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Effect of Replacement of Synthetic Methionine with Naturally Compounded Materials (NCM) in Broiler Chickens

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ABSTRACT
Background and Objective: The use of synthetic methionine in poultry production cannot be overemphasized, as methionine is a limiting amino acid in poultry birds. The main objective of the current study is to focus on the effect of the replacement of synthetic methionine with naturally compounded materials (NCM) in broiler birds. **Materials and Methods:** One hundred and fifty day old broiler chicks of the Ross 308 strain were used to carry out the research work. The birds were selected into five treatment groups, each consisting of 30 birds each and 10 birds per replicate slated in a completely randomized design (CRD). Five diets were used, which had NCM at the rate of 0, 25, 50, 75, and 100% to replace the quantity of synthetic methionine in the diet. Feed and water were given *ad libitum* throughout the research work. The research work lasted for 56 days (8 weeks) (1 week for brooding and seven weeks for data collection). **Results:** Growth performance results showed that birds in treatment 4 (75%) had a superior value in terms of final body weight, body weight gain, and feed conversion ratio, with values of 3015.10, 2804.99 g, and 1.62, respectively. Results obtained for cost benefit analysis showed that birds in treatment 4 had better values in terms of revenue, net profit, and cost benefit ratio with values of #8442.28, #3408.31 and 1.48, respectively, when compared to other treatments and especially the control treatment with the complete methionine in terms of quantity required. **Conclusion:** The naturally compounded material (NCM) can conveniently replace synthetic methionine at 100% replacement level, though best performance was observed in treatment 4 (75% replacement level).

KEYWORDS
Growth performance, cost benefit analysis, synthetic methionine, naturally compounded materials, and broiler birds

INTRODUCTION
One of the major limiting amino acid in poultry birds is methionine, which is basically added to diets as a supplement that usually supports the complex metabolic processes occurring in poultry birds. Also, methionine helps in the synthesis of body proteins which make up muscles, organs and feathers[1]. A lack of methionine nutrition in poultry can lead to reduced immune function and may result in poor feathering, feather pecking cannibalism and mortality. While poultry can obtain methionine from dietary sources such as fish, sunflower meals and insects, it can be difficult to ensure they have sufficient amount of their

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natural feed ration[2]. The impart of methionine in a low or poor protein diet usually is to reduce the negative effects of heat stress and improves the overall performance of the birds. The addition of synthetic methionine in the diets of the birds also improves the amino acid balance and consequently promotes growth performance by enhancing the quantity and quality of egg release, feed conversion rate and protein synthesis as well as the decrease of fat synthesis in poultry breeds which can alter or disrupt egg laying processes[3]. The inclusion of synthetic methionine in the diet of the birds also leads to the improvement of the immune response through the direct effects on protein synthesis, breakdown, and indirect effects on the derivatives of methionine[4]. The stages, such as growing period, type of production, sex, and breed, usually influence the methionine requirement. Also, the methionine required in poultry birds is usually expressed as a percentage of the diet reduces as the birds approach the grower and finisher stages. Synthetic methionine is derived from propene, sulfuric acid, methanol and ammonia and has been permitted in organic poultry due to the importance of methionine in the diet of organic poultry; significant attention has concentrated on how to find a source that is on-synthetic and compatible with organic principles[4].

The easiest way to optimize production and reproduction in poultry species while also mitigating the relatively harmful effects of weather and environmental conditions is through proper nutrition and management of the birds. One of the major important pillars of poultry nutrition is the use of amino acids in poultry diets, among which methionine represents the first limiting amino acid in broiler birds, followed by lysine and tryptophan. Jankowski *et al.*[5] reported that methionine can act as an amino acid in the synthesis of protein and polyamine, a sulfur donor, a precursor of the main intermediate in metabolic pathways, and a methyl donor group for the normal formation of co-enzyme S-adenosyl methionine in normal cellular metabolism in the birds. Also, Alagawany *et al.*[6] reported that methionine functions as an antioxidant factor and the improvement in the antioxidant system activity is one of the solutions available to increase productivity in the poultry industry. Thus, synthetic sources of methionine, such as DL-methionine, are added in poultry diets in order to optimize the dietary level of methionine in the host animal[7]. To this end, any material or combination of materials that can conveniently replace synthetic methionine both in efficiency and potency will be of great importance in poultry, especially the broiler industry.

The attention of the present study is geared towards the effect of the replacement of synthetic methionine with naturally compounded materials (NCM) in broiler chickens.

MATERIALS AND METHODS

Experimental site: This research was conducted at the poultry unit of the Animal Production Technology Department, Federal College of Agriculture, Ishiagu, Ivo Local Government Area of Ebonyi State, from September to November, 2023.

Source and processing of raw materials: The raw materials were purchased at the new market in Enugu State. Foreign fishmeal of 72% cp, Soybean meal of 44% cp, and full-fat soya of 38% cp were obtained. Blood meal of 77.50% cp was also obtained. The blood was crushed at the feed mill into meal.

Experimental design and management of birds: One hundred and fifty broiler birds of Ross 308 strain at day one of age were used for the experiment. The birds were randomly distributed to 5 groups. Each treatment was replicated three times in a completely randomized design (CRD) with 10 birds per replicate, for a total of 30 birds per treatment. The birds were purchased from the 'Cosin farm' in Enugu, Enugu state. The birds were raised on a cemented floor covered with wood shavings as a source of litter. The pens were also divided into partitions such that each partition accommodated 10 birds. Feed and water were given *ad-libitum* in the course of the experiment.

Table 1: Experimental diet for starter broiler birds

	Treatments				
Ingredient	T1	T2	T3	T4	T5
Maize	52.00	52.00	52.00	52.00	52.00
Wheat offal	7.75	7.75	7.75	7.75	7.75
Soybean meal	8.15	8.15	8.15	8.15	8.15
Groundnut cake	20.00	20.00	20.00	20.00	20.00
Fish meal (72%)	3.50	3.50	3.50	3.50	3.50
Blood meal	3.50	3.50	3.50	3.50	3.50
Limestone	1.50	1.50	1.50	1.50	1.50
Bonemeal	2.50	2.50	2.50	2.50	2.50
Methionine	0.35	0.26	0.175	0.09	0.35
NCM	0.00	0.09	0.175	0.26	0.35
Lysine	0.15	0.15	0.15	0.15	0.15
Starter premix	0.35	0.35	0.35	0.35	0.35
Salt	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated value					
Crude protein (CP)	23.85	23.92	23.98	23.93	23.97
MEnergy (Kcal/kg)	2830.40	2839.10	2842.11	2848.20	2856.58
Crude fiber (%)	3.58	3.69	3.68	3.69	3.70
Ether extract (%)	4.20	4.24	4.27	4.29	4.35
Calcium (%)	1.25	1.27	1.27	1.27	1.27
Phosphorus (%)	0.56	0.56	0.56	0.56	0.56
Methionine (%)	0.65	0.65	0.65	0.67	0.69
Lysine (%)	1.25	1.25	1.25	1.25	1.25

NCM: Naturally compounded material

Table 2: Experimental diet for finisher broiler birds

	Treatments				
Ingredients	T1	T2	T3	T4	T5
Maize	58.00	58.00	58.00	58.00	58.00
Wheat offal	6.90	6.90	6.90	6.90	6.90
Soybean meal	6.00	6.00	6.00	6.00	6.00
Groundnut cake	12.00	12.00	12.00	12.00	12.00
Fish meal (72%)	1.50	1.50	1.50	1.50	1.50
Blood meal	3.50	3.50	3.50	3.50	3.50
Palm kernel cake	7.00	7.00	7.00	7.00	7.00
Limestone	1.50	1.50	1.50	1.50	1.50
Bonemeal	2.50	2.50	2.50	2.50	2.50
Methionine	0.35	0.26	0.175	0.09	0.00
NCM	0.00	0.09	0.175	0.26	0.35
Lysine	0.20	0.20	0.20	0.20	0.20
Finisherpremix	0.35	0.35	0.35	0.35	0.35
Salt	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100
Calculated value					
Crude protein (%)	19.45	19.68	19.76	19.93	19.99
MEnergy (Kcal/kg)	3007.90	3039.90	3075.15	3107.61	3119.80
Crude fiber (%)	3.78	3.91	3.89	3.89	3.93
Ether extract (%)	4.73	4.79	4.84	4.99	4.99
Calcium (%)	1.35	1.37	1.39	1.40	1.42
Phosphorus (%)	0.54	0.56	0.56	0.56	0.56
Methionine (%)	0.61	0.59	0.59	0.59	0.59
Lysine (%)	1.11	1.15	1.18	1.21	1.25

NCM: Naturally compounded material

Five experimental diets were formulated, with diet 1 containing 0.35% of synthetic methionine. While diets 2, 3, 4, and 5 contain naturally compounded material (NCM) at the level of 0.25, 0.50, 0.75, and 100% for two stages of growth, namely the starter and finisher phases (Table 1 and 2).

Ethical approval: The study does not in any way pose any threat to the life of the birds or the humans involved therein. As such it is ethically safe both professionally and locally.

Statement of human and animal rights: As a matter of fact the study agrees with the tenacity of the European union which advocated for the use of natural materials to synthetic ones in livestock production which has the ability to impact negatively on the birds and their end users.

Statement of informed consent: The use of natural raw materials for the production of the NCM is acceptable to all authorities as far as feed production for broiler birds is concerned. Disparity of consent did not arise, since there were no toxic substances included in the production of the diet.

Statistical collection: All data collected in the course of the research work were subjected to Analysis of Variance (ANOVA), and the significant means were compared using Duncan's Multiple Range Test at a 5% significance level.

RESULTS AND DISCUSSION

Performance characteristics and cost-benefit analysis of broiler birds fed naturally compounded materials to replace synthetic methionine were shown in Table 3. Final body weight has a superior ($p<0.05$) value of 3015.10 g, which differed from the value of 2975.81 g obtained for birds in treatment 3. Birds in treatment 2 and 5 had similar values of 2955.10 and 2950.60 g, respectively. While final body weight was lowest for birds in treatment 1(control). The results showed that as the replacement levels increase, the values obtained for final body weight also increase, except in treatment 5. This connotes that the birds in the treatments fortified with the NCM were able to annex the nutrients, giving them a better edge over the control treatment. This was in agreement with the report of Ozung *et al.*[8], who observed increased final weight when the level of synthetic methionine decreased as against the test ingredients in broiler chickens. Also, Olabode *et al.*[9] observed better final body weight when a higher level of lizard meal as a protein source was used in broiler diets. Body weight gain followed the same pattern as the final body weight, with birds in treatment 4 having the highest ($p<0.05$) body weight gain of 2804.99 g followed by those in treatment 3 with 2765.32 g. The least value for body weight gain was observed in treatment 1 with 2690.40 g. Birds in treatments 2 and 5 had similar ($p>0.05$) values of 2745.75 and 2740.30 g, respectively. This implies that the necessary substances responsible for the weight gain are embedded in relative form in these ingredients (NCM). This was similar to the work of Olabode *et al.*[10] where they observed increased body weight gain when feather meal was used as a source of protein in starter broiler birds.

Table 3: Performance table (growth performance and cost analysis of broiler birds)

	Treatments					
Parameter	T1	T2	T3	T4	T5	SEM
Initial body weight (g)	210.50	209.35	210.49	210.11	210.30	-
Final body weight (g)	2900.90^d	2955.10^c	2975.81^b	3015.10^a	2950.60^c	10.65
Body weight gain (g)	2690.40^d	2745.75^c	2765.32^b	2804.99^a	2740.30^c	9.72
Feed intake (g)	5354.23^a	4915.19^b	4812.29^c	4544.75^d	4967.11^b	21.90
Daily body weight gain (g)	54.91^c	56.04^b	56.44^b	57.25^a	55.93^b	3.28
Daily feed intake (g)	109.27^a	100.31^b	98.21^c	92.75^d	101.37^b	6.11
Feed conversion ratio	1.99^a	1.79^b	1.74^b	1.62^c	1.81^b	0.89
Cost of birds at day old (₦)	680.00	680.00	680.00	680.00	680.00	4.76
Cost of kg of feed (₦)	980.00^a	925.00^b	870.00^c	815.00^d	760.00^e	5.91
Cost of feed consumed (₦)	5247.15^a	4546.55^b	4186.69^c	3703.97^d	3775.00^e	18.11
Other cost (expenses) (₦)	650.00	650.00	650.00	650.00	650.00	-
Total cost of production (₦)	6577.15^a	5876.55^b	5516.69^c	5033.97^d	5105.00^d	22.09
Revenue (₦)	8122.52^d	8274.28^c	8332.27^b	8442.28^a	8261.68^c	31.40
Net profit (₦)	1545.37^e	2397.73^d	2815.58^c	3408.31^a	3156.68^b	8.99
Cost benefit ratio	4.26^a	2.45^b	1.96^c	1.48^d	1.62^c	0.22

^{abc}Means on the same row with different superscripts are significantly ($p<0.05$) different and SEM: Standard error of mean

Superior ($p<0.05$) value of 5354.23 g for feed intake was obtained in treatment 1 (control), which differed from the value of 4544.75 g observed in treatment 4. Birds in treatment 2 had a value of 4915.19 g, which did not differ from those of 4967.11 g obtained in treatment 5, while birds in treatment 3 had a value of 4812.29 g. This connotes that synthetic methionine can improve palatability, which can be seen in the value obtained for feed intake in treatment 1 (control). This result disagreed with the report of Olabode *et al.*[11] where they observed lower feed intake in the treatments fortified with the test ingredients as compared with the control. Ozung *et al.*[8] also observed a similar decrease in feed intake as the level of synthetic methionine decreased in the diets of broiler chickens. Values obtained for feed conversion ratio were highest ($p<0.05$) in treatment 1 (1.99), while the lowest (in terms of value, but best performed) was obtained in treatment 4 (1.62). Data for feed conversion ratio in treatments 2, 3, and 5 were similar ($p>0.05$) with values of 1.79, 1.74, and 1.81, respectively. This trend of result was similar to the observation of Ozung *et al.*[8] and Olabode *et al.*[12], where they reported a better feed conversion ratio in the treatments with the test ingredient as compared to the control. The same value of #680.00 for the cost of birds at day old was obtained across the treatments. Cost of feed consumed was highest ($p<0.05$) in treatment 1 with #5247.15, while the lowest value of #3775.00 was seen in treatment 5. Values of #4546.55, #4186.69, and #3703.97 were obtained in treatments 2, 3, and 4, respectively, which were different from each other. Managerial cost had the same value of #650.00 for all treatments. The highest ($p<0.05$) value of #8442.28 was seen in treatment 4, which differed from the values of #8274.28 and #8261.68 obtained in treatments 2 and 5, which are by themselves similar to each other. The least value of #8122.52 was observed in treatment 1. Superior ($p<0.05$) value of 1.48 in terms of performance was obtained in treatment 4, while the lowest in terms of performance was seen in treatment 1 with 4.26. Similar values of 1.96 and 1.62 were obtained in treatments 3 and 5, while a feed conversion ratio of 2.45 was seen in treatment 2.

CONCLUSION

Results concluded that naturally compounded materials (NCM) can conveniently replace synthetic methionine up to the level of 100% with the best performance observed in treatment 4 (75% replacement level). Results recommended that other poultry species like layers, turkey, geese, duck and quail be experimented using the NCM to see their performance on it, both at the short and long range.

SIGNIFICANCE STATEMENT

Considering the surge in the price of feed ingredients, especially the synthetic material, it becomes necessary to look for alternate materials that are less expensive and cheaper so as to reduce the cost of production, and at the same time, similar or more potent than the synthetic methionine. Looking at the results of the study, it is imperial to say that the NCM can replace synthetic methionine at 100% level, with best performance 75% level of replacement considering the growth performance and cost benefit factor. This implies that at such rate of inclusion of the NCM, more profit will be generated by the farmers when they compound their feed locally. This is because when the rate of methionine reduces in the diet of the birds, the cost also automatically reduces, as long as performance and health status of the birds are not compromised

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