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The Effects of Medium Chain Fatty Acids in Mash and Crumbled Pellet Diets on Growth Performance of Broilers

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Abstract

The objective of this experiment was to determine the effects of medium chain fatty acids (MCFA) in mash and crumbled pellet broiler diets. A total of 400 male chicks (Cobb 500; initial BW 0.092 lb) were housed in 4 Petersime batteries and used in an 18-d study. Treatments were randomly assigned to 80 cages within location block resulting in 8 cages per treatment with 5 chicks per cage at placement. Treatments were arranged in a 2 × 5 factorial with main effects of feed type (mash and crumbled pellet) and 0.5% MCFA inclusion (no inclusion, control; hexanoic acid, C6; octanoic acid, C8; decanoic acid, C10; and dodecanoic acid, C12). Fat inclusions in the diets were equalized using 0.5% soybean oil in the control diet. Prior to crumbling, diets were conditioned at 185°F for approximately 20 s and pelleted (CPM, model CL-5, Crawfordsville, IN) with a 5/32 × 7/8 in. ring die. Dietary treatments were fed for the full duration of the study. There was no evidence of feed form × MCFA interactions. From d 0 to 18, chicks fed pelleted diets had improved ($P < 0.001$) body weight gain (BWG), feed intake (FI), feed conversion ratio (FCR), and final BW compared to those fed mash diets. For the overall treatment period, there was no evidence of a MCFA effect ($P > 0.10$) on broiler performance. Pelleting and crumbling feed improved growth performance regardless of MCFA inclusion. The MCFA inclusion did not positively influence growth performance of broilers.

Keywords

broilers, medium chain fatty acids, pellet, poultry

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K-STATE Research and Extension

2021 ANIMAL FEED AND PET FOOD RESEARCH

The Effects of Medium Chain Fatty Acids in Mash and Crumbled Pellet Diets on Growth Performance of Broilers

Gage E. Nichols, Haley K. Wecker, Caitlin E. Evans, Cassandra K. Jones,[1] Charles R. Stark, and Chad B. Paulk

Summary

The objective of this experiment was to determine the effects of medium chain fatty acids (MCFA) in mash and crumbled pellet broiler diets. A total of 400 male chicks (Cobb 500; initial BW 0.092 lb) were housed in 4 Petersime batteries and used in an 18-d study. Treatments were randomly assigned to 80 cages within location block resulting in 8 cages per treatment with 5 chicks per cage at placement. Treatments were arranged in a 2 × 5 factorial with main effects of feed type (mash and crumbled pellet) and 0.5% MCFA inclusion (no inclusion, control; hexanoic acid, C6; octanoic acid, C8; decanoic acid, C10; and dodecanoic acid, C12). Fat inclusions in the diets were equalized using 0.5% soybean oil in the control diet. Prior to crumbling, diets were conditioned at 185°F for approximately 20 s and pelleted (CPM, model CL-5, Crawfordsville, IN) with a 5/32 × 7/8 in. ring die. Dietary treatments were fed for the full duration of the study. There was no evidence of feed form × MCFA interactions. From d 0 to 18, chicks fed pelleted diets had improved ($P < 0.001$) body weight gain (BWG), feed intake (FI), feed conversion ratio (FCR), and final BW compared to those fed mash diets. For the overall treatment period, there was no evidence of a MCFA effect ($P > 0.10$) on broiler performance. Pelleting and crumbling feed improved growth performance regardless of MCFA inclusion. The MCFA inclusion did not positively influence growth performance of broilers.

Introduction

Historically, the poultry industry has utilized various feed grade antibiotics to positively influence broiler health resulting in improved growth performance. Consumer pressure, however, has driven the poultry industry to explore ways to reduce or completely remove antibiotics from their production system. Additionally, the implementation of governmental regulations such as the Veterinary Feed Directive has further necessitated effective antibiotic alternatives. The Veterinary Feed Directive final rule, an amendment to the Animal Drug Availability Act of 1996, provides legal control and oversight into the use of medically important antibiotics in feed. Under this regulation, antibiotics such as tetracycline and penicillin are only to be included in feed under the approval and supervision of a licensed veterinarian. One possible antibiotic alternative is the inclusion of medium chain fatty acids in broiler diets. These include caproic acid (C6:0), caprylic acid (C8:0), capric acid (C10:0), and lauric acid (C12:0). Previous

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research determined that MCFA have a bactericidal effect by changing the cells permeability, resulting in the loss of the cell membrane's integrity, effectively killing the cell.[2] However, limited data exist determining the effects of MCFA on growth performance of broilers. Therefore, the objective of this experiment was to evaluate MCFA as a dietary additive in mash and crumbled pellet starter diets for broilers.

Materials and Methods

The Institutional Animal Care and Use Committee at Kansas State University (Manhattan, KS) reviewed and approved the protocols used in this experiment. A total of 400 one-day-old male broilers (initially 0.092 lb; Cobb 500, Cobb-Vantress, Siloam Springs, AR) were used in an 18-d study to determine effects of MCFA inclusion in mash or crumbled pellet diets on broiler growth performance. Broilers were placed in 1 of 4 Petersime batteries with 5 broilers per cage (dimensions, 38.0 × 13.0 in.), balanced by BW. Cages were randomly assigned to 1 of 10 dietary treatments within location block with 8 replicates per treatment. Illumination was provided by fluorescent bulbs for the duration of the experiment. Feed was provided *ad libitum* in a 1-pan feeder (capacity was 4.4 lb) per pen. Water was provided *ad libitum* through water troughs. Body weight and feed intake were recorded on day 12 and 18 post-hatching. The BW gain and feed conversion ratio were calculated for each cage for the respective period. Cage mortality was recorded daily and FCR was corrected accordingly.

Dietary treatments

Medium chain fatty acids (Sigma Aldrich, St. Louis, MO) used in this experiment included hexanoic (C6), octanoic (C8), decanoic (C10), and dodecanoic acid (C12) and were guaranteed ≥ 98% purity. Dietary treatments consisted of a 2 × 5 factorial arrangement of treatments with main effects of diet form (mash and crumbled pellet) and MCFA inclusion (control, 0.5% C6, 0.5% C8, 0.5% C10, and 0.5% C12). All diets were formulated with ingredient nutrient specifications and their respective standardized ileal digestible (SID) amino acid coefficients based on Cobb 500 recommended requirements. Diets were manufactured at the Kansas State University O.H. Kruse Feed Technology Innovation Center. Corn was ground to approximately 700 µm. One master batch of feed (2,000 lb) was made and divided into 5 separate batches of feed (400 lb each). Either 0.5% soybean oil for the control or 0.5% MCFA was mixed into each batch of feed to create dietary treatments. Each batch was then divided, with one half remaining in mash form and the other further processed into a crumbled pellet. Prior to crumbling, diets were conditioned at 185°F for approximately 20 s and pelleted (CPM, model CL-5, Crawfordsville, IN) with a 5/32 × 7/8 in. ring die.

Statistical analysis

Data were analyzed using the GLIMMIX procedure in SAS v. 9.4 (SAS Institute Inc., Cary, NC), with pen as the experimental unit, pen location as the blocking factor and adjusted using Tukey-Kramer multiple comparisons. Results were considered significant if $P \leq 0.05$.

[2] Kim, S. A. and M. S. Rhee. 2013. Marked Synergistic Bactericidal Effects and Mode of Action of Medium-Chain Fatty Acids in Combination with Organic Acids against *Escherichia coli* 0157:H7. Appl. and Envir. Micro. 79:6552-6560. https://doi.org/10.1128/AEM.02164-13.

Results and Discussion

From d 0 to 18, there was no evidence of feed form × MCFA interactions ($P > 0.328$). From d 0 to 18, broilers fed pelleted diets had improved ($P < 0.001$) BW gain, feed intake, FCR, and final BW compared to those fed mash diets. For the overall treatment period there was no evidence of an MCFA effect ($P > 0.119$) on broiler performance. Under the constraints of the current study, pelleting and crumbling feed improved growth performance regardless of MCFA inclusion. Additionally, MCFA inclusion did not positively influence growth performance. More work is needed to determine the optimal inclusion level and type of MCFA required for improvement of broiler growth performance when exposed to a health challenge.

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Table 1. Diet composition (as-fed basis)[1]

Item	Control	Treatments
Ingredients, %		
Corn	60.76	60.76
Soybean meal (46.5% CP)	32.50	32.50
Soy oil	2.00	1.50
Calcium carbonate	1.40	1.40
Monocalcium P (21% P)	2.10	2.10
Salt	0.23	0.23
L-Lys HCl	0.15	0.15
DL-Met	0.23	0.23
L-Thr	0.08	0.08
Mineral-vitamin premix[2]	0.25	0.25
Sodium bicarbonate	0.20	0.20
Choline chloride	0.10	0.10
Medium chain fatty acids[3]	---	0.50
Total	100.00	100.00
Calculated analysis		
ME, kcal/lb	1,373	1,373
CP, %	21.14	21.14
SID Lys, %	1.12	1.12

[1] Treatments were arranged in 2 × 5 factorial design of diet form (meal vs. crumbled pellet) and 0.5% MCFA inclusion (control, C6, C8, C10, and C12).

[2] Composition per kg: 20 g iron, 40 g zinc, 40 g manganese, 4.5 g copper, 0.6 g iodine, and 0.06 g selenium. 3,080,000 IU vitamin A, 1,100,000 IU vitamin D_3, 6,600 IU vitamin E, 4.4 mg vitamin B_{12}, 330 mg menadione, 2,640 mg riboflavin, 2,640 mg d-pantothenic acid, and 11,000 mg niacin.

[3] Medium chain fatty acids (Sigma Aldrich, St. Louis, MO) used in this experiment were guaranteed ≥ 98% purity and included hexanoic (C6), octanoic (C8), decanoic (C10), and dodecanoic acid (C12).

Table 2. Effect of MCFA inclusion in mash or crumbled pellet diets on broiler performance through 18 days posthatch[1]

	Mash					Crumbled pellet						Probability, *P* <		
	Control	C6	C8	C10	C12	Control	C6	C8	C10	C12	SEM	Form	MCFA	Interaction
BW, lb														
d 0	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.001	0.046	0.488	0.306
d 18	1.55	1.50	1.52	1.51	1.52	1.62	1.60	1.59	1.63	1.62	0.027	0.001	0.594	0.689
d 0 to 18														
BWG, lb	1.44	1.38	1.44	1.42	1.43	1.51	1.49	1.50	1.53	1.50	0.025	0.001	0.290	0.695
FI, lb	1.81	1.77	1.82	1.81	1.81	1.87	1.87	1.85	1.89	1.91	0.028	0.001	0.683	0.654
FCR	1.26	1.28	1.27	1.27	1.27	1.24	1.26	1.24	1.23	1.26	0.010	0.001	0.119	0.328

[1] At hatch, 400 male broilers (Cobb 500, Cobb-Vantress, Siloam Springs, AR) were placed in groups of 5 and reared to 18 days with 8 replicates per treatment. Dietary treatments were arranged in 2 × 5 factorial design of diet form (meal and crumbled pellet) and 0.5% MCFA inclusion (no inclusion, control; hexanoic acid, C6; octanoic acid, C8; decanoic acid, C10; and dodecanoic acid, C12).

[a,b] Means within a row followed by different letter are significantly different ($P \leq 0.05$).

BWG = body weight gain. FI = feed intake. FCR = feed conversion ratio.