Review on Use of *Moringa Oleifera* Leaf Meal in Diets of Laying Hens: Effect on Egg Production, and Quality

A.K Darboe [1 2]* T.O Okeno[1] Sayon, S.O.[1 3]
[1] Egerton University, PO Box 536, 20115 Egerton, Kenya
[2] Department of Animal Sciences,
[3] Department of Applied Community Development studies.

Abstract:- One issue affecting the poultry production sectors in developing nations is the rise in feed costs brought on by the high costs of protein and energy sources. Researchers are also looking for organic components that are antibacterial. To cut the expense of the feed, several tropical legumes and plants were added to the diets of chickens as protein sources. Some herbs, spices, and extracts may be coccidiostats, anthelminthic, and antimicrobial, according to recent studies. Most of the tropics are home to the Moringa tree, which has a wide range of applications and is quite significant economically. In order to study its impact on the productive performance of laying hens, nutritionists added it to the diet of poultry. This review's focus is on using Moringa oleifera leaf in diets of laying hens: effect on egg production and quality. Various scientific findings and published research articles were considered about issues such as the study background, objectives, major findings, and review conclusions. M oleifera is also known as a drum stick or miracle tree due to its abundant supply of various nutrients with high biological values. In addition, it has a hypocholesterolemic effect on chickens. It has nutritional as well as therapeutic properties. However, there is still a lot of ambiguity in previously published articles about the major roles of M. oleifera in chicken production performance. Taking this into consideration, the current study provides an outline of the experimental uses of M. oleifera in growth performance, egg production performance, and egg quality, on laying hens, which is supported by previous findings. The gaps in knowledge from previous studies are considered, and the feasibility of M. oleifera in poultry rationing is proposed. The findings have prompted additional research on M. oleifera to determine the most active ingredients and optimal doses in laying hen rations. Finally, the current study shows that M. oleifera supplementation may improve egg quality and production performance.

***Keywords**: Moringa Oleifera; Poultry; Growth Performance; Laying Performance; Health Status.*

I. INTRODUCTION

Even though it is one of the animal sectors with the greatest rate of growth globally, the poultry industry is constrained by a severe lack of feed components, particularly in emerging nations (Al-Harthi et al. 2009). Investigating non-traditional feed sources that could be used in chicken feed formulas is therefore crucial (El-Deek et al. 2010). A versatile tree that grows well in both tropical and subtropical climates is the drumstick tree, Moringa oleifera (Worku 2016). According to Gadzirayi et al. (2012), Moringa oleifera leaf (MOL) has high quantities of vitamins, minerals, and crude protein, which range from 25 to 27 per cent (Yang et al. 2006). MOL's protein quality has reportedly been compared to that of milk and eggs (Fahey 2005). Kakengi et al (2005) when researchers in Tanzania examined the nutritional values of various morphological components of MOL with Leucaena leucocephala leaf meal, found that MOL had a high concentration of pepsin and total soluble protein. A prior study revealed that MOL has significant levels of antioxidants, including flavonoids (Vongsak et al. 2013).

Numerous research demonstrated that adding MOL to the diet could enhance animal performance. MOL supplementation in Rhode Island Red hens led to improvements in egg production, yolk colour, and feed conversion ratio (Mohammed et al. 2012). In a recent study, Kholif et al. (2015) found that goats fed diets containing MOL had higher feed intake, nutrient digestibility, and milk output. A higher supplementation amount could reduce animal performance due to the increased concentration of anti-nutrient components (such as saponins and phenols) since the effect of MOL was shown to be dosage-related (Worku 2016). This review looks into the impact of the graded amount of MOL on consumption, feed conversion ratio (FCR), egg output, and laying hen quality we sought to further demonstrate how various amounts of supplemental MOL affect the functionality and health of layers.

A. Moringa oleifera

Moringa oleifera is a well-known cultivated species in the genus Moringa, (family Moringaceae) under the order Brassicales. The common names of *Moringa oleifera* include drumstick tree, horseradish tree, and ben oil tree or miracle tree (Arora et. 2013). The *M. oleifera* tree is native to South Asia, especially India, Sri Lanka, Pakistan, Bangladesh, Afghanistan; North Eastern and South Western Africa, Madagascar, and Arabia (Fahey, 2005– Moyo, et al., 2016). The Moringa seed and leaves have broad use in the food industry and therapeutic issues. Moringa oleifera is very useful as a feed supplement for animals, as its leaves are highly nutritious. The leaves of M. oleifera are the most nutritious part, being a significant source of vitamin B complex, vitamin C, pro-vitamin A as beta-carotene, vitamin K, manganese, and protein among other essential nutrients (Leone et al., 2015).

B. Role of M. oleifera

The *M. oleifera* tree is well-known throughout the world for its economic and therapeutic properties. The National Institute of Health (USA) named it "Botanical of the Year 2007" (Gupta et al., 2018). To Africans, the tree is also known as the "never die" or "miracle tree." The use of M. oleifera leaf in food preparation is gaining popularity right now. People in Ghana, Nigeria, Ethiopia, East Africa, and Malawi consume the leaves of the Moringa tree directly in their diets (Agbogidi et al., 2012).

M. oleifera leaves have also been used to make soups, foods, bread, cakes, and yoghurt hazmatt et al., 2015). Moringa was thought to contain various anti-nutritional factors such as tannins, phytates, oxalates, and cyanide, which may interfere with normal nutrient digestion and metabolism in animals (moreki et al., 2014). Tannins and phytates are 12 and 21 g kg1 of DM in Moringa, respectively, and can be neutralized by various feed processing techniques such as chopping, socking, heat steaming, and fermentation with beneficial organisms (Nouman et al., 20 14). When it comes to the health benefits of Moringa, it is a one-of-a-kind plant due to its mineral enrichment and lower anti-nutritional components.

C. Mode of action of Moringa oleifera

Antimicrobial and antioxidant effects of Moringa oleifera were discussed by some researchers. Jabeen et al. (2008) 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. (2012), 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.

D. Application of M. oleifera on Performance in Poultry.

In most of the feeding experiments in poultry, the fresh, green, and undamaged mature M. oleifera leaf were properly air-dried, and then the dried leaves were ground to a fine powder in a hammer mill and considered as Moringa leaf powder or leaf meal. Similarly, fresh mature Moringa seeds were air-dried and ground and considered as Moringa seed meal. In some experiments, the ground particles were then soaked in distilled water for 24 h, and the filtered aqueous solution was considered as Moringa extract. Due to the rich nutrient content, especially the high amount of crude protein (CP), vitamins, and minerals, M. oleifera leaf can be used as a useful resource of dietary supplementation for livestock as well as poultry (Nouman et al., 2014), In addition, Briones et al., (2017) stated that Moringa leaf can be applied as a dietary supplement in layers and broilers due to it high production performance and improved egg quality. However, still there are many debates on the chicken's performance with different doses of M. oleifera. There are also many variables on doses and parts of the plant used, such as leaves, extract, sods, or seeds. Finally, many scientists agreed that the M. oleifera plant might have a positive role in improving the production performance and health status of chickens. Further studies are still needed to detect the actual doses of application for optimum performance in chickens.

E. Nutritional Properties of M. Oleifera

M. oleifera is also well-known for its nutritional properties. It is said to be high in six major nutrients: carbohydrates, particularly dietary fibres; proteins; vitamins; minerals; lipids; and water. M. oleifera is distinguished by its high protein, carbohydrate, and fibre content while being low in fat. The leaves are said to contain a variety of essential amino acids and to be a good source of alpha-linoleic (Moyo et al., 2011). The leaves of M. oleifera have been found to have high levels of vitamin A, C, and E. In a rat model, the relative bioavailability of folate derived from M. oleifera leaf was approximately 82 per cent confirming that M. oleifera leaf is a good source of dietary folate (saint et al., 2016). The nutritional per cent of M. oleifera leaf (dry matter basic) revealed dry matter (DM) ranging from 93.63 percent to 95.0 per cent crude protein (CP) ranging from 17.01 per cent to 22.23 per cent, carbohydrate ranging from 63.11 per cent to 69.40 per cent, crude fibre (CF) ranging from 6.77 per cent to 21.09 per cent, crude fat (EE) ranging from 2.11 per cent to 6.41 per cent, ash (total mineral) 7.96 Furthermore, estimated calcium (Ca) was 1.91 per cent; potassium (K) was 0.97 per cent; sodium (Na) was 192.95 per cent; iron (Fe) was 107.48 per cent. Manganese (Mn) was 81.65, Zinc (Zn) was 60.06, and phosphorus (P) was 30.15 parts per million (ppm) (ogbe et al., 2012). Magnesium (Mg) was 0.38%, and copper (Cu) was 6.1%, tannins 21.19%, phytates 2.57%, trypsin inhibitors 3.0%, saponins 1.60%, oxalates 0.45%, and cyanide 0.1% was also reported by (Ogbe and John 2018). The leaves of the plant are enriched with methionine, phosphorus, calcium, and iron. It is believed that the leaves of M. oleifera contain more calcium and twice as much protein than mas higher vitamin C than oranges, higher potassium and iron than bananas, and higher vitamin A than carrots (Kumar..,2016), and thus the plant is considered unique (Ibrahim et al., 2014). , an active component that was identified from M. oleifera, can improve the absorption of different vitamins, minerals, and other micronutrients in the gastrointestinal tract of the host. The nutritional composition of M. oleifera leaf is presented in table 1

Table 1. Chemical compositions of Moringa oleifera leaves.

Nutrient Component	Fresh Leaves	Dry Leaves	Leaf Powder
Calories (cal)	**92**	**329**	**205**
Protein (g)	**6.7–17.1**	**29.4–40.0**	**25.4–27.1**
Fat (g)	**1.7–2.11**	**5.2–6.5**	**2.3**
Carbohydrate (g)	**6.3–12.5**	**38.0–41.2**	**34.3–38.2**
Fiber (g)	**0.9–7.09**	**12.5–21.09**	**19.2**
Vitamin A	**0.9–11.05**	**16.3–18.90**	**-**
Vitamin B1 (mg)	**0.06**	**2.02–2.60**	**2.64**
Vitamin B2 (mg)	**0.05**	**19.82–21.3**	**20.5**
Vitamin B3 (mg)	**0.8**	**7.6–8.3**	**8.2**
Vitamin C (mg)	**220**	**15.8–17.3**	**17.3**
Vitamin E (mg)	**448**	**10.8–77.0**	**113**
Calcium (mg)	**440**	**2185–3050**	**2003**
Magnesium (mg)	**42–82**	**86–448**	**368**
Phosphorus (mg)	**30.15–70**	**204–252**	**204**
Potassium (mg)	**259**	**1236–1384**	**1324**
Copper (mg)	**0.07**	**0.08–0.49**	**0.57**
Iron (mg)	**0.85–10.7**	**25.6–490**	**28.2**
Sulphur (mg)	**-**	**363–630**	**870**
Zinc (mg)	**6.7**	**3.25–13.03**	**-**
Manganese (mg)	**81.6**	**86.8–91.2**	**-**

Source kumar et al 2016
All values are in 100 g per plant material.

Table 2. Amino acid contents in Moringa oleifera leaves.

Amino Acid	Fresh Leaves (mg g^{-1} DM)	Extracted Leaves (mg g^{-1} DM)
Lysine	13.25–26.77	14.06–18.09
Leucine	20.52–42.89	17.5–21.84
Isoleucine	11.91–22.53	8.08–11.30
Méthionine	3.5–8.96	1.13–4.97
Cystine	3.8–5.18	1.0–3.39
Phenylalanine	16.31–27.14	8.9–15.51
Tyrosine	18.88	9.71
Valine	10.62–27.58	7.25–14.26
Histidine	5.17–13.57	7.16–7.50
Threonine	13.5–21.97	7.90–11.70
Serine	10.87–20.79	9.40–10.34
Glutamic acid	28.42–50.85	17.10–25.65
Aspartic acid	20.52–46.11	14.3–22.16
Proline	14.3–25.75	12.41–13.63
Glycine	15.33–26.62	10.3–13.73
Alanine	28.67–30.33	12.51–18.37
Arginine	18.9–30.28	13.25–15.64
Tryptophan	4.25–9.26	5.27–7.16

Source Moyo et al., 2011

F. Effects of M. oleifera on Egg Production, Performance, and Egg Quality in Laying Hens.

Egg quality characteristics such as colour size, shape, colour, shell thickness, and egg yolk cholesterol influence egg consumers in both direct and indirect ways. M. oleifera leaf meal was utilized in the feed of layer chickens from 1 day old to 55 weeks old in a recent study (Voemesse et al., 2019) to explore the effects of Moringa leaf meal on growth performance, egg production performance, and blood parameters. At three distinct levels, M. oleifera leaf per cent as used (0 per cent, 1 per cent, and 3 per cent). This study found no significant variations in feed consumption between 1 day and 20, weeks of age, however, average daily body weight increase was higher, In *M. oleifera*-supplemented groups, final body weight and FCR improved. Feed consumption was lower in Moringa fed groups during the laying period, from 21 to 55 weeks, but laying % and FCR were higher in supplemented fed groups than in the non-supplemented group. Because of the varied active components in Moringa leaf, the higher body weight gain and egg production in supplemented groups could be linked to enhanced digestibility. The author determined that feeding laying hens Moringa leaf meal at a concentration of 1% had a good impact on their growth and egg production. Furthermore, laying hens produced more eggs when Moring oleifera was used at a 10% concentration (Moreki et al., 2014). M. oleifera supplementation, according to Abouz-Elezz et al., (2011), could boost egg production, egg mass, and egg yolk colour scores when compared to non-supplemented groups. The high carotene concentration in Moringa leaves could explain the improvement in yolk colour scores. In laying chicks treated with Moringa stenopetala, higher feed intake, crude protein intake, weight gain, FCR, and protein efficiency ratios were observed. (Melesse et al., 2011). This is due to the Moringa leaf meal's easily available proteins and necessary amino acids. Finally, it was observed that leaf meal at up to 6% levels can be applied in growing chicks' ration.

In contrast, Moringa oleifera seed meal at 0%, 1%, 3% and 5% levels were used to examine the effects of egg production performance, egg quality, and egg fatty acid profile in Hy-Line laying hens (Mabusela et al., 2018). Lower feed intake, egg production per cent, ein gg mass, feed intake, and body weight were observed in Moringa seed meal-fed groups than the control. Higher egg yolk colour scores with higher linolelaidic acid in egg yolk were found in Moringa seed meal supplemented groups than the non-supplemented diets (Mabusela et al., 2018). The Moringa seeds may contain different anti-nutritional factors, which may have deleterious effects on production performance in this study. In addition, Ahmad et al., (2017) also reported that the decrease in production performance of layer chickens was due to high fibre and different anti-nutritional factors' presence in Moringa pod meal. However, this study found a significant positive role in improving β-carotene, quercetin, and selenium levels in egg yolk with Moringa pod supplementation. Moringa pods are naturally enriched with carotenoids and different flavonoids, which possess natural antioxidants that could modify the carotene and quercetin levels in egg yolk (Gakuya, et al., 2014). In addition, the nutrient profile of egg yolk was higher with the supplementation of Moringa pod meal in Hy-Line layers (Ahmad et al., 2017). In another study, found that M. oleifera leaf meal had no effects on egg production, egg weight, and feed intake in Hy-Line Grey commercial layers, but birds fed with Moringa leaf meal at 15% level colour owed deeper egg yolk colour than the non-supplemented fed group. Similarly, the albumen height and Haugh unit were higher in Moringa-supplemented groups during storage of eggs at 4 0C and 28 0C for 4 weeks, the author further stated that 5% Moringa leaf meal can be included in laying hens' ration without adverse effects on egg production and egg quality. Similarly, Abou-Elezz et al., (2011) found that Moringa oleifera leaf meal could improve egg yolk colour scores and albumen percentage. This study further observed the lower egg-laying percentage and egg mass in laying hens fed with Moringa leaf meal.

However, this study did not find any significant differences in final body weight and in other egg quality parameters (yolk per cent, shell per cent, and shell thickness). Finally, the author stated that 10% Moringa leaf meal can be incorporated into the diets of laying hens. Feed intake, feed conversion ratio, and laying percentage were not influenced by adding Moringa leaf meal at a 10% level, which was noticed by (Olugbemi et al., 2010). However, the inclusion of 10% Moringa leaf meal could increase higher egg Roche colour score. A similar report on decreased egg mass and egg production per cent with Moringa leaf meal supplementation at higher levels (at 10% and 20%) in laying hens was observed by (Kakengi et al., 2017).

Interestingly, the Moringa oleifera leaf meal at a 5% level increased the egg weight, but the decreased egg weight was found when the inclusion level was at 20%. The authors assumed that higher feed intake, FCR with lower egg production per cent, egg mass, and egg weight at a higher-level supplementation was due to poor digestibility of nutrients because of different anti-nutritional phytochemical presences in Moringa leaf. Improving the egg quality by means of increasing its anti-oxidative properties by supplementing natural unconventional resources has gained significant interest in poultry research (Mahfuz et al., 2017). The synthesis antioxidants, like butylated hydroxyanisole and butylated hydroxytoluene, are commonly used in food processing. However, they are found to be carcinogenic to human health, therefore, discovering natural antioxidant products as safe and effective alternatives is a very crucial need (Zhang,et al., 2015).

G. Economic analysis of the inclusion of Moringa leaf meal in chickens' diets

According to their observation of the reduction in weight increase in chicken, Zanu et al. (2012) found that the partial substitution of fish meal with Moringa oleifera leaf meal decreased the feed cost and also decreased the net revenue for

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the poultry (Table 2). Adeniji and Lawal (2012) investigated the financial advantages of substituting groundnut cake for Moringa oleifera leaf meal in the diet of grower rabbits. The researchers discovered that bringing the amount of Moringa oleifera leaf meal up to 100% replacement significantly ($P<0.05$) decreased feed costs. A significant (P 0.05) decrease in the cost of feed consumed was seen at replacement levels of 60%, 80%, and 100%. Moreover, the highest profit, gross profitability, and feed cost efficiency values were seen at 100% replacement. Ayssiwede et al., (2011) discovered that the integration of 24% Moringa oleifera leaf meal in diets of developing indigenous Senegal hens produced the highest feed cost/kg carcass. However, the lowest feed cost/kg carcass was reached when 8% and 16% of Moringa oleifera leaf meal was put into the diets of the birds. The authors discovered that adding Moringa oleifera leaf meal at 8% and 16% produced supplemental net margins of 357 and 206 FCFA/kg carcass, respectively, whereas doing so at 24% resulted in a loss of 68 FCFA/kg carcass.

H. Economic analysis of the inclusion of Moringa leaf meal in poultry diet

	Level of dietary MLM			
Variable	**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

Table 3:- MLM: Moringa oleifera leaf meal; GH₵: Ghana cedi. Note: 1.0 US$ = 1.5 GH₵
MLM Moringa oleifera leaf meal KES Kenyan shilling note: 1.0 US$ =119.74 KES

I. Effects of M. oleifera on Health Status in Laying Hens

Analysing blood parameters is very important in detecting the health status of birds. According to (Voemesse et al., 2019). Serum albumin level was higher in laying hens fed with 3% level of Moringa leaf meal than the control group, but the number of white blood cells (WBCs), red blood cells (RBCs), lymphocytes, and the packed cell volume were lower in Moringa-fed groups than the control diets. The authors assumed that lower WBCs and lymphocytes in Moringa-fed chickens may be due to the antimicrobial activity of phytochemicals in the Moringa leaf. It is well known that a high WBC count is related to an infection caused by bacteria in the host. Lower levels of cholesterol content in serum with dietary supplementation of Moringa pod meal were observed, which might be influenced by antioxidants (flavonoids and carotenoids) and high fibre presences in the Moringa pod meal in the experimental diets (Ahmad et al., 2017).

However, this study did not find any significant differences in antibody response against the Newcastle disease virus. Lower values for Malondialdehyde (MDA) and higher glutathione peroxidase in the plasma of laying hens fed with Moringa leaf meal indicated higher antioxidant activities (Wang, et al., 2016). Plasma total protein levels were higher by dietary 5% for Moringa leaf meal supplementation, which is a good indicator of the liver's synthetic function. Furthermore, lower plasma uric acid in supplemented groups indicated higher protein retention in laying hens. The improved antioxidant enzyme activities and the reduced MDA levels in the plasma and egg yolk indicated the fact that dietary Moringa supplementation could improve the antioxidant activities. Moringa oleifera is an effective Photobiotic and is known to possess broad-spectrum antibacterial properties and immuno-modulatory functions (Rehman et al., 2018).

II. CONCLUSIONS

This review study found that oleifera could be used as a feed supplement in poultry. Despite the fact that M. oleifera was used in poultry experimental diets, some researchers pushed for more research into the effects of M. oleifera doses on chicken performance and health. As a result, a future study examining the use of M. oleifera in response to a pathogen challenge, as well as dosages, should be well-designed. This report recommends further research using M. oleifera as an antibiotic alternative in hens, with the goal of adopting it as an effective strategy for organic meat and egg production. It's feasible to infer this. M. oleifera can be used as an environmentally friendly feed addition in chicken rations. Future researchers will be able to pinpoint the critical effects of M. oleifera on immunity and health status that earlier study has been unable to investigate. As a consequence, supplementing with M. oleifera could be a novel chicken production study concept. M. oleifera at a concentration of up to 10% in the diets of broilers and laying hens could be recommended. 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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