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The use of *Moringa oleifera* in poultry diets

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Abstract: Poultry production sectors in developing countries are facing some problems, one of which is an increase in the cost of feed due to high prices of protein and energy sources. In addition, they are also faced with the problem of the development of antibiotic-resistant pathogens due to unwise and excessive use of antibiotics. Researchers are therefore looking for cheap, available, and safe alternative sources of protein and energy. In addition, scientists are also searching for natural antimicrobial ingredients. Some tropical legumes and plants were introduced into poultry diets as protein sources to decrease the cost of the feed. Recent studies report that some herbs, spices, and extracts may have antimicrobial, coccidiostatic, and anthelminthic properties. *Moringa oleifera* is a tree with many uses, and of great economic importance, found throughout most of the tropics. It was incorporated into the poultry diet by nutritionists to examine its effects on weaner rabbits', broilers', and laying hens' productive performance.

Key words: *Moringa oleifera*, chemical analysis, broilers, layers, performance

1. Introduction

In many tropical and subtropical countries, various parts of *Moringa oleifera* (leaves, fruits, immature pods, and flowers) are incorporated into the traditional food of humans (1,2). Leaves of the moringa tree are the preferred part for use in animal diets as leaf meal. Research was conducted to study the effect of this leaf meal on the growth performance of layer chicks (3), on the productive performance of laying hens (4–6), on broilers' performance (7,8), and on the growth, carcass, and blood indices of weaner rabbits (9). The effect of *Moringa oleifera* seeds on broilers' performance was also examined by researchers (10).

2. *Moringa oleifera*

Moringa oleifera is a widely grown crop in India, Ethiopia, the Philippines, and Sudan. The tree is being grown in West, East, and South Africa and in tropical Asia, Latin America, the Caribbean, Florida, and the Pacific Islands (11). Many researchers have noticed its nutritional and medicinal benefits (12–15).

2.1. Chemical analysis of *Moringa oleifera*

Yameogo et al. (16) reported that, on a dry matter basis, *Moringa oleifera* leaves contained 27.2% protein, 5.9% moisture, 17.1% fat, and 38.6% carbohydrates. Anwar and Rashid (17) noticed that on a dry matter basis, *Moringa oleifera* seeds contained 34.80% ether extract, 31.65% protein, 7.54% fiber, 8.90% moisture, and 6.53% ash contents. Makkar and Becker (13) found that the essential amino acid contents of the leaves and sulfur-containing amino acids of the kernel were higher than the amino acid pattern of the FAO reference protein, but other essential amino acids of the kernel were deficient. Regarding antinutritional factors, Makkar and Becker (13) mentioned that the concentrations of antinutritional factors (tannins, trypsin and amylase inhibitors, lectins and cyanogenic glucosides, glucosinolates, and saponins) were either undetectable or negligible in leaves, twigs, and stems. Kernels, meal (fat-free kernels), extracted kernels, and extracted meal had low levels of saponins; trypsin and amylase inhibitors were absent. However, hemolytic activity was observed in kernels and extracted kernels. Hemagglutination activity was detected in kernels and meal but not in their extracted samples. Ogbe and Affiku (18) also found low levels of antinutrients in *Moringa oleifera* leaves. These authors reported that tannins, phytates, trypsin inhibitors, saponins, oxalates, and cyanide content of leaves were 21.19 ± 0.25%, (2.57 ± 0.13%, 3.0 ± 0.04%, 1.6 ± 0.05%, 0.45 ± 0.01%, and 0.1 ± 0.01%, respectively. Table 1 shows the chemical compositions and gross energy (GE) of different fractions of *Moringa oleifera*.

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Table 1. Chemical compositions and gross energy (GE; on dry matter basis) of different fractions of *Moringa oleifera* (13).

Parts/fractions	Dry matter g/kg						GE MJ/Kg
	Crude protein	Lipid	Ash	NDF	ADF	ADL	
Leaves	264	ND	88.7	151	92	11	19.35
Twigs	72	ND	93.0	564	515	83	18.52
Stems	62	ND	69.0	684	609	110	18.95
Shells	99	22	22.7	842	805	452	21.62
Kernels	367	417	31.8	48	39	14	26.68
Meal (fat-free kernels)	614	nil	56.5	82	67	25	19.39
Extracted kernels	353	538	23.0	61	50	18	31.21
Extracted meal	703	nil	45.0	145	120	44	20.30

ND: not determined; NDF: neutral detergent fiber; ADF: acid detergent fiber; ADL: acid detergent lignin.

2.2. Mode of action of *Moringa oleifera*

Antimicrobial and antioxidant effects of *Moringa oleifera* were discussed by some researchers. Jabeen et al. (19) mentioned that the antimicrobial properties of the *Moringa oleifera* seed extracts may be due to lipophilic compounds. These compounds may attach to the cytoplasmic membrane. The authors also suggested that extracts of *Moringa oleifera* seeds may contain antibiotic metabolites, such as carboxylic acid, 2,4-diacetyl phloroglucinol, and cell wall-degrading enzymes and chitinases. The antioxidant effect of *Moringa oleifera* leaf extract and fruit was explained by Luqman et al. (20), who noticed that it was due to the presence of polyphenols, tannins, anthocyanin, glycosides, and thiocarbamates, which remove free radicals, activate antioxidant enzymes, and inhibit oxidases.

2.3. Effect of moringa leaf meal on the laying performance of hens

Melesse et al. (3) reported that use of *Moringa stenopetala* leaf meal in the diet of Rhode Island Red chicks produced significant ($P < 0.05$) increase in feed and crude protein intake, average weight gain, feed efficiency ratios, and protein efficiency ratios when compared to a control diet. The authors related these findings to the presence of readily available protein in moringa leaf meal, which is convenient for monogastric animals, and also to the higher levels of methionine and other essential amino acids when compared to the soybean meal of a control diet. The authors concluded that inclusion of *Moringa stenopetala* leaf meal in amounts of up to 6% in the diet of growing chicks to replace expensive conventional protein sources has no negative effects on the chicks. Kakengi et al. (4) declared that addition of 10% and 20% *Moringa oleifera* leaf meal to the laying hen diet, as a substitute for sunflower seed meal, significantly ($P < 0.05$) increased feed intake and dry matter feed intake and decreased egg mass production. Egg production percentage decreased with an increase of *Moringa oleifera* leaf meal level. Feed conversion ratio (kg feed/kg egg) increased when 20% *Moringa oleifera* leaf meal was added to the laying hen diet. An addition of 5% *Moringa oleifera* leaf meal significantly ($P < 0.05$) increased egg weight, but lower egg weight was observed at a level of 20%. The authors explained that increase in feed intake and feed conversion ratio, and decrease in egg mass production, egg production percentage, and egg weight at a higher level of *Moringa oleifera* leaf meal, are mainly due to low digestibility of energy and protein. Olugbemi et al. (5) noticed that supplementation of *Moringa oleifera* leaf meal at levels of up to 10% in a cassava chip-based diet offered to laying hens had no significant effect on feed intake, feed conversion ratio, and laying percentage. Egg weight significantly increased as a result of the supplementation of *Moringa oleifera* leaf meal with cassava chip when compared to a control diet (free of *Moringa oleifera* leaf meal and cassava chip). Abou-Elezz et al. (6) mentioned that inclusion of different levels of *Moringa oleifera* leaf meal (0%, 5%, 10%, and 15%) in the laying hens' diets linearly decreased egg-laying percentage and egg mass, while egg weight and feed intake showed a quadratic trend with the increased levels of *Moringa oleifera* leaf meal with the absence of a significant effect on feed conversion ratio. Generally, Kakengi et al. (4), Olugbemi et al. (5), and Abou-Elezz et al. (6) agreed that use of *Moringa oleifera* leaf meal up to a level of 10% had

no negative effect on the productive performance of laying hens, but levels above that (15% and 20%) are expected to produce adverse effects.

2.4. Effect of moringa leaf meal on the performance of broilers

Olugbemi et al. (8) found that an addition of 5% *Moringa oleifera* leaf meal to cassava-based broilers' diet (20% and 30%) had no significant ($P > 0.05$) effect on weight gain, feed conversion ratio, final body weight, and feed cost per kilogram of weight gain when compared to a diet free of cassava and free of *Moringa oleifera* leaf meal, a diet containing 20% cassava and 0% *Moringa oleifera* leaf meal, and a diet containing 30% cassava and 0% *Moringa oleifera* leaf meal. However, levels above 5% of *Moringa oleifera* leaf meal decreased broilers' performance. In contrast to these findings, Juniar et al. (7) reported that the inclusion of *Moringa oleifera* leaf meal at amounts up to 10% did not produce significant ($P > 0.05$) effects on feed consumption, body weight, feed conversion ratio, carcass weight, production efficiency factor, and income over feed cost. Disagreement may be due to the inclusion of *Moringa oleifera* leaf meal in the cassava-based broiler diet in the previous study.

2.5. Effect of moringa seeds on the performance of broilers

Abbas and Ahmed (10) performed an experiment to study the effect of *Moringa oleifera* undecorticated seed powder (MOUSP) in the broilers' diet (0%, 0.37%, 0.75%, and 1.5%), specifically concerning performance and carcass characteristics. The authors observed that during the starter period (8–21 days), use of 1.5% MOUSP significantly ($P < 0.05$) reduced weight gain, body weight, and feed efficiency. During finisher (22–35 days) and whole (8–35 days) periods, supplementation of different levels (0.37%, 0.75%, and 1.5%) of MOUSP failed to produce a significant ($P > 0.05$) effect on weight gain, final live body weight, feed efficiency, dressing percentage, and liver and heart weights. Therefore, use of MOUSP at an amount of 1.% during the finisher period overcomes its deleterious effect during the starter period. Therefore, it is better to use this level during the finisher period only.

2.6. Effect of moringa leaf meal on growth, carcass, and blood indices of weaner rabbits

Nuhu (9) noticed that offering weaner rabbits a diet containing moringa leaf meal significantly ($P < 0.05$) increased dry matter and protein digestibility, daily weight gain, and crude protein of meat, and it reduced ether extract of meat when compared to a control diet. Diets containing moringa leaf meal had no significant ($P > 0.05$) effect on crude fiber and ether extract digestibility, daily feed intake, feed conversion ratio, carcass characteristics, and blood components (hemoglobin, packed cell volume, red blood cells, white blood cells, neutrophils, lymphocytes, eosinophils, cholesterol, total protein, albumin, and globulin). The author attributed the improvement of rabbit growth to the higher level of vitamin A in moringa leaf meal, as reported by Grubben and Denton (21). Regarding the increase in protein digestibility with the addition of moringa leaf meal, Fahey et al. (22) mentioned that moringa contains highly digestible protein.

2.7. Economic analysis of inclusion of moringa leaf meal in broilers', growing rabbits', and indigenous chickens' diets

Zanu et al. (23) noticed that partial replacement of fish meal with *Moringa oleifera* leaf meal decreased the feed cost and also decreased the net revenue for broilers, according to their reduction in weight gain (Table 2). Adeniji and Lawal (24) examined the economic benefit of *Moringa oleifera* leaf meal in the diet of grower rabbits to replace groundnut cake. They found that increasing the levels of *Moringa oleifera* leaf meal up to 100% replacement significantly ($P < 0.05$) reduced feed cost. At levels of 60%, 80%, and

Table 2. Economic analysis of inclusion of moringa leaf meal in broilers diet (23).

Variable	Level of dietary MLM			
	0% MLM	5% MLM	10% MLM	15% MLM
Feed cost/kg diet (GH₵)	1.08	1.05	0.89	0.86
Feed cost/bird (GH₵)	5.46	5.88	5.04	5.46
Price/bird at 8 weeks (wt/kg) (GH₵)	6.00	6.00	6.00	6.00
Value/bird (GH₵)	13.04	11.16	11.28	8.76
Net revenue/bird (GH₵)	7.04	5.16	6.24	3.30

MLM: *Moringa oleifera* leaf meal; GH₵: Ghana cedi. Note: 1.0 US$ = 1.5 GH₵.

100%, replacement, a significant ($P < 0.05$) reduction in cost of feed consumed was recorded. In addition, at 100% replacement, highest profit, gross profitability, and feed cost efficiency values were observed. Ayssiwede et al. (25) noticed that incorporation of 24% *Moringa oleifera* leaf meal in diets of growing indigenous Senegal chickens produced the highest feed cost/kg carcass. However, the lowest feed cost/kg carcass was achieved when 8% and 16% of *Moringa oleifera* leaf meal was introduced into the diets of the birds. Regarding supplementary net margin, the authors found that inclusion of 8% and 16% of *Moringa oleifera* leaf meal resulted in an additional net margin of 357 and 206 FCFA/kg carcass, respectively, while at 24% they experienced a loss of 68 FCFA/kg carcass.

3. Conclusion

Moringa leaf meal can be used at levels of up to 6% of the diet of growing layer chicks, up to 10% of the diet of laying hens, up to 5% of the diet of broilers, and up to 20% of the diet of weaner rabbits without deleterious effects on performance. Moringa undecorticated seed powder can also be used in amounts of up to 1.5% of the diet of broilers during the finisher period, but not during the starter period. Regarding economic benefits, the levels of inclusion of *Moringa* leaf meal that can be expected to be cost-effective are 10% to replace fish meal in broilers' diets, 100% to replace groundnut cake in growing rabbits' diets, and, finally, 8% and 16% introduction in the diet of indigenous chickens.

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