

Nutrient Digestibility and Serum Electrolyte Profiles of Starter Broilers Fed Moringa and Black Plum Leaf Meals

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ABSTRACT

Background and Objective: The concept of phytogenic in the livestock sector has been in existence since time immemorial, but the discovery of the uses of plant-based materials (phytogenics) came recently due to the need to shift from synthetic materials. The objectives of this study hinge on the determination of nutrient digestibility and serum electrolytes of starter broiler birds fed diets supplemented with moringa and black plum leaf meal. **Materials and Methods:** One hundred and twenty days old SAYED strain broilers were purchased from Cosin farms in Enugu State, Nigeria. Fresh leafs of moringa and black plum was used as test ingredients in the project. Five different diets containing the test ingredients in the ratio of 1:4, 2:3, 3:2, and 4:1 represent treatments 2, 3, 4, and 5, while treatment 1 served as the control. Faeces of birds were obtained and processed to calculate the nutrient digestibility, while blood was collected from the birds at the end of the research work to determine the serum electrolyte. Data were analyzed using ANOVA, and significant means were separated by Duncan's Multiple Range Test at a 5% significance level. **Results:** Nutrient digestibility results showed that treatment 1 had the highest value of 81.07% for dry matter, while the lowest value of 74.21% was seen in treatment 3. Crude protein was superior in treatment 1, with the least in treatment 4 (69.57%). Crude fiber increased steadily, with the highest in treatment 5 (73.45%). The highest value of 74.68% for nitrogen-free extract was observed in treatment 3, while the lowest was seen in treatment 4 (70.43%). Serum electrolyte value was superior for calcium with 0.49 mmol/L, which differed from the lowest value of 0.44 mmol/L in treatment 1. Data obtained for phosphorus had a higher value of 6.35 mg/dL in treatment 5, while the lowest value of 6.15 mg/dL was obtained in treatment 1 (control). Sodium had a superior value of 146.03 mmol/L in treatment 5, which varies from the value of 138.14 mmol/L obtained in treatment 1. **Conclusion:** The inclusion of moringa and black plum leaf meal in the diet of finisher broiler birds can be tolerated by the birds and does not pose any negative effect on the birds in terms of their digestibility factor and serum mineral as observed in the skeletal and bone normalcy of the birds at that stage of growth.

KEYWORDS

Nutrient digestibility, serum electrolytes, finisher broiler birds, moringa, black plum, leaf meal

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INTRODUCTION

Leaf meals have been observed to have potential in non-ruminant nutrition and feeding, especially in poultry production. The nutrient contents of leaf meals of most leguminous plants have relatively higher crude protein content than those of the non-leguminous plants and cereals¹. Leaf meals usually contain crude fiber, which is higher than that of other feed materials utilized by animals². In most cases, the crude fiber content of leaf meal may equal or even exceed the crude protein content, such as in the case of tropical plants like *Cajanus cajan*, *Prosopis chilensis*, *Albizia falcata*, and *Manihot esculenta*³. Thus, there tends to be a reduction in the overall digestibility when there is a significant proportion of leaf meal in the diet, as well as a decrease in the growth and egg production of birds⁴. Leaf meals also provide some essential vitamins such as vitamins A and C, minerals, and oxycarotenoids, which cause the yellow colour of broiler chickens' skin, beak, shanks, and egg yolk. Also, the lysine concentration in leaf meal is relatively higher than that of grains and some by-products such as coconut oil and meal⁴, but not as high as to be compared with those of fish meal or soybean meal. They are equally deficient in sulphur-containing amino acids, though their usage can be enhanced by supplementation with methionine.

With the recent ban on antibiotic use in animal nutrition due to the emergence of microbial resistance, alternative growth promoters must be assessed. Thus, the removal of antibiotics as growth promoters has been reported⁵. A wide range of herbs, spices, and their extracts exert beneficial effects within the digestive tract, such as laxative acid, spasmolytic effects, and reduction of flatulence. These active components' effects largely depend on its dosage administered. An increase in the quantity of doses can even be detrimental to animals, and subsequent dose reduction in quantity poses no effect on the animal⁶. These medicinal herbs contain some chemical substance that produces a better physiological action on the human body and animal system. Some of such medicinal plants include moringa leaf and black plum leaf. These leaves largely possess various pharmacological activities such as anti-amoebic, antibacterial, antidiarrheal, antifungal, and anti-inflammatory properties, which could reduce the competition between the host animal and negative microbes for feed and nutrients and thus act as a growth promoter to the birds⁷. This study thus focused on determining the nutrient digestibility and serum electrolyte indices of finisher broiler birds fed moringa and black plum leaf meal.

MATERIALS AND METHODS

Experimental site: The experiment was carried out at the poultry unit of Federal College of Agriculture, Ishiagu, Ivo Local Government Area, Ebonyi State, Nigeria from July to August, 2022.

Source and processing of black plum leaf: Moringa and black plum leaves of about 7.5 kg were sourced from within the College and Ishiagu Town, all in Ebonyi State. The leaves obtained were washed, shade-dried for a week, and then exposed to direct sunlight for 2 hrs to make them crispy. The leaves were then ground separately in the hammer mill into powder.

Experimental design and management of birds: A total number of 120 days old broiler chicks were used for the experiment. The birds were brooded for one week, after which they were randomly distributed into five treatments. Each treatment was replicated three times in a Completely Randomized Design (CRD) with eight birds per replicate. The birds were purchased from the Cosin farm in Enugu, Enugu State, Nigeria.

Before the arrival of the birds, the pens were washed and cleaned to avoid pathogenic and disease infection. Charcoal and bulbs were provided, which served as insulators to keep the chicks warm. Feeders and drinkers were thoroughly washed and cleaned. The birds were raised on a deep litter system with wood shavings, which served as a source of litter. The chicks were brooded for one week, after which they were randomly distributed to their various pens. Feed and water were given *ad libitum*. All the routine vaccination and medications necessary for the birds' good health during the entire growth cycle from day old to the end of the experiment was strictly adhered to according to specifications.

Table 1: Experimental diet for starter broiler birds fed graded levels of black plum and moringa leaf meal

Ingredient	Treatments				
	T1	T2	T3	T4	T5
Maize	52.00	50.00	50.00	50.00	50.00
Wheat offal	7.75	4.75	4.75	4.75	4.75
Soyabean 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
Black plum leaf meal	0.00	1.00	2.00	3.00	4.00
Moringa leaf meal	0.00	4.00	3.00	2.00	1.00
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	0.35	0.35	0.35	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	23.90	23.88	23.86
M Energy (Kcal/kg)	2830.40	2829.70	2829.35	2828.92	2829.70
Crude fiber (%)	3.58	3.69	3.68	3.69	3.70
Ether extract (%)	4.20	4.24	4.23	4.19	4.17
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	0.65	0.65
Lysine (%)	1.25	1.25	1.25	1.25	1.25

During the last week of the research work, fifteen birds were collected, one bird from each replicate for the nutrient digestibility trial. Three days were for acclimatization and four days for data collection. Feed and water were given to the birds *ad libitum*, and faeces were collected on a daily basis. The faeces were dried and taken for analysis at the end of the research work.

Also, blood samples were obtained from fifteen birds (one bird per replicate). A 2 mL blood sample was collected from the wing vein into a sample bottle without anticoagulant to determine the serum electrolytes.

Five experimental diets were formulated, with diet 1 containing 0% moringa leaf meal and black plum leaf meal, which served as the control. Diets 2, 3, 4, and 5 contained moringa leaf meal and black plum leaf meal at the levels and ratios of 1:4, 2:3, 3:2, and 4:1, respectively (Table 1).

Statistical collection: Data obtained in the research work were subjected to One-way Analysis of Variance (ANOVA), and significant means were compared using Duncan's Multiple Range Test at 5% significance level.

Ethical statement: There was no harm or issue relating to a zoonotic problem arising from the research work. All necessary precautions were duly observed to ensure the safety of both the researcher and the animal, and also animal products arising from the research work.

RESULTS AND DISCUSSION

Nutrient digestibility values are shown in Table 2. Data showed that there were significant ($p < 0.05$) differences across the treatments for all parameters studied. The value of dry matter was superior in treatment 1 with 81.07%, which did not differ ($p < 0.05$) from the values obtained for treatments 4 and 2 with 80.30 and 78.30%. Values of 76.77 and 74.21% obtained for dry matter in treatments 5 and 3 were similar ($p > 0.05$) to each other. The trend showed that dry matter values were lower in treatments fortified

with moringa and black plum leaf meal when compared to the control. This was similar to the report of David *et al.*⁷, where they obtained higher dry matter when compared to the control. This suggestion was due to certain bio-nutrient and active substances in the leaf meals which limited their intake, which were originally absent in the control diet. Dietary treatments were significant ($p < 0.05$) for crude protein across the treatment group. Superior value for crude protein was obtained in treatment 1 with a value of 79.82% which did not differ from the value of 78.12% observed in treatment 2, but was significantly ($p < 0.05$) different from the values obtained for crude protein in treatments 4 and 3 with values of 75.35 and 73.47%. The lowest value of 69.57% was obtained in treatment 5. Values showed that nutrient digestibility for crude protein was also lower in treatments where moringa and black plum leaf meal were added. This research work is similar to the work carried out by Mishael *et al.*¹, where they obtained higher level of crude protein above 70% across the treatment group while working on black plum leaf meal in broiler birds, which could suggest better available of bio-nutrients to the birds, which they were able to optimize to their advantage. The highest value for crude fiber was obtained in treatment 5 with 73.45%, which was followed by 73.26, 72.68, and 71.38% corresponding to crude fiber value in treatments 3, 4, and 2, respectively. The lowest value for crude fiber was obtained in treatment 1 with a value of 68.20%. This was due to the impact of the test ingredients in those diets. This work agrees with the research of Agu *et al.*⁶ where they observed moderately higher levels of crude fiber.

The result for the ether extract showed a significant ($p < 0.05$) effect across the treatment group studied. The highest value of 69.03% was obtained for ether extract in treatment 1, while the least value of 62.34% was obtained for ether extract in treatment 5, which did not differ ($p > 0.05$) from those obtained in treatment 3 with the value of 62.53%. Value of 66.20% obtained for ether extract in treatment 2 was significantly ($p < 0.05$) different from that of 64.41% observed in treatment 4, respectively. The effect of diet on ash parameter values was significantly ($p < 0.05$) influenced across the treatment group. The highest value for ash was obtained in treatment 1 (60.63%), which was similar to 60.60, 58.43, and 59.18% corresponding to treatments 2, 3, and 5, while the lowest value of 57.78% was obtained for ash in treatment 4. Ash values were higher in the control than treatments with fortified moringa and black plum leaf meal. The effect of dietary treatment showed that nitrogen-free extract values were significantly ($p < 0.05$) affected across the treatment groups studied. The highest value of 74.68% was obtained for nitrogen-free extract in treatment 1, while the lowest value of 70.43% for nitrogen-free extract was obtained in treatment 3, which was also similar to the value of 70.72% obtained in treatment 4, respectively. Treatments 2 and 5 had values of 72.13 and 71.48%, which are by themselves, similar ($p > 0.05$) to each other statistically. The trend obtained in this study showed that the control diet had the highest value for nutrient digestibility across all parameters except crude fiber. These could be due to the presence of anti-nutritional factors (namely tannin, saponin, and phytate), which are usually in high proportion in leaf meals. Also, high crude fiber content in the leaf meals could be responsible for the low level of nutrient digestibility in those diets fortified with the test ingredients. The results obtained in this study for nutrient digestibility were also in consonance with the observation of other authors, like Makinta *et al.*⁸, who reported decreased nutrient digestibility in the diets apart from the control. They suggested that, this could be due to the variability in nutrient content and interactions with other nutrients in the diet.

Table 2: Nutrient digestibility of starter broiler birds fed supplemental levels of moringa and black plum leaf meal

Component (%)	Treatments					SEM
	T1	T2	T3	T4	T5	
Dry matter	81.07 ^a	78.30 ^a	74.21 ^b	80.30 ^a	76.77 ^b	0.80
Crude protein	79.82 ^a	78.12 ^a	73.47 ^b	75.35 ^b	69.57 ^c	1.03
Crude fiber	68.20 ^b	71.38 ^a	73.26 ^a	72.68 ^a	73.45 ^a	0.78
Ash	60.63 ^a	60.60 ^a	58.43 ^a	57.78 ^b	59.18 ^a	0.40
Ether extract	69.03 ^a	66.20 ^b	62.53 ^d	64.41 ^c	62.34 ^d	0.68
Nitrogen free extract	74.68 ^a	72.13 ^b	70.43 ^c	70.72 ^c	71.48 ^b	0.42

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

Table 3: Serum mineral profile of broiler birds fed supplemental levels of moringa and black plum leaf meal

Component	Treatments					SEM
	T1	T2	T3	T4	T5	
Calcium (mmol/L)	0.44 ^b	0.46 ^b	0.48 ^a	0.48 ^a	0.49 ^a	0.008
Phosphorus (mg/dL)	6.15 ^c	6.34 ^a	6.25 ^b	6.26 ^b	6.35 ^a	0.02
Magnesium (mg/dL)	2.14 ^c	2.32 ^a	2.22 ^b	2.30 ^a	2.37 ^a	0.02
Potassium (mmol/L)	3.49 ^d	3.79 ^b	3.69 ^c	3.63 ^c	3.91 ^a	0.04
Sodium (mmol/L)	138.14 ^d	144.01 ^b	141.29 ^c	145.22 ^a	146.03 ^a	0.79

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

Dietary effect on serum minerals showed a significant ($p < 0.05$) impact for all the parameters studied (Table 3). The effect of diet on calcium showed that there was a significant ($p < 0.05$) effect across the treatment group studied. A superior ($p < 0.05$) value of 0.49 mmol/L was observed in treatment 5, which was similar ($p > 0.05$) to those obtained in treatments 4 and 3, with the same value of 0.48 mmol/L each. The lowest value of 0.44 mmol/L was obtained in treatment 1, which did not differ ($p > 0.05$) from that of 0.46 mmol/L in treatment 2. The phosphorus value was highest in treatment 5 with 6.35 mg/dL, which was similar ($p > 0.05$) to the value of 6.34 mg/dL obtained for phosphorus in treatment 2. The least value of phosphorus was seen in treatment 1 with 6.15 mg/dL, which was significantly ($p < 0.05$) different from those of 6.25 and 6.26 mg/dL corresponding to treatments 3 and 4, respectively.

The dietary effect on magnesium was significantly ($p < 0.05$) affected. A higher value of 2.37 mg/dL was observed in treatment 5, which did not differ ($p > 0.05$) from the values of 2.32 and 2.30 mg/dL obtained for magnesium in treatments 2 and 4. The least value of 2.14 mg/dL was observed in treatment 1, which was significantly ($p < 0.05$) different from those obtained for magnesium in treatment 3, with a value of 2.22 mg/dL, respectively. The effect of dietary treatment was significantly ($p < 0.05$) influenced by values obtained in potassium. A superior value of 3.91 mg/dL was observed in treatment 5, while the lowest value of 3.49 mg/dL was seen in treatment 1. Treatment 3 and 4 had values of 3.69 and 3.63 mg/dL, which were, by themselves, similar ($p > 0.05$) to each other statistically. The potassium value in treatment 2 was 3.79 mg/dL. The effect of diet on sodium parameters showed that there was a significant ($p < 0.05$) impact of the test ingredient on the parameter across the treatment group. The highest value for sodium was observed in treatment 5 with 146.03 mmol/L, which did not differ ($p > 0.05$) from the value of 145.22 mmol/L obtained for sodium in treatment 4. The lowest value of 138.14 mmol/L was observed in treatment 1, which was significantly ($p < 0.05$) different from those obtained for sodium in treatments 2 and 3 with values of 144.01 and 141.29 mmol/L, respectively.

The limitation encountered in the course of the work came from the drying of the leaves because of the seasonal changes. Shade drying was a little bit difficult because of the weather conditions.

It was recommended that the use of an oven or dryer be used to enable the drying of the leaves all throughout the season, as this will go a long way to remove the limitation.

CONCLUSION

The inclusion of black plum and moringa leaf meal in the diets of both starter and finisher broiler birds at varying ratios (1:4, 2:3, 3:2, and 4:1) was well tolerated and did not negatively affect nutrient digestibility or serum mineral levels, as evidenced by normal skeletal development. Treatment 1 consistently showed superior digestibility for dry matter (81.07%) and crude protein, while treatment 5 recorded the highest crude fiber (73.45%) and serum mineral values, particularly for calcium and sodium. These findings suggest that alternative processing methods and different inclusion ratios may further enhance nutrient absorption. Future studies could explore the efficacy of these ingredients in other poultry species.

SIGNIFICANCE STATEMENT

Considering the need to make available good quality chicken meat to the growing populace of humanity, it has become expedient to focus on the use of herbal plants, which have little or no side effects when used in the production of livestock and poultry birds in particular. Herbal plants, such as moringa and black plum, have been used as medicinal plants over the years, and their significant impact in the area of antibacterial, antifungal, and antioxidant effects cannot be overemphasized. Thus, the pivot of this research work circles around the use of these herbal plants as feed additives in the diet of starter broiler chickens.

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