EFFECTS OF VARYING LEVELS OF METHIONINE ON CARCASS CHARACTERISTICS AND MEAT QUALITY FOR BROILER CHICKENS REARED IN THE HOT SEASON

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ABSTRACT
A study was conducted in a completely randomized design to determine the effects of dietary levels of methionine (Met) on carcass characteristics and meat quality of broiler chickens (5-8 weeks). A total of 285 mixed sex Abor acre broiler chickens in 5 groups and 3 replications were fed maize-soybean meal-based diets supplemented with five levels of Met at 0.40, 0.45, 0.50, 0.55 and 0.60%, respectively. Data on live weight, carcass weight, wings, thighs, drumsticks, back, abdominal fat pad and internal organs were collected and subjected analysis of variance. The live weight (LW), carcass weight (CW), wings, thighs, drumsticks, back, gizzard and abdominal fat were significantly (P<0.05) improved by the dietary treatments. Broiler chickens fed 0.60% dietary methionine had the highest values for LW, CW, wings, thigh, drumstick and the least value for abdominal fat pad. Additional, dietary treatments had significant (p<0.05) effects on tissue fat and tissue crude protein. It was observed that broiler chickens fed 0.60 had the best values for carcass characteristics, tissue fat and tissue crude protein. The study shows that supplementation of methionine in slight excess of the Met concentration required for maximum growth performance improved the carcass characteristics and meat quality of broilers.
Keywords: Broiler, Carcass, Meat quality, Methionine, Tropics,

INTRODUCTION

The importance of amino acids in poultry nutrition is well known (Teng *et al*., 2023). Poultry diets are now formulated on the basis of essential dietary amino acids rather than crude protein in itself. It is therefore of vital importance to provide all the required amino acids necessary for maintenance, growth, production and reproduction (Zafar, *et al*., 2014). Over the past years, broiler production has encountered major significant changes as a result of diet manipulations and genetic progress leading to tremendous improvement with respect to both growth rate and feed efficiency (Opoola *et al*., 2012). Results from research in the area of broiler diets manipulation based on limited amino acids requirements have had positive shifts on performance broiler production. Sulphur amino acids (SAA), in particular the essential amino acid (AA) methionine (Met), are important determinants of the biological value of protein in poultry diets (Opoola *et al*., 2012; Majdeddin *et al*., 2019; Teng *et al*., 2023). Typical corn-soybean meal-based diets for growing broiler chickens, not supplemented with pure AA, contain only 0.3–0.4% of Met (Majdeddin *et al*., 2019), i.e. much less than the value recommended by NRC (1994). For this reason, Met deficiency in feed raw materials should be compensated for by supplementing diets with feed-grade Methiomine (Met) to meet the nutrient requirements of birds. Carcass composition has also moved towards leaner birds. This has led to a substantial shift in the nutrient needs of these birds and particularly for nutrients that are potentially limiting for growth and protein deposition. Synthetic DL-methionine (DLM) supplements poultry diets may enhance production by its impact upon protein deposition and muscle growth and some other functions like digestion and immunity (Opoola *et al*., 2012).

Among essential amino acids, methionine seems to have many interrelationships with other nutrients because many metabolic pathways and other nutrients (cystine, choline, betain, vitamin B, vitamin B and folate) involve methionine (Rajavel, 2020). It is very important to know that poultry require both methionine and cysteine for protein synthesis, so the Total Sulphur Amino Acids (TSAA) requirement should be taken into account. Due to high cost of feed ingredients, it becomes imperative to know the optimum requirements of these amino acids for optimum growth performance of broiler chickens. The findings of Opoola *et al*. (2012) and Teng *et al*. (2023) suggest that the Met content of broiler diets should be higher than that recommended by NRC (1994). The reasons may be due to seasons of rearing and genotype of birds. Experiments involving broiler chickens have shown that dietary Met levels may affect carcass and meat quality (Majdeddin *et al*., 2019). The available literature in the tropical environment provides scant information on the quality of meat from broiler chickens fed diets with increased levels of Met. The aim of this study was to determine the effect of different dietary levels of Met on the carcass and meat quality of broiler chickens.

MATERIAL AND METHODS

Birds, management and diets

The experiment was carried out at the Poultry unit of the livestock farm, Division of Agricultural Colleges, Ahmadu Bello University, Samaru -Zaria. A total of Two hundred and eighty-five (285) mixed sex Abor acre finisher broiler chickens were used in this study. The mean weights of birds for all the pens were made to be approximately equal. The birds were kept in 2 × 2 m pens on litter in a building with a controlled environment. The birds had free access to feed and water. Five broiler finisher diets were formulated such that diets 1, 2, 3, 4 and 5 contained methionine at 0.40, 0.45 0.50, 0.55 and 0.60%, respectively (Table 1). The diets were formulated to be isocaloric and isonitrogenous. (CP=21.50%, ME=2983 Kcal/Kg). They were formulated to meet the requirements for energy, protein, calcium, phosphorus and lysine for broiler finishers according to National Research Council (1994) standards.

Table 1: Composition of Broiler Finisher Diets Containing Graded Levels of Supplemental Methionine Fed during the Hot Season (5-8 weeks)

Ingredients	Treatments				
	1 Met 0.40%	2 Met 0.45%	3 Met 0.50%	4 Met 0.55%	5 Met 0.60%
Maize	47.08	47.20	47.65	47.40	47.45
Full fat soybean	7.50	7.50	7.50	7.50	7.50
Brewers Dried Grain	5.00	5.00	5.00	5.00	5.00
Palm Kernel Cake	5.00	5.00	5.00	5.00	5.00
Groundnut Cake	27.20	27.00	26.80	26.70	26.60
Palm oil	3.00	3.00	3.00	3.00	3.00
Bone meal	3.10	3.10	3.10	3.10	3.10
Common Salt	0.30	0.30	0.30	0.30	0.30
Lime stone	1.00	1.00	1.00	1.00	1.00
Premix**	0.30	0.30	0.30	0.30	0.30
Lysine	0.46	0.46	0.46	0.46	0.46
Methionine	0.09	0.14	0.19	0.24	0.29
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
ME Kcal/kg	2983	2983	2983	2983	2983
Crude protein %	21.50	21.50	21.50	21.50	21.50
Ether extract%	7.28	7.28	7.28	7.27	7.27
Crude fibre%	4.28	4.28	4.26	4.26	4.25
Calcium%	1.00	1.00	1.00	1.00	1.00
Lysine%	1.28	1.28	1.28	1.28	1.28
Methionine%	0.40	0.45	0.50	0.55	0.60
Available P%	0.54	0.54	0.54	0.54	0.54
Met + Cys.%	0.70	0.75	0.80	0.85	0.90

Met = Methionine; P= Phosphorus; ME= Metabolizable Energy; Cys= Cysteine ** Biomix premix supplied per kg of diet: Vit. A, 10,000 iu; Vit. D3, 2000 iu; Vit E, 23 mg; Vit. K, 2mg: Vit. B_1, 1.8; Vit B_2, 5.5mg; Niacin, 27.5mg; Pantothenic acid, 7.5mg; Vit. B_{12}, 0.015mg: Folic acid, 0.75mg; Biotin, 0.06mg; Choline Chloride, 300mg; Cobalt, 0.2mg; Copper, 3mg; Iodine 1 mg; Iron, 20 mg; Manganese, 40 mg; Selenium, 0.2 mg; Zinc, 30mg; Antioxidant, 1.25mg.

Data Collection

Carcass Analysis

Two birds per replicate with weights closest to the mean body weight of the replicate were used for the carcass study. The birds were slaughtered after being kept off-feed for twenty-four hours. The birds were weighed, slaughtered, de-feathered and eviscerated. Weights of the conventional cut up parts as well as the giblets and the abdominal fat were taken and expressed as percent of the live weight.

Tissue Fat and Tissue Protein Analyses

Two birds per replicate used for the carcass analysis were also used for tissue fat and crude protein analysis. Parts of the tissues (breast, thigh, drumstick, wings and back) from each bird from all the treatments were chopped and minced together and taken to the Department of Animal Science, Ahmadu Bello University laboratory for tissue fat and tissue protein analyses. Samples for each bird were analysed separately.

Statistical Analysis
Data obtained from all the experiments were subjected to the analysis of variance (ANOVA) using the general linear model procedure of SAS (2001). Significant differences among treatment means were separated using the Duncan's Multiple Range Test in SAS (2001).

RESULTS AND DISCUSSION
The effects of supplemental methionine (Met) in broiler chickens' diet from 5 – 8 weeks on carcass study is shown in table 2. The live weight (LW), carcass weight (CW), wings, thighs, drumsticks and back were significantly ($P<0.05$) improved by the dietary treatments. In addition, the gizzard and abdominal fat pad was affected significantly ($P<0.05$) by the diets while the liver, heart, kidneys, spleen and lungs were not affected.

Table 2: Carcass Characteristics of Broiler Finisher Chickens fed Graded levels of Methionine in the Hot Season. (5-8) Weeks

Parameters	Treatments					
	1	2	3	4	5	SEM
	0.40%Met	0.45%Met	0.50%Met	0.55%Met	0.60%Met	
Live weight (g)	1816.67^{b}	2033.00^{b}	2320.00^{a}	2383.33^{a}	2433.33^{a}	28.54
Carcass weight (g)	1333.30^{b}	1450.00^{b}	1683.30^{b}	1833.33^{a}	1870^{a}	32.29
Dressing (%)	73.00	71.47	72.53	76.82	76.80	1.18
Prime cuts and organ weights expressed as % of live weight						
Breast	17.58	18.46	19.54	16.61	19.70	0.47
Wings	8.81^{b}	9.44^{ab}	9.61^{ab}	9.97^{ab}	10.28^{a}	0.16
Thigh	11.43^{b}	13.78^{ab}	14.30^{a}	14.42^{a}	14.81^{a}	0.39
Drumsticks	10.61^{b}	11.99^{ab}	11.66^{ab}	12.95^{a}	13.04^{a}	0.25
Back	13.32^{b}	16.70^{a}	16.29^{a}	16.57^{a}	17.76^{a}	0.39
Liver	2.95	3.12	2.13	2.08	2.29	0.14
Heart	0.60	0.71	0.46	0.41	0.59	0.04
Kidney	0.43	0.71	0.62	0.32	0.46	0.07
Gizzard	3.34^{ab}	3.51^{a}	2.93^{ab}	2.62^{b}	2.60^{b}	0.12
Abdominal fat	3.79^{c}	3.64^{c}	2.14^{b}	1.38^{a}	0.99^{a}	0.10
Spleen	0.18	0.18	0.16	0.15	0.17	0.03
Lung	0.56	0.90	0.71	0.56	0.59	0.05

a,b,c=Means with different superscript on the same row differ significantly ($P<0.05$)
SEM = Standard Error of Means
Met= Methionine

In the present experiment the broiler finisher chickens fed highest level of Met (0.60%) had the highest values for LW, CW, wings, thigh, drumstick and the least value for abdominal fat pad. Improvement in LW, CW, wings, thigh and drumstick. These results agree with the findings of Zafar, *et al*., (2014) who reported significant increase in carcass meat yield of broiler chickens. The increased body weight of broilers on the L-Met diets might give rise to better carcass characteristics and other associated organs of the body. The carcass dressing percentage was comparable in all groups and similar to the findings of Barekatain, and Kluenemann, (2023), who reported that Met supplementation had no effect on dressing percentage. The higher dietary Met level did not increase the relative weight of breast muscle in broiler finisher chickens, which is consistent with the findings of Zafar, *et al*., (2014) who reported that the inclusion of Met had no significant effect on breast muscle of broiler chickens. Abdominal fat decreased significantly ($P<0.05$) as the dietary levels of supplemental methionine increased. This disagrees with the findings of Murawska *et al*. (2018), who reported that Met supplementation had no influence on carcass fat content. However, Zafar *et al*. (2014) demonstrated that adequate dietary Met levels are required to increase lean carcass content and reduce abdominal fat deposition in broilers. This phenomenon may be due to high feed intake or less energy used for protein synthesis. According to several investigators, feeding low-protein with amino acid supplementation increases feed consumption, and consequently increases carcass fat deposition (Murawska. *et al*., 2018).

The dressing percentage was not significantly affected by dietary treatments; this disagrees with the findings of Barekatain, and Kluenemann, (2023) who reported significant difference in dressing percentages of birds fed synthetic methionine as well as those fed non supplemental diet. The tissue fat and tissue crude protein of broiler finisher chickens fed diets with graded levels of supplemental methionine (Table 3) was significantly ($P<0.05$)

affected by the experimental diets. The lowest tissue fat was obtained in treatment 5 containing 0.60% supplemental methionine. There were significant (P<0.05) differences in the tissue fat content. Treatment 5 containing methionine level of 0.60% had the lowest tissue fat. This result is similar to the result obtained in the birds raised in the cool season (Opoola *et al*., 2012) and the findings of Zeitz *et al*. (2020) and Teng *et al*. (2023) who reported that the higher the levels of methionine the lower the tissue fat in broiler chickens. This result may be due to the fact that an increase in protein intake induces a decrease in protein calorie ratio that is a reduction in energy intake relative to the protein intake, resulting in decreasing body fat percentage.

The low-fat deposit observed in the tissue would enhance the quality of meat as most consumers would prefer low fat broiler meat. Tissue crude protein were significantly (P<0.05) affected by dietary treatments. Treatment 5 had the highest crude protein followed by treatment 4, 2, 3 and 1 respectively. It was observed that the tissue protein increased with higher dietary methionine level. This result is similar to the findings of Teng *et al*. (2023) who reported that broiler chickens fed lower concentrations of methionine had low tissue protein levels. The resultant effect of reduction in lower tissue fat and increase in tissue protein content at higher dietary methionine level is increase lean meat. This may be due to the role of methionine as an essential amino acid crucial for protein synthesis, directly impact muscle development in broilers.

Table 3: Effect of Graded Levels of Methionine on Tissue Fat Deposits and on Tissue Protein Contents of Broiler Finishers Reared During the Hot Season2 (5-8weeks).

	0.40	0.45	0.50	0.55	0.60	SEM
Tissue fat (%)	26.68^{a}	25.41^{b}	22.99^{c}	20.56^{d}	18.82^{e}	0.12
Crude protein (%)	42.13^{c}	44.09^{ab}	42.61^{bc}	44.26^{ab}	45.50^{a}	0.24

a, b,c,d=Means with different superscripts on the same row differ significantly (P<0.05)
SEM = Standard Error of Means
Met= Methionine

CONCLUSION AND RECOMMENDATION

Based on the findings of this study it revealed that broiler finisher diets with Met content exceeding NRC (1994) recommendations may induce positive significant changes in carcass characteristics and meat quality. However, additional research is needed to further ascertain the optimum requirement and explore other natural sources of methionine for broiler production.

REFERENCES

Barekatain, R. and Kluenemann, M. (2023). Intestinal permeability, microbiota composition, and expression of genes related to intestinal barrier function of broiler chickens fed different methionine sources supplemented at varying concentrations. *Poultry Science*, 102 (2023), Article 102656.

Majdeddin, M., Golian, A., Kermanshahi, H., Michiels, J. and De Smet, S. (2019). Effects of methionine and guanidinoacetic acid supplementation on performance and energy metabolites in breast muscle of male broiler chickens fed corn-soybean diets. *British Poultry Science*, 60 (2019), pp. 554-563.

Murawska, D., Kubińska. M., Gesek, M., Zduńczyk. Z, Brzostowska. U, and Jankowski, J. (2011).The effect of different dietary levels and sources of methionine on the growth performance of Turkeys, carcass and meat quality. *Annals of Animal. Science*, Vol. 18, No. 2 (2018) 525–540.

NRC. (1994). Nutrient Requirements of Poultry. 9th rev. ed. National Academy Press, Washington, DC.

Opoola. E., Ogundipe. S.O., Bawa. G.S., Ajide, S.O. and Abejide, O. (2012). Effect of varying levels of methionine on growth response, tissue fat and protein of broiler chickens reared in the cool season under the tropical environment. *Nigerian Journal of Animal Science*, 14: 62-70.

Rajavel, E. (2020).Methionine Nutrition and Metabolism: Insights from Animal Studies to Inform Human Nutrition. *The Journal of Nutrition*. Pp. 2518S-2523S

SAS Institute. 2003. SAS/STAT User's Guide: Statistics: Release 9.1 Ed.; SAS Institute Inc.: Cary, NC, USA.

Teng, P.Y., Liu, G., Choi, J., Yadav, S., Wei, F. and Kim, W.K. (2023). Effects of levels of methionine supplementations in forms of l- or dl-methionine on the performance, intestinal development, immune response, and antioxidant system in broilers challenged with *Eimeria* spp. *Poultry Science*. 102 (2023), Article 102586.

Zafar. H., Abd ur. R., Kashif. A, b., Umar. F, and Gulbeena. S. (2014) Evaluation of a natural methionine source on broiler growth performance. Research article (wileyonlinelibrary.com).

Zeitz, J. O., Fleischmann, A., Ehbrecht, T., Most, E., Friedrichs, S., Whelan, R., Gessner, D.K., Failing, K., L€utjohann, D and Eder, K. (2020). Effects of supplementation of DL-methionine on tissue and plasma antioxidant status during heat-induced oxidative stress in broilers. *Poultry Science*, 99:6837–6847.