

Effect of added dietary lysine and methionine above recommended levels, on growth performance, breast meat yield and financial returns in broilers

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ABSTRACT

This study investigated the effect of added lysine and methionine above recommended levels in broiler diets, on their growth, breast meat yield and financial returns. A total of 175 one-day-old Cobb 500 chicks were assigned to seven dietary treatments in a completely randomized design. Treatment one (T1) was a control diet formulated to breed specifications. Treatments two (T2) and three (T3) contained 1.2 times recommended levels of Lys and Met respectively. Treatment four (T4) contained Lys and Met at 1.2 times recommended levels. Treatments five (T5) to seven (T7) had similar combinations of Lys and Met as T2 to T4 but their inclusions were 1.4 times recommended levels. On day 43 five birds per treatment were slaughtered for breast meat yield measurements. Broilers on T6 had heavier ($P<0.05$) breast meat (691.6 g) and tenderloin weights (126.4 g) compared to birds on T1 (491.2 and 93.8 g respectively). The premium on the price of breast meat more than offset the added feed cost of the nutrient dense diets. However, if the finished dressed broilers are to be sold whole and uncut, this trial showed that it is better to feed the birds at the manufacturers recommended levels of Lys and Met.

Keywords: Lysine; Methionine; Broilers; Breastmeat; Financial analysis
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Introduction

Poultry plays an important role in the provision of high-quality protein for human consumption. It is estimated that about 25% of the world's meat supply is from poultry (FAO, 2016). With an increase in the world's population, it is imperative that poultry production is improved in order to meet the anticipated increase in demand (Elferink & Schierhorn,

2016). The growth performance of broilers is influenced by genetics, nutrition and the environment (Rosa *et al.*, 2007; Gous *et al.*, 2012). Understanding how these factors can be manipulated to improve overall production, including the breast meat yield of broilers is important. The mature broiler breast meat which is almost entirely composed of white muscles is one of the most desired portions compared

to the other parts (Barbut, 2002). In addition, the breast meat is the most expensive part of the broiler carcass, and can, in some cases be more expensive than the whole chicken itself (Foster, 2017). This can have a significant impact on economic returns for the farmer when the broilers are sold as cut portions. The broiler industry is moving towards rearing for higher breast meat yield due to economic reasons, and also to meet the increasing demand by health-conscious consumers for leaner meat (Poultry World, 2015; Phindile, 2012).

Dietary nutrient manipulation, specifically protein, plays a key role in breast meat yield in broilers (Bartov & Plavnik, 1998; Horniakova & Abas, 2009). Sulfur-containing amino acids (SAA) and lysine are known to improve the carcass composition of broilers especially the breast meat yield. These amino acids also have a tendency to reduce abdominal fat deposition (Nasr & Kheiri, 2011; Andi, 2012 & Berri *et al.*, 2008). Elevated lysine requirements are associated with broilers which have been genetically bred for high breast meat yield (Garcia *et al.*, 2006). Schutte and Pack (1995) and Leclercq (1998) showed that SAA and lysine requirements for breast meat yield were higher than the amount required for overall weight gain and feed efficiency. Broilers fed with dietary lysine above recommended levels were shown to have an increase in breast meat yield as a percentage of both the actual weight gain and carcass weight (Kerr *et al.*, 1999). Ross 708 broilers that were fed with diets containing elevated levels of digestible lysine recorded increased breast meat compared to a control group (Dozier *et al.*, 2009).

In Ghana, about 80% of imported frozen broiler meat is in “cuts”, made up of the drumstick, wings and breast (Ghana Annual Poultry Report, 2017). The breast meat is sold at a premium, and although consumers prefer

this cut of the chicken, they also expect the other parts to be sold at a much cheaper price. Due to the high price of the chicken breast meat, many consumers fall back to buying the other cuts. Therefore, the aim of this study was to manipulate the diet of broilers by increasing the levels of Met and/or Lys to improve their growth performance and increase their breast meat yield. By doing so producers who choose to sell their broilers as choice cuts will be able to maximize their returns through the sale of the breast, and still be able to sell the other parts at an affordable price to less affluent consumers who cannot afford the high premium placed on the breast meat.

The hypothesis of the current study was that feeding Cobb 500 broiler birds with elevated levels of Lys and Met will improve breast meat yield. The objectives were:

- i. to study the effect of elevated dietary Lys and Met levels either alone or combined, on broiler performance and carcass characteristics including breast meat yield, and
- ii. to look at the cost-effectiveness of such a diet and implications for producers who wish to sell the finished product either as whole birds or as cuts.

Materials and methods

Experimental site and duration of study

The trial was conducted at the Livestock and Poultry Research Centre (LIPREC), School of Agriculture, College of Basic and Applied Sciences, University of Ghana, Legon. The growth trial lasted for six weeks between the months of March and April 2018, followed immediately by a one-day carcass assessment.

LIPREC is about 8 km off the Legon-Aburi road from the 'Ritz Junction' at Madina, in the Greater Accra Region of Ghana. It is within the Coastal Savannah zone of Ghana and on latitude 05°40'N and longitude 00°16'W (GSS, 2014). Mean annual rainfall at the Centre is 785 mm with a range of 128 – 1,709 mm. The average daily temperature ranges from 24°C at night to about 30°C during the day.

Experimental Diets

A three-phase feeding regime made up of a starter, a grower and a finisher phase was used. The trial lasted for 42 days, and the change-over of diets from the starter to the grower, and from the grower to the finisher phases was at

d14 and d28 respectively. There were seven treatments in total. Treatment one (T1) was formulated to meet the recommended nutrient levels based on age and weight for Cobb 500 broilers (Table 1). Treatments two (T2) and T5 had regular levels of Met, but 1.2 times and 1.4 times the recommended levels of Lys respectively. T3 and T6 had regular levels of Lys but 1.2 times and 1.4 times the recommended levels of Met respectively. T4 had 1.2 times the recommended levels of both Met and Lys, while T7 had 1.4 times the recommended levels of both Met and Lys. The composition and calculated nutrient content of the basal diets are shown in Table 1 below.

TABLE 1
Basal diets ingredient composition and their calculated nutrient content (as-fed basis)

<i>Ingredient (%)</i>	<i>Starter</i>	<i>Grower</i>	<i>Finisher</i>
	<i>kg/100kg</i>		
Maize	55.36	59.08	62.58
Soybean meal	35.05	31.00	25.00
Wheat bran	3.00	3.00	5.00
Soybean oil	2.60	3.00	3.50
Dicalcium phosphate	1.10	1.10	1.10
Oyster shell	1.25	1.25	1.25
Salt	0.40	0.40	0.40
L-Lysine HCL	0.30	0.27	0.27
DL-Methionine	0.44	0.4	0.40
Mineral Premix ¹	0.25	0.25	0.25
Vitamin Premix ²	0.25	0.25	0.25
Total	100.00	100.00	100.00
Calculated Nutrient Content			
Crude Protein (CP), %	22.00	20.00	18.80
ME, MJ/kg	12.50	12.90	13.20

Total Lys, %	1.32	1.19	1.05
Digestible Lys, %	1.18	1.05	0.95
Total Met, %	0.50	0.48	0.43
Digestible Met, %	0.45	0.42	0.39
Total P, %	0.60	0.57	0.53
Available P, % ³	0.45	0.42	0.38
Calcium, %	0.90	0.84	0.76

¹Provided the following per kilogram of diet: vitamin A, 8,250 IU; vitamin D₃, 825 IU; vitamin E, 40 IU; niacin, 35 mg; D-pantothenic acid, 15 mg; riboflavin, 5 mg; menadione, 4 mg; folic acid, 2 mg; thiamine, 1 mg; D-biotin, 0.2 mg; and vitamin B₁₂, 0.025 mg.

²Provided the following per kilogram of diet: Zn, 100 mg, as ZnSO₄; Fe, 80 mg as FeSO₄; Cu, 50 mg as CuSO₄; Mn, 25 mg as manganous sulfate; I, 0.5 mg as Ca iodate; and Se, 0.1 mg as Na₂SeO₃.

³Calculated from analyzed phytate contents in corn, wheat bran and soybean meal (Sauvant *et al.*, 2004).

Chemical analysis

Feed samples were finely ground through a Retsch mill (Model ZM200, Retsch GmbH, Retsch-Allee 1-5, Haan Germany) over a 0.1mm sieve and subjected to proximate analysis according to the Association of Official Analytical Chemist (AOAC,1984) procedures, to determine the dry matter, crude protein, crude fibre, ether extract (fat) and ash contents (Table 2).

Birds and housing

The care of the birds conformed to the Ethics Committee Guidelines (2018) of the College of Basic and Applied Sciences of the University of Ghana. All the diets were in mash form.

TABLE 2
Analyzed chemical composition of experimental diets¹

<i>Nutrient, %</i>	<i>Broiler starter</i>	<i>Broiler grower</i>	<i>Broiler finisher</i>
Dry Matter	88.91	88.72	88.65
Crude protein	22.1	19.87	18.92
Crude fiber	2.53	2.84	3.0
Ether extract	3.4	3.8	4.2
ADF	6.74	6.72	6.69
NDF	6.65	6.59	6.48
Ash	10.89	11.10	10.05

¹Reported analyses are for control diets (T1).

The broilers were given routine vaccination and prophylaxes medication as recommended by the attending veterinarian and in accordance with best practices.

A total of 175 one-day-old mixed-sex Cobb 500 broiler chicks were obtained from a reputable commercial hatchery. The birds were distributed to 35-floor pens located within a short-walled (2 ft.) open/wire mesh-sided modern facility with each pen measuring 1m x 1m. Distribution of the birds within the pens followed a Completely Randomized Design (CRD) arrangement. There were five birds per replicate and five replicates per treatment. The birds were placed on new wood shavings at the start of the study. Each pen was provided with a plastic tube feeder and a waterer. The lighting regime used was 23:1 (light: dark) throughout the experiment. Supplemental heat was provided in the form of coal-heated clay pots and the temperature of the house was maintained at roughly 33°C from d1 to d7, 29°C from d 8 to d14, and ambient (about 27°C) thereafter. Birds had ad-libitum access to feed and water throughout the study.

Growth trial

The growth trial lasted for 42 days. The birds in a replicate, which represented the experimental unit were collectively fed, and left-over feed, together with individual bird weight was taken on d1, and weekly thereafter. Birds that died were removed, weighed and recorded daily. This was then used to calculate the average daily feed intake (ADFI), average daily gain (ADG) and adjusted feed conversion efficiency (FCE).

Carcass characteristics

On day 43, one bird per replicate (five birds per treatment) was randomly chosen and used for carcass trait analysis. Each bird was weighed and subsequently killed by cervical dislocation after which their throats were slit. Killed birds were allowed to bleed out completely and then defeathered. Weights of defeathered birds were

taken and certain key organs of interest were harvested. Chicken parts and organs of interest included, full gastrointestinal weights, gizzard weights, breast meat weights, tenderloin weights and dressed weights.

Financial returns

The following financial indicators and how they were arrived at were also determined:

1. FC/kg BM, GHC: Feed cost per kg of breast meat. This was determined by dividing the total cost of feed eaten by the weight of the breast meat.
2. FC/kg BMTL GHC: Feed cost per kg of breast meat plus tenderloin. This was determined by dividing the total cost of feed eaten by the weight of the breast meat and tenderloin.
3. BM:DW: This was the ratio of the breast meat to the dressed weight.
4. FC/kg BMTL:DB GHC: This is the feed cost applied directly to the breast meat and tenderloin portion of the whole bird. The value was obtained by multiplying the total cost of feed consumed by the ratio of breast meat and tenderloin to the total dressed broiler weight.
5. TIBMTL GHC: This refers to the amount of money that the sale of breast meat plus tenderloin will fetch. At the time of the trial, breast meat was sold at GHC25.00 per kg.
6. TIDB GHC: This refers to the total income accruable from the sale of the dressed broiler. At the time of the trial, a kg of dressed broiler was sold at GHC 15.20 per kg.
7. FC/kg DW GHC: This refers to the cost of feed /kg of dressed weight. This val-

ue was obtained by dividing the cost of feed eaten, by the dressed weight.

8. PPRBR (%): This is the percent profit in terms of sale of dressed broiler over feed costs. This value was obtained by dividing TIBD by the total cost of feed eaten and multiplying by 100.
9. PPRBMTL (%): This is the percent profit in terms of sale of breast meat and tenderloin over feed cost. This value was obtained by dividing TIBMTL by FC/kg BMTL:DB GH¢ and multiplying by 100.
10. LOC GH¢: This refers to the price at which the rest of the carcass can be sold (once the breast meat and tenderloins have been sold at prevailing market prices) in order to break-even on feed costs

Statistical analysis

Data collected was analysed as a Completely Randomized Design using the Generalized Linear Model (GLM) procedure of the SAS 9.4 edition. Significant differences among means were separated using the Student Newman-Kuels' (SNK) test at a 5% probability level.

Results

Growth Parameters

There were no differences in ADG, ADFI and adjusted FCE among the treatments (Table 3). The birds that were fed diets containing Met at 1.4 times the recommended levels (T6) had significantly higher ($P < 0.05$) live weights compared to the other birds. Live weights of birds on T1, T2, T3, T4, T5 and T7 were similar.

TABLE 3
Effect of levels of lysine and methionine on broiler growth performance

Growth parameters	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	SEM	P-value
ADG, g	59.21	59.01	58.74	63.79	57.44	66.22	62.95	3.3389	0.4569
ADFI, g	117.85	119.80	117.75	124.72	118.15	121.33	118.53	6.0813	0.9833
Adjusted FCE	0.53	0.52	0.52	0.54	0.50	0.57	0.55	0.0269	0.7477
Final Live-weight, g	3120 ^b	3030 ^b	3066 ^b	3372 ^{ba}	3472 ^{ba}	3788 ^a	3506 ^{ba}	144.9059	0.0078

T₁: regular lysine and methionine, T₂: 1.2 times lysine and regular methionine, T₃: regular lysine and 1.2 times methionine, T₄: 1.2 times lysine and 1.2 times methionine, T₅: 1.4 times lysine and regular methionine, T₆: regular lysine and 1.4 times methionine, T₇: 1.4 times lysine and 1.4 times methionine.

Wt: Weight. Means of treatments were obtained from five replicates per treatment.

^{ab}Means with different superscripts in a row are significantly different.

Carcass characteristics

The trends for defeathered weight, followed the same pattern as was observed in the final live weight (Table 4). Birds on T6 had the highest defeathered weight (3,526 g) which was similar to birds on T4, T5 and T7 (3,141, 3,082 and 3,256g, respectively) but higher ($P < 0.05$) than birds on T1, T2 and T3 (2,676, 2,810 and 2,848 g, respectively). For broilers on T6 dressed weight was 2,989 g, and this was higher ($P < 0.05$) than birds on T1 (2,389 g) but similar to birds on T2, T3, T4, T5 and T7 (2,473, 2,490, 2,676, 2,720 and 2,762 g respectively).

There were no observed differences in the full GIT, tenderloin and gizzard weights. The breast meat and tenderloin yield from birds on the various treatments are shown in Figure 1. Birds on T2 (1.2 times Lys; recommended Met) recorded the lowest breast meat weight (419.2g) and this was similar to the breast meat weights of birds on T1 (recommended Lys and Met levels), T3 (recommended Lys: 1.2 times Met), T4 (1.2 times Lys: 1.2 times Met), T5 (1.4 times Lys: recommended Met) and T7 (1.4 times Lys: 1.4 times Met). Again, birds on T6 (regular Lys: 1.4 times Met) had carcasses with the heaviest ($P < 0.05$) breast meat yield of 691 g.

TABLE 4
Effect of levels of lysine and methionine on broiler carcass parameters

<i>Carcass parameters, g</i>	<i>Treatment</i>							<i>SEM</i>	<i>P-value</i>
	<i>T₁</i>	<i>T₂</i>	<i>T₃</i>	<i>T₄</i>	<i>T₅</i>	<i>T₆</i>	<i>T₇</i>		
Defeathered weight	2676.0 ^b	2810.0 ^b	2848.0 ^b	3141.0 ^{ba}	3082.0 ^{ba}	3526.0 ^a	3256.0 ^{ba}	146.4208	0.0050
Dressed weight	2389.0 ^{ba}	2473.0 ^{ba}	2490.0 ^{ba}	2676.0 ^{ba}	2720.0 ^{ba}	2989.0 ^a	2762.0 ^{ba}	119.5387	0.0223
Full GIT	115.4	101.8	90.0	104.8	102.2	139.8	127.6	13.8944	0.2075
Gizzard weight	72.0	68.8	69.2	78.8	73.8	83.4	72.6	4.9402	0.3693
Breast weight	519.6 ^{bc}	419.2 ^c	521.6 ^{bc}	608.8 ^{bac}	630.2 ^{bac}	691.6 ^a	674.6 ^{ba}	39.4892	0.0042
Tenderloin weight	103.80	93.38	99.20	102.40	100.80	126.20	117.60	6.1704	0.0116

T₁: regular lysine and methionine, T₂: 1.2 times lysine and regular methionine, T₃: regular lysine and 1.2 times methionine, T₄: 1.2 times lysine and 1.2 times methionine, T₅: 1.4 times lysine and regular methionine, T₆: regular lysine and 1.4 times methionine, T₇: 1.4 times lysine and 1.4 times methionine.

Wt: Weight. Means of treatments were obtained from five replicates per treatment.

^{a-c}Means with different superscripts in a row are significantly different.

TABLE 4
Effect of levels of lysine and methionine on broiler carcass parameters

Carcass parameters, g	Treatment							SEM	P-value
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇		
Defeathered weight	2676.0 ^b	2810.0 ^b	2848.0 ^b	3141.0 ^{ba}	3082.0 ^{ba}	3526.0 ^a	3256.0 ^{ba}	146.4208	0.0050
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Gizzard weight	72.0	68.8	69.2	78.8	73.8	83.4	72.6	4.9402	0.3693
Breast weight	519.6 ^{bc}	419.2 ^c	521.6 ^{bc}	608.8 ^{bac}	630.2 ^{bac}	691.6 ^a	674.6 ^{ba}	39.4892	0.0042
Tenderloin weight	103.80	93.38	99.20	102.40	100.80	126.20	117.60	6.1704	0.0116

T₁: regular lysine and methionine, T₂: 1.2 times lysine and regular methionine, T₃: regular lysine and 1.2 times methionine, T₄: 1.2 times lysine and 1.2 times methionine, T₅: 1.4 times lysine and regular methionine, T₆: regular lysine and 1.4 times methionine, T₇: 1.4 times lysine and 1.4 times methionine.

Wt: Weight. Means of treatments were obtained from five replicates per treatment.

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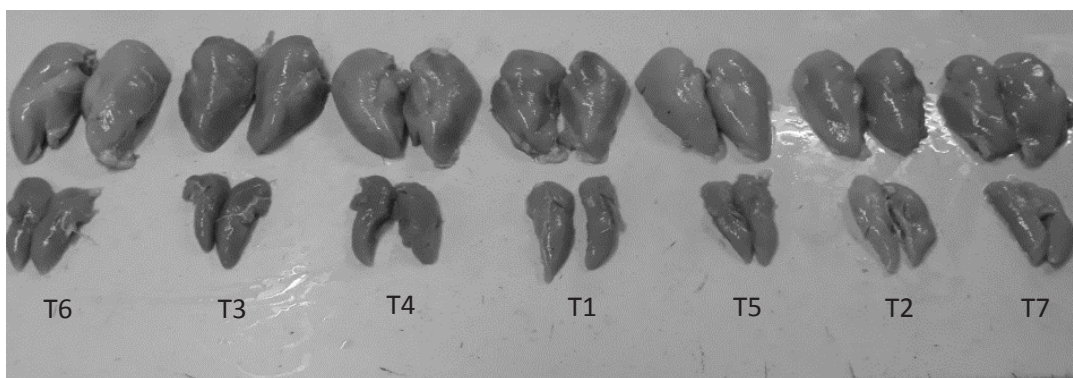


Fig. 1: Breast meat and tenderloins from the different treatment

T₁: regular lysine and methionine, T₂: 1.2 times lysine and regular methionine, T₃: regular lysine and 1.2 times methionine, T₄: 1.2 times lysine and 1.2 times methionine, T₅: 1.4 times lysine and regular methionine, T₆: regular lysine and 1.4 times methionine, T₇: 1.4 times lysine and 1.4 times methionine.

There was no dietary influence on the ratio of breast meat to dressed weight (BM:DW): (Table 5). Also, there was no difference in treatments when the cost of feed was applied directly to the breast and tenderloin portions of the dressed bird (FC/kg BMTL:DB).

For some of the carcass traits, financial returns accruable from the sale of birds (saleable value over feed costs) were positively impacted by feeding birds with levels of Lys and Met (either individually or in combination) that were above the Cobb 500 recommendations. Feed cost per kg breast meat was lower for birds on T6 and T7 (GhC 31.7 and GhC 31.0

respectively) than for birds on T2 (GhC 44.4). Similarly, the feed cost/kg breast meat plus tenderloin (FC/Kg BMTL) for T6 and T7 (GhC 26.8 and GhC26.4) were lower than the cost for birds on T2 (GhC37.2). The total income from the sale of breast meat plus tenderloin and dressed broiler (TIBMTL and TIDB) for birds on T6 (GhC 20.5 and GhC 45.4 respectively) was higher than the income received for birds on T1 (GhC 15.6 and GhC36.3, respectively). Increasing the levels of Lys and Met to 1.4 times the recommended level saw increasing trends in the percent profit (returns over cost of feed) for both breast meat and dressed weight.

TABLE 5
Effect of Lysine and Methionine on costs and financial returns

	<i>Treatment</i>							<i>SEM</i>	<i>P-value</i>
	<i>T1</i>	<i>T2</i>	<i>T3</i>	<i>T4</i>	<i>T5</i>	<i>T6</i>	<i>T7</i>		
Total cost of feed eaten, GhC	20.89	21.58	20.65	21.93	20.93	21.56	20.83		
COST/kg feed, GhC	4.19	4.27	4.17	4.17	4.21	4.23	4.19		
FC/kgBM ¹ , GhC	40.4 ^{ba}	44.4 ^a	40.6 ^{ba}	36.3 ^{ba}	35.0 ^{ba}	31.7 ^b	31.0 ^b	2.5268	0.0063
FC/kg BMTL, GhC	33.6 ^{ba}	37.2 ^a	34.0 ^{ba}	31.1 ^{ba}	30.0 ^{ba}	26.8 ^b	26.4 ^b	1.9760	0.0051
BM: DW,	0.27	0.24	0.25	0.27	0.27	0.27	0.29	0.0130	0.2212
FC/kg BMTL:DB GhC:	5.6	5.1	5.1	5.8	5.6	5.9	6.0	0.2689	0.1478
TIBMTL, GhC	15.6 ^{bc}	14.6 ^c	15.5 ^{bc}	17.8 ^{bac}	18.3 ^{bac}	20.5 ^a	19.8 ^{ba}	1.0711	0.0029
TIDB, GhC	36.3 ^b	37.6 ^{ba}	37.9 ^{ba}	40.7 ^{ba}	41.3 ^{ba}	45.4 ^a	42.0 ^{ba}	1.8167	0.0224
FC/kg DW, GhC	8.9 ^a	8.7 ^{ab}	8.4 ^b	8.2 ^{bc}	7.8 ^{bc}	7.3 ^d	7.6 ^c	0.3803	0.0398
PPRBR, %	173.9 ^c	174.2 ^c	183.2 ^{bc}	185.5 ^{bc}	197.6 ^b	210.5 ^a	201.5 ^{ab}	8.6387	0.0370
PPRBMTL%	286.1 ^c	286.5 ^c	301.4 ^{bc}	305.1 ^{bc}	325.0 ^b	346.2 ^a	331.6 ^{ab}	14.208	0.0370
LOC, GhC	5.30 ^{ab}	6.95 ^a	5.13 ^{ab}	4.15 ^{ab}	2.65 ^{ab}	1.12 ^b	1.02 ^b	1.07	0.003

FC/kg BM: Feed Cost per kg of breast meat; FC/kg BMTL: Feed Cost per kg of breast meat and tenderloin; BM:DW: Ratio of breast meat to dressed weight; FC/kg BMTL:DB GhC: Feed Cost applied directly to the breast meat and tenderloin; TIBMTL: Total income from sale of Breast meat and tenderloin; TIDB: Total Income re-

ceived from sale dressed broiler; FC/kg DW: Feed Cost per kg of Dressed weight; PPRBR: Percent profit over feed cost to produce a whole broiler; PPRBMTL: Percent profit in terms of sale of breast meat and tenderloin over feed cost. LOC: Price to sell remaining carcass to break even on feed cost. T1: regular lysine and methionine, T2: 1.2 times lysine and regular methionine, T3: regular lysine and 1.2 times methionine, T4: 1.2 times lysine and 1.2 times methionine, T5: 1.4 times lysine and regular methionine, T6: regular lysine and 1.4 times methionine, T7: 1.4 times lysine and 1.4 times methionine.

¹Feed cost consumed to obtain breast meat relative to final body weight.

Means of treatments were obtained from five replicates per treatment.

^{a,b}Means with different superscripts in a row are significantly different.

Discussion

Results from this study showed that increasing the levels of dietary total Lys above the Cobb recommended levels of 1.32% (starter), 1.19% (grower), 1.05% (finisher) and also Met 0.50% (starter), 0.48% (grower) and 0.43% (finisher) by up to 1.4 times, resulted in improvements in final live weight and some carcass parameters. Similar ADFI values that were observed in this trial may be due to the fact that all the diets were isocaloric and any of the known effects of dietary energy on feed intake may have been eliminated. The lipostatic theory of feed intake states that birds will attempt to consume feed to meet their energy requirements. The lower the energy content of a particular feed, the more the bird will consume until it is limited by gut fill or other physiological limitations (Ferket & Gernat, 2006). The lack of differences in ADG, ADFI and FCE was similar to results obtained by Saki *et al.* (2007) who reported no significant differences in the feed intake between birds fed regular diets and that of those fed increased levels of Met.

Significant improvements in some carcass parameters and financial indicators were observed when the dietary levels of Met alone were raised to 1.4 times the Cobb recommendations. In the current study, the absence of any differences in the total GIT and gizzard weights, and an increase in the defeathered and dressed weights for birds on T6 and T7, translated into heavier breast

meat yields. Generally, a heavier bird will be expected to have a heavier GIT and gizzard, so long as the dietary nutrient (particularly fibre) levels are the same. However, in a situation where two birds of different weights have the same GIT and crop weights, the heavier birds will be expected to have heavier dressing percentage, as was the case in this study. With the exception of birds on T6, the lack of response observed in the live weight of birds on the other treatments could be an indication that the limits of tolerance in the dietary ideal amino acid profiles for broilers may have been exceeded. Very high levels of Lys and Met could initiate physiological mechanisms to rid the body of excess amino acids and bring the dietary amino acids levels down to the ideal profile (Cobb 500, 2018). Such mechanisms could be energetically inefficient. Excess amino acid above actual requirements cannot be stored and therefore must be excreted as uric acid. This process requires energy which otherwise would have been available for growth (Mavromichalis, 2016). Although elevated levels of amino acids were fed in all but the control, significant improvements in gains for some treatments could mean that the ideal ratios of some of the essential amino acids may be more flexible than originally thought. The lack of any differences in treatments when the cost of feed was applied directly to the breast and tenderloin portions of the dressed bird (FC/kg BMTL:DB) was due in part to the fact that

the ratio between the breast meat and whole dressed bird (BM: DW) was not influenced by the diet (range from 0.27 to 0.29).

Contrary to the findings of this study, Pillai *et al.* (2006) observed increased weight gain of 22-day-old broilers fed increased levels of Met. Ahmed and Abbas (2011) also, observed improved weight gain and FCR when levels of Lys and Met were set at 130% of NRC requirement and fed to broiler for 42day. Ojani-Dirian and Waldroup (2002) again reported higher weights for birds fed increasing (0.38, 0.44 and 0.50%) levels of Met. Kidd *et al.* (2004) and Kerr *et al.* (1999) observed improved body weights in broilers aged 28 and 48 days respectively when elevated levels of Lys were included in their diets. Mukhtar *et al.* (2007) also reported increased weight and daily feed intake for birds fed increased levels of dietary Lys.

As the dietary levels of Lys and Met rose, there were small but insignificant improvements in ADFI, ADG and FCE. These slight numerical increases cumulatively resulted in an improved final liveweight of birds fed these elevated amino acid diets. Again, high levels of Lys and Sulphur-containing amino acids in broiler diets are important for improved carcass characteristics such as breast meat yield (Kidd *et al.*, 2004). Coupled with the fact that GIT weights were not significantly different among the treatments, birds on high amino acids diets had overall improved breast meat yield and other carcass characteristics due mainly to an improved dressing percentage.

Met and Lys are the most important limiting amino acids in practical broiler diets (Ojani-Dirian & Waldroup, 2002; Gill, 2003). Addition of high levels of Lys and Met in diets have been found to stimulate insulin secretion from the pancreas. This causes the release of

both amino and fatty acids from body reserves, leading to protein synthesis (Murray *et al.*, 1998). If the above is true, then it can be speculated that in the current study, increases in dietary limiting amino acid concentrations may have increased protein synthesis and deposition (Gous, 2007) leading to improved yield in the breast meat and other carcass characteristics. Results from the present study agreed with the findings of Zhai *et al.* (2016) who reported improved breast meat yield when the supplemental Lys and Met content of broiler diets were set at 120% and 140% of NRC requirements respectively. Hesabi *et al.* (2006) also observed improved breast meat yield when birds were fed 20% more Lys and Met above NRC requirements.

The reduced cost of feed per kg of breast meat and dressed weight observed for broilers fed increased levels of Met and Lys was due in part to an increase in final liveweight, without a corresponding increase in total GIT weight. Also, Met and Lys are essential amino acids which are important for protein synthesis. Hence so long as an ideal amino acid profile for broilers of that age and breed are met, it can be expected that growth and carcass yields will be improved, as was observed in this trial.

Conclusion

When dietary Met levels were elevated to 1.4 times the recommended level for Cobb 500 broilers, there was an improvement in final live weight and breast meat yields. This improvement in carcass yields was accompanied with some financial benefits.

Recommendations

The results of this trial have indicated that, so long as the intent of the farmer is to sell broilers as choice cuts or parts, it is financially sound to

formulate feed containing 1.4 times the recommended levels of Met up to six weeks of age. The results also indicated that Lys can be maintained at recommended levels. When this strategy is adopted, and breast meat is sold at a premium, most of the income accruing from the sale of the remaining parts may go into profit, since the farmer would have “broken even” on cost, from the sale of the breast meat alone.

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