietary coarse ground corn on broiler live performance, body weight, excreta nitrogen, and particle size preference behaviors. Poultry Science, Vol 94:1549-1556. https://doi.org/10.3382/ps/pev074.

[3] Zaman, Q.U., T. Mushtaq, H. Nawaz, M.A. Mirza, S. Mahmood, T. Ahmad, M.E. Babar, M.M.H. Mushtaq. 2008. Effect of varying dietary energy and protein on broiler performance in hot climate. Animal Feed Science and Technology Vol 146:302-312. https://doi.org/10.1016/j.anifeedsci.2008.01.006.

Statistical Analysis

Data were analyzed as a completely randomized design. Treatments were arranged in a 2 × 3 factorial design of ME content (1,376 and 1,346 ME, kcal/lb) and crumble fines (NS, 0.06-in. screen, and 0.03-in. screen) to determine the response of growth performance. There were 10 replicates per treatment. Data were analyzed using the GLIMMIX procedure of SAS 9.4 (Cary, NC).

Results and Discussion

There was no evidence of an interaction between crumble fines removal and ME content of the diet or main effect of ME content of the diet. Body weight gain (BWG) and total feed intake (TFI) increased ($P < 0.05$) when broilers were fed crumbles sifted with a 0.06-in. screen compared to those fed NS or crumbles sifted with a 0.03-in. screen. Broiler FCR improved ($P < 0.001$) when broilers were fed crumbles sifted with a 0.06-in. screen compared to those fed NS or crumbles sifted with a 0.03-in. screen.

In the study conducted herein, increasing the ME content of the diet 1,346 to 1,376 kcal/lb (increasing soy oil concentration from 0.55 to 1.81%) did not impact growth performance of broilers or influence the response observed based on percent fines of crumbles. Starter broiler diets are commonly crumbled and fed as-is to accommodate the size of the bird. However, during the process of crumbling, fines are created as the pellets are broken down. The results of this experiment suggest that screening crumbles to remove those fines (< 1,532 μm) increases bird performance. More research is needed to determine an acceptable quantity and size of fines needed to optimize broiler performance.

In conclusion, broilers fed crumbles with particles < 1,532 μm removed had improved FCR and an increased BWG and TFI regardless of the ME content of the diet. However, removing particles < 864 μm did not improve growth performance of broilers compared to those fed NS crumbles. Increasing ME from 1,346 to 1,376 kcal/lb did not influence growth performance of broilers.

Table 1. Diet composition (as-is)

Ingredients, %	1,346 kcal/lb ME diet	1,376 kcal/lb ME diet
Ground corn	59.92	58.41
Soybean meal (46.5% CP)	35.69	35.95
Soy oil	0.55	1.81
Limestone	1.00	0.99
Dicalcium phosphate	1.41	1.42
Salt	0.46	0.47
L-Lysine	0.21	0.21
DL-Methionine	0.33	0.33
L-Threonine	0.13	0.13
Phytase[1]	0.01	0.01
Choline chloride	0.04	0.04
Vitamin trace mineral premix	0.25	0.25
Total	100	100
Calculated nutrient analysis		
ME (kcal/lb)	1,346	1,376
Crude protein, %	22.8	22.8
Crude fat, %	3.4	3.4
Ca, %	0.73	0.73
Available P, %	0.45	0.45
Digestible lysine, %	1.26	1.26

[1]Quantum Blue (AB Vista, Marlborough Wiltshire, UK) provided 341–455 phytase units (FTU)/lb with a release of 17.5–19.5% available P.

Table 2. The effect of energy content of the diet and crumble fines on body weight gain (BWG), total feed intake (TFI), and feed conversion ratio (FCR)[1,2]

	1,346 kcal ME/lb			1,376 kcal ME/lb				Probability, *P*		
	NS	0.06 in.	0.03 in.	NS	0.06 in.	0.03 in.	SEM	Energy × screen	Energy	Screen
BWG	710.5^{c}	780.4^{a}	739.2^{abc}	727.0^{bc}	770.6^{ab}	743.8^{abc}	18.18	0.754	0.791	0.008
TFI	853.7^{b}	921.1^{a}	886.4^{ab}	880.6^{ab}	899.2^{ab}	890.5^{ab}	17.75	0.367	0.829	0.0499
FCR	1.20^{ab}	1.18^{bc}	1.20^{bc}	1.21^{a}	1.17^{c}	1.20^{ab}	0.0116	0.640	0.908	0.0094

[1] At hatch, 300 male broilers (Cobb 500, Cobb-Vantress, Siloam Springs, AR) were placed in battery cages with 6 broilers per cage and 10 replicates per treatment.

[2] Dietary treatments consisted of a low energy diet (1346 kcal/lb) with either no screen (NS), screened using a 0.06-in. screen, or screened using a 0.03-in. screen, and a high energy diet (1376 kcal/lb) with either NS, screened using a 0.06-in. screen, or screened using a 0.03-in. screen resulting in 6 treatments.