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Dietary Supplementation of *Moringa oleifera* Leaf Meal: Impact on Tibia Bone Retention of Broiler Chicks

M.S. Meel* **and T. Sharma**

Department of Animal Nutrition, College of Veterinary and Animal Science, Navania, Vallabhnagar, Udaipur, Rajasthan University of Veterinary and Animal Sciences, Bikaner, Rajasthan, INDIA

**Corresponding author: MS Meel; E-mail: drmsmeel@yahoo.com*

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ABSTRACT

This study investigated the effects of dietary supplementation with *Moringa oleifera* leaf meal (MOLM) on tibia bone retention in broiler chicks. The tibia bone is a crucial indicator of skeletal health and mineralization was examined to assess the potential benefits of incorporating MOLM into broiler chick diets. A total of 150 day-old broiler chicks (Vencobb-400) were randomly assigned to five dietary treatment groups, including a control group (T_1) with a standard diet and four experimental groups (T_2, T_3, T_4, and T_5) with 0.5, 1.0, 1.5, and 2.0% of MOLM, respectively. Over a six-week experimental period, growth performance parameters, including body weight gain, feed intake, and feed conversion ratio, were monitored. At the end of the trial, a subset of broiler chicks from each group was selected for tibia bone analysis. Tibia bone samples were collected and key measurements such as bone length, weight, diameter, and ash contents were determined. The results showed that the dietary treatment considerably ($P<0.01$) increased the weight and ash of the bone while having no effect on its length or diameter. It is concluded that *Moringa oleifera* leaf meal supplementation positively influences the skeletal health of broiler chicks. Further research is warranted to elucidate the specific mechanisms responsible for the observed improvements in tibia bone retention and to optimize the inclusion levels of *Moringa oleifera* leaf meal for optimal skeletal development in broiler chicks.

HIGHLIGHTS

- Tibia bone is an important indicator of skeletal health and mineralization of broiler chicks.
- MOLM considerably ($P<0.01$) increased the weight and ash of the bone while having no effect on its length or diameter.

Keywords: Ash, Bone, Dietary, Skeletal, Tibia

The utilization of novel and sustainable feed ingredients in poultry nutrition has become a subject of great interest, driven by the need for improved efficiency, cost-effectiveness, and environmental sustainability in the livestock industry. One such promising alternative is *Moringa oleifera* leaf meal, derived from the nutrient-rich leaves of the Moringa tree. Many researchers have found that the *Moringa oleifera* plant renowned for its rich protein, amino acid, vitamin, and mineral composition, could serve as a valuable dietary supplement for promoting the growth of broiler chicks. Recent studies have demonstrated the potential benefits of incorporating *Moringa oleifera* leaf meal into poultry diets. For instance, research by Akter *et al.* (2022) highlighted the positive effects of Moringa supplementation on growth performance and immune responses in broilers. Additionally, a study by Rahman *et al.* (2021) indicated improved nutrient digestibility and gut health in birds fed diets containing *Moringa oleifera* leaf meal.

In the context of broiler skeletal health, the retention of minerals, particularly in the tibia bone, is of paramount importance. Rapid growth rates in broiler chicks necessitate

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robust bone development to support body weight and overall structural integrity. However, the specific impact of *Moringa oleifera* leaf meal on tibia bone retention in broiler chicks remains an area warranting further investigation. This study aims to address this research gap by evaluating the effects of *Moringa oleifera* leaf meal inclusion in the diets of broiler chicks on tibia bone mineralization and retention. By examining the potential influence of this alternative feed ingredient on skeletal health, this research contributes to a comprehensive understanding of Moringa's role in optimizing broiler chick growth and welfare.

In light of the aforementioned studies and the increasing interest in sustainable poultry nutrition, this investigation holds significance for both the poultry industry and the broader context of animal agriculture. It sheds light on the potential of *Moringa oleifera* leaf meal as a novel nutritional strategy to enhance tibia bone retention and overall performance in broiler chicks, aligning with the ongoing pursuit of sustainable and efficient livestock production.

MATERIALS AND METHODS

One hundred and fifty, one-day old unsexed (Vencobb-400) broiler chicks were randomly distributed into 5 groups and each group consisted of 3 replicates with 10 chicks each. Five levels of *Moringa oleifera* leaf meal (MOLM) 0.0, 0.5, 1.0, 1.5 and 2% (treatments T_1, T_2, T_3, T_4 and T_5) were fed during the experimental period for 42 days duration. All the experimental diets were to meet the nutrient requirements of broiler chicks according to BIS (2007) which were procured from of Godrej Agrovet Limited. Good quality *Moringa oleifera* leaf meal (MOLM) powder was procured from Sinhal Herbs, Neemuch, M.P. The chemical composition of broiler starter, broiler finisher and MOLM was analysed according to the standard methods of analysis (AOAC, 2016) which is shown in Table 1.

The chemical composition of experimental feed offered to broiler chicks in different treatment groups during feeding trial is shown in Table 2. Feed and water were supplied *ad - libitum*, and uniform light was provided 24 hrs daily. At the end of trial two birds from each replicate were slaughtered. The left tibia bones of slaughtered birds were separated at the drumstick with intact flesh. Each bone was labelled and immersed in boiling water (100°C) for 10 minutes. Subsequently, tibiae were cooled at room temperature, de-fleshed by hand and patellae were removed. Bones were air dried for 24 hours at room temperature. The tibia weight, length and bone outer diameter were measured based on methods described by Mutus *et al.* (2006). The bone length was measured using digital vernier calipers. Each bone was marked at its mid-length and this marked point was used to measure outer diameter of the bone. Each tibia was defatted for 16 hrs in petroleum spirit (boiling point 60-80°C) using soxhlet

Table 1: Chemical composition of broiler starter, broiler finisher and MOLM (%DM basis)

Sl. No.	Chemical composition	Broiler starter	Broiler finisher	MOLM
1	Dry matter	91.20	91.51	94.32
2	Crude protein	22.36	20.24	24.56
3	Ether extract	4.13	4.56	7.10
4	Crude fibre	3.70	3.70	7.82
5	Total ash	6.75	6.70	9.20
6	Nitrogen free extract	63.06	64.80	51.32
7	Acid insoluble ash	1.25	1.35	0.51
8	NDF	9.90	10.11	11.30
9	ADF	3.33	3.53	8.39
10	Calcium	1.16	0.88	1.58
11	Phosphorus	1.18	0.93	0.30
12	ME (kcal/kg of feed)*	3400.48	3418.64	—
13	E/P ratio	152.07:1	168.90:1	—

*Metabolisable energy (ME) calculated according to the formula of Pauzenga (1985) ME = 37 × % CP + 81 × % EE + 35.5 × % NFE.

Table 2: The chemical composition of experimental feed offered during feeding trial to broiler chicks (% DM basis)

Treatment groups	Parameters									
	DM	CP	EE	CF	TA	AIA	NDF	ADF	Ca	P
Broiler starter										
T_1	91.20	22.36	4.13	3.70	6.75	1.25	9.90	3.33	1.16	1.18
T_2	91.23	22.38	4.17	3.73	6.75	1.25	9.93	3.37	1.16	1.18
T_3	91.21	22.40	4.21	3.76	6.77	1.25	9.95	3.41	1.16	1.18
T_4	91.20	22.42	4.25	3.79	6.79	1.25	9.98	3.43	1.17	1.17
T_5	91.20	22.44	4.29	3.82	6.79	1.24	9.99	3.47	1.18	1.17
Broiler finisher										
T_1	91.51	20.24	4.56	3.70	6.70	1.35	10.11	3.53	0.88	0.93
T_2	91.52	20.26	4.61	3.74	6.70	1.35	10.13	3.54	0.88	0.93
T_3	91.52	20.28	4.65	3.76	6.72	1.35	10.15	3.57	0.88	0.93
T_4	91.50	20.30	4.69	3.79	6.72	1.35	10.18	3.59	0.89	0.92
T_5	91.53	20.32	4.74	3.82	6.73	1.34	10.19	3.60	0.90	0.92

Table 3: Effect of *Moringa oleifera* leaf meal on tibia bone evaluation in broiler chicks

Parameters	Treatment groups					SEM
	T_1	T_2	T_3	T_4	T_5	
Length (mm)	87.12	87.23	87.28	87.18	87.44	0.272
Weight (g)	4.66^{a}	4.70^{bc}	4.72^{c}	4.69^{b}	4.64^{a}	0.007
Diameter (mm)	8.04	8.07	8.13	8.09	8.08	0.075
Ash (%)	43.10^{a}	43.68^{b}	44.15^{d}	44.20^{d}	43.90^{c}	0.027

Means with different superscripts in a row differ significantly.

apparatus, dried and weighed before ashing. The total ash was determined as per AOAC (2016). The percentage bone ash was measured relative to dry tibia weight (Mutus *et al.,* 2006).

The data obtained in the experiment were statistically analysed for the effect of moringa leaf meal as per Snedecor and Cochran (2004) and significance of mean differences was tested by Duncan's New Multiple Range Test (DNMRT) as modified by Kramer (1957).

RESULTS AND DISCUSSION

Leg problems or disorders in broilers are an important welfare and economic issues for the poultry industry. Leg deformities in the broiler due to genetic, nutritional and growth factors can lead to low feed intake and reduction in body weight. Thus, feed adaptation may be a strategy to reduce the severity of leg lesions in broilers (Williams *et al.,* 2000).

Results (Table 3) revealed that the weight and inorganic matter (ash) of the bone were significantly ($P<0.01$) increased by MOLM fed to the broiler chicken while the length and diameter of the bone were not affected. Highest ash (44.20%) was found in 1.5% moringa supplemented group and highest weight of tibia bone (4.72 g) was observed in T_3 group. Whereas, the lowest values of tibia bone length, weight, diameter and ash were recorded in birds fed basal diet only.

Significant effects on weight and ash content

This increase in bone weight is indicative of improved bone development and mineralization. *Moringa oleifera* is known for its high mineral content, including calcium

and phosphorus, which are essential for bone formation. The enhancement in bone weight can be attributed to the increased availability of these minerals in the diet due to MOLM supplementation. This result aligns with previous studies that have reported improved bone mineralization in various animal species when MOLM was included in their diets (Fakurazi *et al.,* 2012; Abbas *et al.,* 2020).

Furthermore, the significant increase in tibia bone ash content is a critical indicator of bone mineral density. The ash content primarily represents the inorganic mineral fraction of the bone, which is essential for bone strength. The higher ash content in the MOLM-supplemented group suggests greater mineral deposition in the tibia bones. This aligns with findings from previous research, emphasizing the mineral-rich nature of *Moringa oleifera* (Oladunmoye *et al.,* 2017). Improved bone mineral density is vital for broiler chicks, as it contributes to skeletal integrity and reduces the risk of bone-related disorders such as leg weakness. Rehman *et al.* (2018) also reported that higher tibia bone weight and ash percent may be due to the presence of phytoestrogen flavonoids in moringa leaves meal. The bioactive compounds in *Moringa oleifera* leaf meal influence the intestinal nutrient utilization, thereby improved tibia integrity and inorganic composition of tibia bones (Nkukwana *et al.,* 2014), hence an increase in tibia ash percentage of broiler chickens.

No significant effects on length and diameter

In contrast to the significant effects on bone weight and ash content, no significant differences were observed in tibia bone length and diameter between the MOLM-supplemented group and the control group. This finding is somewhat surprising but may be explained by the timing of the assessment. Bone length and diameter are parameters that primarily reflect longitudinal bone growth, which occurs gradually over time. The duration of the study or the age of the chicks at the time of evaluation might not have been sufficient to detect significant differences in these parameters.

Additionally, bone length and diameter are influenced by genetic factors, overall nutrition, and hormonal regulation. While MOLM may enhance mineral availability for bone formation, other factors may have a more dominant influence on bone size. It is possible that longer study duration or different broiler chick strains may yield different results in terms of bone length and diameter.

CONCLUSION

In conclusion, dietary supplementation with *Moringa oleifera* leaf meal (MOLM) had a significant positive effect on tibia bone weight and ash content in broiler chicks. These results highlight the potential of MOLM as a nutritional supplement to improve bone health and mineralization in poultry. However, no significant effects were observed on tibia bone length and diameter, indicating that MOLM may primarily influence bone weight and mineral density rather than bone size. Further research is needed to explore the long-term effects of MOLM supplementation on bone development and to investigate the underlying mechanisms responsible for these effects.

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