Cobb 700 response to increasing lysine by growth phase

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Primary Audience: Researchers, Nutritionists, Live Production Managers

SUMMARY

The Cobb MV × Cobb 700 male broiler was evaluated for BW and feed conversion ratio (**FCR**) when fed diets of increasing levels of digestible lysine (**Lys**) and ME within each growing phase (0–12 D, 12–26 D, 26–35 D, and 35–55 D). Male BW was highest ($P < 0.0001$) at 12 D of age for birds fed 1.24% digestible Lys and 3,194 ME vs. birds fed 1.20% digestible Lys and 3,084 ME. Male BW were also highest ($P < 0.0001$) at 26 D of age for birds fed 1.23% digestible Lys and 3,194 ME. However, birds were able to compensate with increased FCR ($P < 0.0001$) when fed diets with lower levels of digestible Lys and ME from 26 to 55 D to achieve similar BW ($P > 0.05$) compared with the birds on the highest level and duration of digestible Lys and ME. The control group, that is, industry standard digestible Lys and ME levels, had the lowest levels of digestible Lys and ME for the duration of the experiment and had the highest ($P < 0.0001$) FCR and the lowest ($P < 0.0001$) BW. The results for BW and FCR suggest that the digestible Lys needs are higher than previously established. More investigations within each growing phase should be performed to better define the requirements of the Cobb MV × Cobb 700 broiler for digestible Lys.

Key words: broiler, lysine, protein, Cobb 700

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DESCRIPTION OF PROBLEM

It is thought that NRC [1] amino acid needs, established with multipurpose broiler chickens, are lower than needed to support good growth and yield of late-maturing, high-yielding broiler strains (e.g., Cobb MV × Cobb 700) [2]. Late-maturing, high-yielding broiler strains from Aviagen International and Cobb-Vantress, Inc. are becoming breeds of choice in the United States. These breeds are considered high yielding in breast meat in comparison with multipurpose standard commercial strains [3, 4]. The Cobb MV × Cobb 700 high-breast-yielding broiler breed cross has been on the commercial market since 2015. High-yielding broilers are predominately located in the United States market because of white meat–driven consumer preference and the increasing

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poultry consumption per capita. From 1987 to 2017, the per capita consumption of poultry meat in the United States increased 66.6% to 41.2 kg, broiler production increased 168% to 1.9 million metric tons/yr and exports of broiler meat increased 804% to 3.1 million metric tons/yr [5]. The increase in broiler meat production can be attributed in part by the increase of live broiler BW, where in 1987, the live broiler BW in the United States was approximately 1.9 kg and has increased 49% to 2.9 kg in 2017 [6].

Previous research demonstrated that requirements for digestible lysine (**Lys**) differ depending on the genotype and gender of the broiler [7, 8]. As these different lines have changed, bird nutrient needs have as well. Sterling et al. [7] observed 3-way interactions between genotype and their response to the increasing levels of dietary CP and digestible Lys. Havenstein et al. [9] studied broilers from a 2001 breed strain and a 1957 breed strain–fed diets comparable with diets from 2001 to 1957, demonstrating that the 1957 broiler fed 2001 diets required more than 42 D to reach the same BW as the 2001 broiler strain fed 2001 diets [8], suggesting that the bird's nutritional needs have changed.

Published research on late-maturing, high-yielding broiler strains is scarce resulting in little knowledge of the nutritional requirements of these birds. The scarcity of research is partly attributed to the primary broiler breeder's fast pace of line substitutions, and the time to produce the cross to produce the breeder is at least 3 yr. For instance, the Cobb 700 broiler breeder female was first paired with the standard "Cobb Male." Next, Cobb launched the "Cobb MX" male, which paired with the same Cobb 700 female producing the next version of the Cobb 700 broiler. Then, in 2015, the "Cobb MV" male was paired with the Cobb 700 female to produce the most modern Cobb 700 broiler, the Cobb MV × Cobb 700 broiler. These line crosses encompassed 12 yr since the Cobb 700 introduction in 2007 [10]. There has been one study published using the Cobb MV × Cobb 700 broiler evaluating differing levels of AME and AA density. Maynard et al. [11] reported that BW and yield responses to the density of AA within the diets weres not limited by the AME within their diets.

This trial was designed to evaluate the effects of feeding increasing digestible Lys and ME to Cobb MV × Cobb 700 male broilers to 55 D of age.

MATERIALS AND METHODS

Trial Diets and Feeding Phases

The trial was divided into 4 feeding phases to mimic Cobb 700 broiler commercial practices [2, 4]. There were 6 dietary treatments consisting of increasing the percentage of digestible Lys and ME as shown in Tables 1 and 2. The starter diet for T1 to T4 consisted of 2,996 ME kcal/kg, 21.0% CP, and 1.20% digestible Lys; for T5, the starter diet consisted of 3,084 ME kcal/kg, 21.6% CP, and 1.24% digestible Lys; and the T6 starter diet consisted of 3,084 ME kcal/kg, 24.0% CP, and 1.38% digestible Lys. The grower diet for T1 to T3 consisted of 3,084 ME kcal/kg, 19.6% CP, and 1.07% digestible Lys; for T4 and T5, the grower diet consisted of 3,194 ME kcal/kg, 21.3% CP, and 1.19% digestible Lys; and the T6 grower diet consisted of 3,194 ME kcal/kg, 21.9% CP, and 1.23% digestible Lys. The finisher diet for T1 and T2 consisted of 3,172 ME kcal/kg, 17.0% CP, and 0.95% digestible Lys; for T3 to T5, the finisher diet consisted of 3,282 ME kcal/kg, 17.6% CP, and 0.98% digestible Lys; and the T6 finisher diet consisted of 3,282 ME kcal/kg, 19.5% CP, and 1.09% digestible Lys. The withdrawal diet for T1 consisted of 3,172 ME kcal/kg, 16.5% CP, and 0.90% digestible Lys; for T2 to T5, the withdrawal diet consisted of 3,282 ME kcal/kg, 17.3% CP, and 0.93% digestible Lys; and the T6 withdrawal diet consisted of 3,282 ME kcal/kg, 19.0% CP, and 1.06% digestible Lys. All other amino acids were formulated to digestible Lys ratios by feeding phase. A CP formulation constraint was not imposed as digestible Lys increased. Dietary treatments by feeding phase for all 6 treatments can be found in Table 3. All diets were analyzed for CP content and were within specifications of the diet.

Table 1. Composition of experimentation diets[1] fed to Cobb MV × Cobb 700 male broilers from 0 to 12 D, 12 to 26 D, 26 to 35 D, and 35 to 55 D of age.

	Treatments											
	Starter diet (0–12 D)			Grower diet (12–26 D)			Finisher diet (26–35 D)			Withdrawal diet (35–55 D)		
Ingredients % of diet	1[2]–4	5	6	1–3	4 and 5	6	1 and 2	4 and 5	6	1	2–5	6
Corn	59.12	54.62	46.82	61.74	53.24	51.24	67.97	63.45	57.20	69.76	65.65	60.23
Soybean meal	35.01	37.22	43.68	31.81	36.88	38.51	25.24	27.11	32.32	23.75	25.25	29.68
Poultry fat	2.54	4.83	6.20	3.44	6.83	7.19	3.82	6.48	7.58	3.50	6.11	7.08
Dicalcium P	1.94	1.94	1.89	1.79	1.77	1.76	1.61	1.61	1.57	1.62	1.62	1.59
Alimet[3]	0.34	0.36	0.43	0.28	0.34	0.36	0.27	0.29	0.34	0.24	0.26	0.32
Limestone	0.31	0.29	0.26	0.30	0.27	0.27	0.31	0.29	0.27	0.31	0.30	0.28
Salt	0.19	0.20	0.22	0.27	0.28	0.28	0.24	0.25	0.27	0.25	0.25	0.26
L-Lys HCl	0.16	0.15	0.12	0.10	0.10	0.10	0.16	0.14	0.12	0.14	0.13	0.14
Threonine 98%	0.11	0.11	0.12	0.06	0.08	0.09	0.04	0.04	0.05	0.09	0.10	0.11
Mineral premix[4]	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Choline	0.09	0.08	0.06	-	-	-	0.13	0.12	0.10	0.13	0.13	0.11
Vitamin premix[5]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Zoamix 25%[6]	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05

[1]Experimentation diets consisted of different percentage of digestible Lys and different ME.

[2]Treatment 1 diets were set to Cobb 700 broiler nutrition recommendations for digestible Lys as a percentage of diet and ME, kcal/kg; by age.

[3]Alimet is the tradename for liquid methionine produced by Novus International, Saint Charles, Missouri.

[4]Mineral premix contained in diets: manganese = 120 ppm; zinc = 110 ppm; selenium = 0.30 ppm; iron = 45 ppm; iodine = 3.5 ppm; copper = 125 ppm.

[5]Vitamin premix contained per metric ton: vitamin A = 13,343 IU; vitamin D_3 = 5,810 IU; vitamin E = 119 IU; vitamin K = 6.52 g; thiamine = 5.34 g; riboflavin = 15.27 g; niacin = 54.69 g; pantothenic acid = 32.90 g; pyridoxine = 7.08 g; biotin = 0.43 g; folic acid = 4.49 g; vitamin B_{12} = 0.076 g.

[6]Zoamix 25% is an anticoccidial manufactured by Zoetis Services, LLC. Parsippany-Troy Hills, NJ.

Table 2. Composition of experimentation diets[1] fed to Cobb MV × Cobb 700 male broilers from 0 to 12 D, 12 to 26 D, 26 to 35 D, and 35 to 55 D of age.

	Treatments											
	Starter diets (0–12 D)			Grower diets (12–26 D)			Finisher diets (26–35 D)			Withdrawal diets (35–55 D)		
Nutrients, %[2]	1[3]–4	5	6	1–3	4 and 5	T6	1 and 2	3–5	6	1	2–5	6
ME, kcal/kg	2,996	3,084	3,084	3,084	3,194	3,194	3,172	3,282	3,282	3,172	3,282	3,282
CP	21.0	21.6	24.0	19.6	21.3	21.9	17.0	17.6	19.5	16.5	17.3	19.0
Calcium	0.90	0.90	0.90	0.84	0.84	0.84	0.76	0.76	0.76	0.76	0.76	0.76
Available P	0.45	0.45	0.45	0.42	0.42	0.42	0.38	0.38	0.38	0.38	0.38	0.38
Sodium	0.19	0.19	0.20	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
Chloride	0.20	0.20	0.20	0.22	0.22	0.22	0.24	0.24	0.24	0.24	0.24	0.24
Na + K-Cl, mEq/kg	276	285	316	265	285	292	229	235	258	223	232	252
Digestible Arg	1.30	1.36	1.54	1.21	1.34	1.39	1.03	1.07	1.21	0.97	1.00	1.14
Total Lys	1.33	1.37	1.53	1.19	1.32	1.36	1.05	1.08	1.21	1.00	1.03	1.17
Digestible Lys	1.20	1.24	1.38	1.07	1.19	1.23	0.95	0.98	1.09	0.90	0.93	1.06
Total Met	0.63	0.65	0.73	0.55	0.63	0.65	0.51	0.53	0.60	0.48	0.49	0.56
Digestible Met	0.60	0.62	0.71	0.53	0.60	0.63	0.49	0.51	0.58	0.46	0.47	0.54
Digestible TSAA	0.89	0.92	1.02	0.80	0.89	0.92	0.74	0.76	0.85	0.70	0.76	0.85
Digestible Trp	0.23	0.24	0.27	0.21	0.23	0.24	0.18	0.18	0.21	0.18	0.18	0.21
Digestible Thr	0.78	0.81	0.90	0.70	0.77	0.80	0.59	0.61	0.68	0.61	0.63	0.72
Digestible Ile	0.82	0.86	0.96	0.73	0.82	0.86	0.65	0.68	0.76	0.65	0.67	0.77
Digestible Val	0.90	0.93	1.04	0.79	0.90	0.92	0.74	0.76	0.85	0.70	0.72	0.83
Choline, mg/kg	1,742	1,742	1,742	1,220	1,304	1,337	1,742	1,742	1,742	1,742	1,742	1,742

[1]Experimentation diets consisted of different percentage of digestible Lys and different ME.

[2]Treatment 1 diets were set to Cobb 700 broiler nutrition recommendations for digestible Lys as a percentage of diet and ME, kcal/kg; by age.

[3]Nutrients are percentage of diets unless otherwise noted.

Table 3. Experimental design by treatment of diets fed to Cobb MV × Cobb 700 male broilers with increasing digestible lys as percentages of the diets and ME (kcal/kg) in the diets fed 0 to 12 D, 12 to 26 D, 26 to 35 D, and 35 to 55 D of age.

	Age phases in the experiment							
	0–12 D		12–26 D		26–35 D		35–55 D	
Treatment	ME, kcal/kg	Digestible Lys, %	ME, kcal/kg	Digestible Lys, %	ME, kcal/kg	Digestible Lys, %	ME, kcal/kg	Digestible Lys, %
1[1]	2,996	1.20%	3,084	1.07%	3,172	0.95%	3,172	0.90%
2							3,282	0.93%
3					3,282	0.98%		
4			3,194	1.19%				
5	3,084	1.24%						
6		1.38%		1.23%		1.08%		1.04%

[1]Treatment 1 diets are equivalent to Cobb-Vantress, Inc. recommendations for the Cobb MV x Cobb 700 broiler dietary requirements.

Bird Housing and Management

At 0 D of age, 3,600 Cobb MV × Cobb 700 male broilers were randomly placed into 48 floor pens after being vent sexed. Each pen's dimensions were 2.44 m × 3.05 m, allowing 0.1 square meters per bird of floor space and mimicked commercial equipment. Pine wood shavings were used for bedding material at a depth of no less than 4". Chicks were given 24 h of continuous light from 1 to 3 D. At day 4, daily light h were reduced to 20 continuous h. At 7 D, the light h were reduced to 18 continuous h for the remainder of the 8-wk brooding period.

Cobb 700 broiler commercial feeding programs were starter = 0 to 12 D of age, grower = 12 to 24 D of age, finisher = 24 to 35 D of age, and withdrawal = 35 to 55 D of age. Feed and water were provided ad libitum.

Pens contained 2 hanging feeders with 13.6 kg capacity (Chore-Time, Inc., Milford, IN) resulting in the equivalent of 37.5 birds per hanging feeder. During the brooding phase (0–10 D of age), an additional 2 supplemental feeder lids were used (one per 37.5 birds). Nipple water lines (Ziggity Systems, Inc., Middlebury, IN) were used with 12 nipples per pen resulting in 6.25 birds per water nipple. One supplemental Biddy drinker (Big Dutchman, Vechta-Calveslage, Germany) was used per pen during the first 5 D.

Data Collection and Calculations

Before placement, birds were counted into chick boxes of 100 chicks per box. Chick boxes were weighed to obtain the mean chick weight. Mortality was recorded daily. Feed intake was recorded by pen. At the beginning of each phase, the amount of treatment specific feed assigned to that pen was weighed and recorded. At the end of each phase, the remaining feed was weighed and recorded. Any remaining feed at the end of each feeding phase was discarded, and the next diet assigned to that pen was fed for the appropriate feed phase for assessing live performance. In addition, a sample of 6 birds per pen was tagged at the end of the withdrawal phase for processing measures, including woody breast scores.

BW were obtained concurrently with feed changes by the feeding phase and represented as total BW kg per pen. Feed conversion ratio (**FCR**) for the pen divided by the number of birds remaining in the pen = BW, kg;/bird. FCR for the pen was calculated for each phase by pen: feed intake by feeding phase/BW for the pen + mortality BW = FCR. The FCR was also calculated for the entire trial period: 0 to 55 D of age by pen.

The sample for processing from each pen was obtained by finding the treatment mean and tagging 2 birds within +1 standard deviation of the treatment mean, 2 birds within −1 standard deviation of the treatment mean, one bird within +1 and +2 standard deviation of the treatment mean, and one bird within −1 and −2 standard deviation of the treatment mean. Bird tag numbers corresponded to pens. At 56 D, the sample birds were processed for yields at the University of Arkansas Pilot Processing Plant in

Fayetteville, Arkansas. The following weights were recorded by the bird tag number: live BW, carcass weight, breast fillet, breast tender, total drum, total thigh, total wing, and abdominal fat. Each part weight was calculated as a percent of live BW. Breast fillets were palpated and scored for woody breast and white stripping on a 0 to 3 scale where 0 was no incidence, 1 mild incidence, 2 moderate incidence, and 3 severe incidence.

Animal Welfare

The birds were reared under normal industry conditions, and all daily animal care expectations and welfare outcomes were compliant with the animal welfare standards required by Cobb-Vantress, Inc. The Cobb-Vantress, Inc. animal welfare standards meet or exceed the standards and recommendations of the National Chicken Council for broiler chickens and breeding chickens. PAACO (Professional Animal Auditor Certification Organization)-certified auditors routinely conducted welfare audits at each study location to verify compliance with animal welfare standards and company expectations. Audits included a review of the poultry facilities, bird handling procedures, record keeping of daily bird care, and training records for biosecurity and animal welfare. All employees at Cobb-Vantress, Inc. who work with live animals are provided with animal welfare training on a monthly, quarterly, and annual basis. Training includes relevant awareness topics for improving knowledge about animal welfare in their respective work area(s), poultry care and handling standards, and the importance of proactive evaluation of behavior, quality, and environmental conditions so that poultry welfare is optimized.

Statistical Analysis

The experimental design for this trial was a complete randomized block design. Analysis of variance was performed using JMP 14 software (SAS Institute, Inc., Raleigh, NC), and means were separated by Tukey-Kramer; P-value $<$ 0.05 [12].

Pen was used as the statistical unit. When dietary treatments were fed the same diets in a feeding phase, pens were considered one treatment, that is, for the starter phase, treatments 1, 2, 3, and 4 were on the same diet and analyzed as one treatment until the following growing/feeding phase. In the grower phase, T1, T2, and T3 were on the same diet; however, T4 was analyzed at this point as another treatment.

RESULTS AND DISCUSSION

Starter phase BW were highest ($P < 0.0001$) for birds fed diets with the highest levels of digestible Lys and ME in T6 (Table 4); however, T1 to T4 receiving 1.20% digestible Lys and 2,996 ME and birds in T5 receiving 1.25% digestible Lys and 3,084 ME did not differ in BW ($P > 0.05$). The grower phase BW of birds fed T6 diets from 0 D to 26 D were highest ($P <$ 0.0001), and those birds fed of T1 to T3 diets, T4 diets, and T5 diets BW being similar ($P >$ 0.05). Birds fed T6 diets had higher finisher (35 D) BW than those of birds fed T1 to T2 diets ($P < 0.05$) and birds fed T3 to T5 diets having intermediate BW. Similarly, the BW of birds fed T6 diets in the withdrawal phase (55 D) was higher ($P < 0.001$) than that of the birds fed T1 to T3 diets, with bird fed T4 and T5 diets being intermediate BW.

Body weight increased in response to digestible Lys and ME. Dietary digestible Lys is considered an essential amino acid in poultry, especially for the deposition of breast muscle in high-yielding commercial broilers. The Cobb MV $\times$ Cobb 700 broiler has been bred for improved overall body carcass yield and especially that of white breast meat as a percentage of their live BW. The increase of digestible Lys from 1.20 to 1.24% and increase in ME from 2,996 to 3,084 kcal/kg in the starter phase did not result in increased BW ($P > 0.05$). However, increasing the digestible Lys to 1.38 resulted in higher BW ($P < 0.0001$) in the starter phase. Although the BW was not different ($P > 0.05$) between birds fed 1.20% digestible Lys and 2,996 kcal/kg ME and those fed digestible Lys % of 1.24 and 3,084 kcal/kg ME, BW was increased ($P < 0.0001$) when the birds were fed 1.38% digestible Lys and 3,084 kcal/kg ME. It appears that the Cobb MV $\times$ Cobb 700 male broilers dietary requirement for digestible Lys maybe higher

Table 4. Cobb MV × Cobb 700 male broilers fed diets[1] with increasing digestible lys as a percentage of the diet and ME (kcal/kg) by ages 0 to 12 D, 12 to 26 D, 26 to 35 D and 35 to 55 D, body weights and adjusted feed conversion for mortality (FCR).

	Treatment with increasing digestible Lys[1] and ME kcal/kg[2] of the diets							
	1	2	3	4	5	6	SEM	*P*-value
Body weight, g								
12 D		322^{b}			326^{b}	342^{a}	2.6	<0.0001
26 D		$1{,}303^{b}$		$1{,}327^{b}$	$1{,}336^{b}$	$1{,}393^{a}$	11.2	<0.0001
35 D	$2{,}150^{b}$		$2{,}193^{a,b}$	$2{,}197^{a,b}$	$2{,}210^{a,b}$	$2{,}271^{a}$	17.0	0.0003
55 D	$4{,}014^{c}$	$4{,}077^{b,c}$	$4{,}076^{b,c}$	$4{,}111^{a,b,c}$	$4{,}134^{a,b}$	$4{,}219^{a}$	27.2	0.0004
FCR								
0–12 D		1.102^{a}			1.083^{a}	1.042^{b}	0.0064	<0.0001
0–26 D	1.319^{a}			1.265^{b}	1.248^{b}	1.228^{b}	0.0076	<0.0001
0–35 D	1.425^{a}		1.418^{a}	1.372^{b}	$1.369^{b,c}$	1.337^{c}	0.0067	<0.0001
0–55 D	1.716^{a}	1.659^{b}	$1.660^{a,b}$	1.646^{b}	1.648^{b}	1.610^{b}	0.0112	<0.0001

[a–c]Mean values within a row that have different letters are different at $P < 0.05$ (Tukey's Test).

[1]Treatments were fed diets with the following different digestible Lys as a percentage of the diet for ages 0 D to 12 D, 12 D to 26 D, 26 D to 35 D, and 35 D to 55 D; T1 = 1.20, 1.07, 0.95, 0.90%; T2 = 1.20, 1.07, 0.95, 0.93%; T3 = 1.20, 1.07, 0.98, 0.93%; T4 = 1.20, 1.19, 0.98, 0.93%; T5 = 1.24, 1.19, 0.98, 0.92%; and T6 = 1.38, 1.23, 1.08, 1.04%, respectively.

[2]Treatments were fed diets with the following different ME, kcal/kg; by diet for ages 0 D to 12 D, 12 D to 26 D, 26 D to 35 D, and 35 D to 55 D; T1 = 2,996, 3,084, 3,172, 3,172; T2 = 2,996, 3,084, 3,172, 3,282; T3 = 2,996, 3,084, 3,282, 3,282; T4 = 2,996, 3,194, 3,282, 3,282; and T5 and T6 = 3,084, 3,194, 3,282, 3,282, respectively.

than 1.24% digestible Lys in the starter phase. Because the ME of T5 and T6 were equal, the increase in BW ($P < 0.0001$) was driven by the increased digestible Lys or the increase in Lys in relationship to energy.

Mortality-adjusted FCR was highest ($P < 0.0001$) for the starter phase of those treatments fed the lowest level of digestible Lys and ME of T1 to T4, which was similar ($P > 0.05$) to birds fed the T5 diet with an FCR of 1.083 (Table 4). The starter phase FCR of birds fed the T6 diet was lowest ($P < 0.0001$). The grower phase diets of T1 to T3 had the highest ($P < 0.0001$) FCR of 1.319, and lowest FCR ($P < 0.0001$) was observed in treatments fed the T4 to T6 diets. The finisher phase diets of T5 and T6 had the lowest ($P < 0.0001$) FCR of 1.369 and 1.337, respectively. Finisher phase treatments of T1 and T2 that had been fed the lowest digestible Lys and ME had the highest ($P < 0.0001$) FCR of 1.425; however, T1 and T2 FCR were similar to ($P > 0.05$) that of birds fed the T3 diets. The withdrawal phase FCR was lowest ($P < 0.0001$) for birds fed the T2, T4, T5, and T6 diets; the FCR of birds fed T1 diets was highest ($P < 0.0001$), with birds on the T3 diets having an intermediate response.

When birds were reared on the lowest combination of digestible Lys and ME kcal/kg during the starter and grower phases and then fed on increased digestible Lys and ME kcal/kg in the finisher phase, they were able to achieve similar BW to those fed the highest levels during the starter, grower, and finisher phases. The birds were able to achieve this BW with increased FCR ($P < 0.0001$) in all 3 phases. In previous works, the digestible Lys need of Cobb Male × Cobb 700 (previous Cobb 700 breed cross) in the third growing phase (28 D–42 D) was found to be 0.99% for BW gain, 1.05% for FCR, 0.94% for carcass weight, and 0.95% for breast weight [11]. This study would suggest that the Cobb MV × Cobb 700 need for digestible Lys is higher than that of the previous Cobb Male × Cobb 700 broiler for BW. The FCR response within the starter phase would conversely agree with the BW responses previously discussed. Hence, FCR was lowest ($P < 0.0001$) when the birds were fed the highest digestible Lys % and ME kcal/kg suggesting that the need for digestible Lys is higher than that of 1.24%. Feed conversion response continued to improve with increasing ME (0–56 D), however the influence in FCR response owing to the increase in digestible Lys ranging from 1.19 to 1.23% in the grower phase, 0.98 to 1.08% in the finisher phase, and 0.93 to 1.04% in the withdrawal phase,

Table 5. Cobb MV × Cobb 700 male broilers fed diets differing in digestible lys[1] as a percent of diets and ME[2] (kcal/kg) of diets at different ages; 56-D body weights and processing yields as percentages of live body weight.

	Treatments							
	1	2	3	4	5	6	SEM	*P*-value
Body weight, g	3,822[b]	3,928[a,b]	3,964[a,b]	3,976[a,b]	4,039[a]	4,065[a]	38.3	0.0014
Carcass, %	80.0	79.9	80.1	80.2	80.1	80.5	0.18	0.2243
White meat, %	29.2	29.1	28.9	29	28.9	29.9	0.29	0.1247
Fillet, %	24.6	24.5	24.4	24.5	24.4	25.3	0.27	0.1839
Tenders, %	4.6	4.6	4.5	4.5	4.4	4.6	0.07	0.2488
Wings, %	7.4	7.5	7.3	7.5	7.4	7.5	0.06	0.1921
Thighs, %	14.6	14.5	14.6	14.6	14.6	14.4	0.80	0.8731
Drums, %	9.5	9.6	9.6	9.5	9.5	9.6	0.10	0.9762
Abdominal fat, %	1.4	1.4	1.5	1.3	1.5	1.2	0.06	0.1020

[a–c]Mean values within a row that have different letters are different at $P < 0.05$ (Tukey's Test).

[1]Treatments were fed diets with the following different digestible Lys as a percentage of the diet for ages 0 D to 12 D, 12 D to 26 D, 26 D to 35 D, and 35 D to 55 D; T1 = 1.20, 1.07, 0.95, 0.90%; T2 = 1.20, 1.07, 0.95, 0.93%; T3 = 1.20, 1.07, 0.98, 0.93%; T4 = 1.20, 1.19, 0.98, 0.93%; T5 = 1.24, 1.19, 0.98, 0.92%; and T6 = 1.38, 1.23, 1.08, 1.04%, respectively.

[2]Treatments were fed diets with the following different ME, kcal/kg; by diet for ages 0 D to 12 D, 12 D to 26 D, 26 D to 35 D, and 35 D to 55 D; T1 = 2,996, 3,084, 3,172, 3,172; T2 = 2,996, 3,084, 3,172, 3,282; T3 = 2,996, 3,084, 3,282, 3,282; T4 = 2,996, 3,194, 3,282, 3,282; and T5 and T6 = 3,084, 3,194, 3,282, 3,282, respectively.

supported decreased 0 to 55 D FCR. For instance, the ME from 0 to 12 D was the same between T5 and T6; however, the digestible Lys was 1.24% in the T5 diet and 1.38% in the T6 diet, resulting in a decrease ($P < 0.0001$) in FCR for those birds fed T6 diets.

The 56-D processing live BW were highest ($P < 0.01$) for birds fed the T5 and T6 diets and were lowest ($P < 0.01$) for birds fed the T1 diets, with birds fed the T2 to T4 having intermediate BW (Table 5). There were no significant differences ($P > 0.05$) among treatments

Table 6. Cobb MV × Cobb 700 male broiler breast fillet myopathy scores[3] as mean percentages[4] for wooden breast and white stripping.

	Treatments with increasing percent digestible Lys[1] and increased ME, kcal/kg[2]							
	1	2	3	4	5	6	SEM	*P*-value
Males white stripping, %								
Score 0.5	4.6	22.9	19.2	6.3	4.2	6.7	4.50	0.0244
Score 1.0	71.3	52.5	50	61.3	66.3	60.8	7.19	0.3257
Score 2.0	24.2	22.5	30.8	32.5	29.6	32.5	6.71	0.8527
Score 3.0	0.0	2.1	0.0	0.0	0.0	0.0	0.35	0.4296
Males wooden breast, %								
Score 0.0	4.6	8.3	4.2	4.2	4.2	0.00	2.61	0.5450
Score 0.5	27.5	31.3	31.7	23.8	23.8	34.2	6.70	0.8354
Score 1.0	32.9	27.9	35.4	37.1	32.1	44.2	7.00	0.7040
Score 2.0	23.3	17.1	17.5	23.8	22.9	14.6	6.18	0.8637
Score 3.0	11.7	15.4	11.3	11.3	17.1	7.1	5.04	0.7939

[1]Treatments were fed diets with the following different digestible Lys as a percentage of the diet for ages 0 D to 12 D, 12 D to 26 D, 26 D to 35 D, and 35 D to 55 D; T1 = 1.20, 1.07, 0.95, 0.90%; T2 = 1.20, 1.07, 0.95, 0.93%; T3 = 1.20, 1.07, 0.98, 0.93%; T4 = 1.20, 1.19, 0.98, 0.93%; T5 = 1.24, 1.19, 0.98, 0.92%; and T6 = 1.38, 1.23, 1.08, 1.04%, respectively.

[2]Treatments were fed diets with the following different ME, kcal/kg; by diet for ages 0 D to 12 D, 12 D to 26 D, 26 D to 35 D, and 35 D to 55 D; T1 = 2,996, 3,084, 3,172, 3,172; T2 = 2,996, 3,084, 3,172, 3,282; T3 = 2,996, 3,084, 3,282, 3,282; T4 = 2,996, 3,194, 3,282, 3,282; and T5 and T6 = 3,084, 3,194, 3,282, 3,282, respectively.

[3]Myopathy scores were assigned to the breast fillets as 0 = no incidence, 0.5 = slight incidence, 1.0 = low incidence, 1.5 = mild incidence, 2.0 = moderate incidence, and 3.0 = severe incidence.

[4]Myopathy percentages were figured as counts by score/total fillets counted by pen.

for all carcass parts as a percentage of live BW. Breast quality measurements for woody breast and white striping also had no significant differences ($P > 0.05$) for all treatments (Table 6).

Unlike the live bird results for BW and FCR, processing yields were not significantly different ($P > 0.05$) for any part weights as percentages of live weight. Many studies have shown that dietary amino acid density fed in the first growth phase can have residual positive effects for processing yields [7, 13–22]. The current work suggests that the higher digestible Lys levels were either not high enough in some of the treatments or possibly in the case of T6, the digestible Lys levels were not high enough to maintain the BW and potential processing yields in the third and fourth phase. Although there were no differences in percentage of yields, total meat processed of carcass parts were higher ($P < 0.05$) owing to the increased processed BW (data not presented).

Woody breast and white stripping are of interest to the commercial broiler industry as the increase in breast myopathies results in increased downgrade or condemnation of valuable white meat. Within this study, breast myopathies were not affected by the increase of digestible Lys or ME between any of the dietary treatments ($P > 0.05$). In a previous study, total digestible Lys intake influenced woody breast and white striping of the Cobb MV × Cobb 700 broiler [22]. The results of this study suggest that the accumulated digestible Lys intake may not have been sufficient to result in an increase in the incidence of breast myopathies.

CONCLUSIONS AND APPLICATIONS

1. Cobb MV × Cobb 700 broilers reared to 55 D of age exhibited responsiveness to dietary Lys in the 0- to 12-D growth phase for BW and FCR.

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