AMINO ACIDS OPTIMIZATION OF MEAT AND BONE MEAL BASED DIETS: EFFECTS ON SERUM MINERALS OF BROILER CHICKENS

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ABSTRACT

The use of Meat and Bone Meal (MBM) in broiler chickens ration is essentially limited because of deficiencies that have been recorded in its amino acid profile. This study evaluated the effect of partial replacement of soybean meal (SBM) with MBM supplemented with limiting amino acids on serum minerals of broiler chickens. Two hundred and forty (240) day-old broiler chicks were allotted to six dietary treatments in a Completely Randomized Design for a 6-week trial. Diets included: T1 (positive control, 0% MBM), T2 (10% MBM without amino acid supplement), T3 (10% MBM + lysine), T4 (10% MBM + methionine), T5 (10% MBM + lysine + methionine) and T6 (10% MBM + lysine + methionine + threonine). Each treatment was replicated four times with 10 birds per replicate. At the end of the feeding trial, blood was sampled from the birds and serum analyzed for mineral profile. Results showed that serum mineral concentrations were significantly ($p<0.05$) higher in MBM diets supplemented with amino acids, with broiler chickens on T6 yielding the highest values for Ca (109.76 µg/g), Fe (1.32 µg/g) and Zn (353.20 µg/g). Copper concentrations, however, were not significantly ($p>0.05$) affected by dietary treatments. It was concluded that 10% MBM inclusion supplemented with lysine, methionine, and threonine improved the serum mineral profile of broiler chicken, which could support bone development, immune function and overall metabolic health in rapidly growing broiler chicken.

Keywords: *Mineral Bioavailability, Nutrition, Poultry, Protein, Supplementation.*

1.0 Description of Problem

The high cost per unit of conventional feed stuffs such as maize and soybean meal has been a concern for practitioners, as feed cost could constitute up to about 80 % of variable costs of production. Corn and soybean meal (SBM) have shown superior performance but are more expensive [1]. Soybean meal, being the most predominant source of protein widely used in poultry and swine diets, provides both energy and protein critical for growth and immune function [2]. Meat and bone meal (MBM), a rendering by-product, is high in protein and rich in calcium and phosphorus, thereby offering prospects for partial substitution of SBM in broiler chickens nutrition [3].

Meat and bone meal use in poultry can minimize dependency on soybean meal, although meat and bone meal are restricted by deficiencies in essential amino acids (lysine, methionine and threonine) and variability in nutrient composition [4] Amino acid supplementation especially in low-protein diets can improve growth and enhance retention of minerals including calcium, phosphorus, copper, manganese and zinc which helps to improve overall nutrient utilization in broiler chicken [5,6]. Despite existing research on MBM fortification, there is limited information on the combined supplementation of lysine, methionine and threonine in MBM-based diets under Nigerian production conditions. This study, therefore, evaluated the effects of amino acid optimization of MBM-based diets on the serum mineral profile of broiler chickens.

2.0 MATERIALS AND METHOD

2.1 Experimental Site, layout and management

The study was conducted at the Poultry Unit of the Directorate of University Farms (DUFARMS), Federal University of Agriculture, Abeokuta (FUNNAB), Ogun State, Nigeria. A total of 240-day-old Arbor Acre broiler chicks were randomly allotted to six dietary treatments in a completely randomized design. Each treatment consisted of 4 replicates of 10 birds per replicate. The feeding trial lasted six weeks. The treatments were: T1 (control, no MBM), T2 (10 % MBM), T3 (10 % MBM + lysine), T4 (10% MBM + methionine), T5 (10 % MBM + lysine + methionine) and T6 (10 % MBM + lysine, methionine, and threonine). Standard management practices were observed, including brooding, vaccination and routine medication. Feed and water were offered *ad libitum* throughout the trial.

Table 1: Gross composition of experimental diets

Parameters	T1	T2	T3	T4	T5	T6
Maize	58	58	58	58	58	58
Meat and bone meal	0	10	10	10	10	10
Soybean meal (SBM)	33	23	23	23	23	23
Palm kernel oil	3	3	3	3	3	3
Bone meal (BM)	2	2	2	2	2	2
Limestone	2.75	3.2	2.7	2.7	2.2	2
Methionine	0.3	-	-	0.5	0.5	0.5
Lysine	0.15	-	0.5	-	0.5	0.5
Threonine	-	-	-	-	-	0.2
Salt	0.3	0.3	0.3	0.3	0.3	0.3
Premix	0.5	0.5	0.5	0.5	0.5	0.5
Total	100	100	100	100	100	100

Premix contains vitamin A: 12,000,000 IU, Vit D3: 2, 5000,000 IU, Vit K: 2,000 mg, Vit B1: 2,250 mg, Vit B2: 6,000 mg, Vit B6: 4,500 mg, Vit B12: 15 mg, Niacin 40,000 mg, Pantothenic acid: 15,000 mg, Folic acid: 1,500 mg, Biotin: 50 mg, Choline chloride: 300,000 mg, Manganese: 80,000 mg, Zinc: 50,000 mg, Iron: 20,000 mg, Copper: 5,000 mg, Iodine: 1,000 mg, Selenium: 200 mg, Cobalt: 50 mg, Antioxidant: 125,000 mg.
T1 - control (no MBM); T2 -10 % MBM; T3 - 10 % MBM + lysine; T4 - 10% MBM + methionine; T5 - 10 % MBM + lysine + methionine and T6 - 10 % MBM + lysine, methionine, and threonine

2.3 Data Collection- Serum Mineral Analysis

At the end of the 6-week trial, two birds were randomly selected from each replicate. Blood samples were collected from the jugular vein into plain tubes. The blood was centrifuged at 3000 RPM for 15 minutes to separate the serum. Serum samples were then analyzed for mineral concentrations (P, Ca, Cu, Fe, Zn) using standard laboratory procedures, specifically the inductively coupled plasma (ICP) method.

2.4 Statistical Analysis

All data were subjected to Analysis of Variance (ANOVA) using SPSS statistics version 27. Significant differences between treatment means were determined using Duncan's Multiple Range Test.

3.0 RESULTS AND DISCUSSION

The effect of amino acids optimization of broiler chickens on MBM diets on serum minerals is presented in Table 2. Phosphorus, calcium, iron and zinc concentrations were significantly ($p <$

0.05) influenced by the dietary treatments, however, copper concentration in serum remained unchanged due to treatments imposed. Meat and bone meal is rich in bioavailable minerals such as calcium and phosphorus, making it a valuable protein and mineral source for poultry [7]. In this study, birds fed MBM-based diets particularly those supplemented with amino acids, exhibited higher levels of serum calcium, phosphorus, iron and zinc. The serum phosphorus concentration ranged between 168.06 µg/g in diet T2 and 196.02 µg/g in T5. Calcium concentration was significantly ($p<0.05$) highest in T6 (109.76 µg/g) fed 10 % MBM with lysine, methionine and threonine supplementation, while the lowest (95.31 µg/g) was recorded in T2 fed 10 % MBM without amino acid supplementation.

Supplementing amino acids to diets have shown improved retention of key minerals and optimizing nutrient utilization [6]. Furthermore, MBM provides heme iron with superior bioavailability compared to plant-based sources [8] and amino acid supplementation has been shown to enhance overall mineral retention and utilization in poultry [9]. This is similar to findings in this study, in which the serum iron concentration of diets T1 and T2 without amino acid supplementation were significantly ($p<0.05$) lower than those of T3, T4, T5 and T6 fed amino acid supplementation in the diet. Zinc absorption is similarly improved through the formation of soluble amino acid–mineral complexes [10]. These findings indicate that MBM, combined with amino acid optimization, not only serves as a cost-effective protein source but also enhances mineral profile, supporting bone development, immune function and overall metabolic health in rapidly growing broiler chickens.

Table 2: Effect of amino acids optimization of meat and bone meal (MBM) based diets on serum minerals of broiler chickens (0-6 weeks)

Parameters	T1	T2	T3	T4	T5	T6	SEM	P-Value
P (µg/g)	172.61^{c}	168.06^{c}	190.18^{b}	191.69^{b}	196.02^{a}	194.55^{a}	4.91	0.024
Ca (µg/g)	98.41^{c}	95.31^{c}	101.83^{b}	102.71^{b}	106.94^{a}	109.76^{a}	2.17	0.035
Cu (µg/g)	3.53	3.24	3.55	4.48	4.92	4.93	0.31	0.073
Fe (µg/g)	1.26^{b}	1.18^{c}	1.31^{a}	1.32^{a}	1.32^{a}	1.32^{a}	0.02	0.028
Zn (µg/g)	312.75^{d}	313.90^{d}	335.96^{c}	340.61^{b}	347.26^{a}	353.20^{a}	6.95	0.047

^{abcd} *Means with different superscript in each row are different significantly ($P<0.05$).*
P- Phosphorus, Ca- Calcium, Cu- copper, Fe- Iron, Zn- Zinc
T1 - control (no MBM); T2 -10 % MBM; T3 - 10 % MBM + lysine; T4 - 10% MBM + methionine; T5 - 10 % MBM + lysine + methionine and T6 - 10 % MBM + lysine, methionine, and threonine

4.0 CONCLUSION AND APPLICATION

Amino acid supplementation improved the performance and mineral utilization of MBM-based diets in broiler chickens. The combination of lysine, methionine and threonine yielded optimal results, comparable to soybean meal-based diets. Thus, MBM with amino acids accompanied with strategic amino acid fortification can be included in the diets of broiler chickens to reduce feed costs and enhance sustainability in poultry production.

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