Journal of Farm, Companion and Aquatic Animals (2022)1:1-6

Nutritional significance of *Moringa oleifera* in livestock and poultry diet: A review

Kaushalendra Kumar* Pankaj Kumar Singh and Sanjay Kumar

Abstract

Moringa oleifera is one of the most useful trees as feed supplements to animals as their leaves and pods are highly nutritious with excellent palatability, digestibility having balanced composition of protein and minerals. Moringa leaves are readily eaten by cattle, buffaloes, sheep, goats and rabbits. However, using moringa leaves as a feed source in poultry, pigs and fish is feasible but only in limited amounts due to the presence of fibre and anti-nutritional factors. Feeding chickens with Moringa leaves and seeds will improve egg production. Moringa leaves totally replacing cottonseed cake in growing lambs fed on low-quality hay increased hay intake, diet DM digestibility and daily weight gain. Feeding moringa leaves had variable effects on dry matter intake and milk yield but did not change milk composition in dairy cattle. So, more attention need to be paid to the uses of Moringa oleifera in livestock, poultry and aquaculture as feed supplement on large scale in tropical countries for improving nutrition and food security.

Keywords : Moringa oleifera, Livestock, Performance, Poultry, Nutrition

Introduction

Trees and browse species have been used as livestock fodder for many centuries. These have been used for multiple purposes, such as food, shelter, wood or non-wood-based products, oil, biodiesel, or medicines. However, it is very difficult to get all these benefits just from one plant or system. Scientists are now looking for the availability of fodder trees that are good for their nutritional value and are available throughout the year, especially during dry months. *Moringa oleifera* is a remarkable species with its high nutritional value and good biomass production, which can be used as a nutritional supplement and additive (Sanchez et al., 2006). The present review encompasses the potential of *M. oleifera* as a possible valuable resource for livestock and poultry by analyzing its strengths and weaknesses. The nutritional qualities and harmful compounds of moringa leaves and seeds, as well as its prospective as livestock fodder and additive in poultry will also be discussed.

Taxonomy

Kingdom	:	Plantae
Clade	:	Angiosperms
Clade	:	Eudicots
Order	:	Brassicales
Family	:	Moringaceae
Genus	:	*Moringa*
Species	:	*M. oleifera*

Nutritional Value of Moringa

The nutritional value and composition have been strongly emphasized in the literature for different trees and shrubs to expose their importance for livestock (D'Mello and Devendra, 1995). The recommendation of trees, shrubs, or fodder crops is based on proximate analysis including crude protein, crude fibre, ash mineral contents, etc. Their high protein content is one of the most cited advantages of moringa leaves. For example, they contain 9 times more protein than yoghurt does, as is repeatedly mentioned in the literature (Mathur, 2006). In various reports (Chandan, 2006), it has been reported that cow, buffalo, goat, and sheep milk provide average CP contents of 3.4%, 4.7%, 4.1%, and 6.3%, respectively,

✉ Dr. Kaushalendra Kumar
drkaushalbvc@gmail.com
Department of Animal Nutrition, Bihar Veterinary College, BASU, Patna-800 014,

while fresh and dry moringa leaves exhibit CP contents of 67.0 and 271.0 g kg^{-1}, respectively. Likewise, Mendieta-Araica et al. (2011) reported 292 g kg^{-1} CP contents in moringa leaves. These comparisons confirm that moringa leaves contain higher amounts of CP in comparison with milk. Moreover, Soliva et al. (2005) reported that CP contents in raw and extracted moringa leaves are 47% and 64% higher, respectively, than those of common forages and grasses consumed by livestock. As is evident from these reports that moringa leaves are a rich protein source (Thurber and Fahey, 2009), they can be used by physicians, nutritionists, and members of the health community to solve the malnutrition problem, especially in Third World and developing countries. Moreover, this statement seems reasonable in light of the fact that 1tablespoon of moringa leaf powder contains 9.9-13.6% of the daily CP requirement of children and breast-feeding mothers.

Different mixtures composed by different parts of moringa plants have different nutritional value. It is reported that moringa fodder leaves have higher CP contents (21.87%) than moringa tree leaves (23.51%). Similarly, lower NDF and ADF contents were recorded in moringa fodder leaves, which show better fodder quality. Thus, the mixtures with different proportions of moringa leaves, twigs, or branches have different CP and NDF contents (Aregheore, 2002). The mixture of moringa leaf meal with soft twigs have lower CP and higher NDF contents, while moringa leaves with seed cake have higher CP contents (Fujihara et al., 2005). Depending upon the quality of different moringa fractions, the farmers can decide which animals can utilize these fractions in the best way.

Table 1. Nutritional value of *Moringa oleifera* leaves

Nutrients	Composition (per 100 g)
Water	7.30 g
Protein	21.93 g
Total lipid (fat)	4.78 g
Carbohydrate, by difference	52.10 g
Fiber, total dietary	10.40 g
Calcium, Ca	1246 mg
Iron, Fe	42.46 mg
Magnesium, Mg	694 mg
Phosphorus, P	481 mg
Potassium, K	4466 mg
Sodium, Na	211 mg
Zinc, Zn	4.72 mg
Vitamin C, total ascorbic acid	566.7 mg
Thiamin	1.252 mg
Riboflavin	1.500 mg
Niacin	10.707 mg
Vitamin A, RAE	293 μg
Vitamin A, IU	5850 IU
Total saturated fatty acids	0.115 g
Total monounsaturated fatty acids	2.232 g
Total polyunsaturated fatty acids	0.328 g
Cholesterol	0.00 mg
Energy	279 kcal

It has also been reported that the amino acid profile of moringa leaves meets the standards of the World Health Organization (WHO). Moringa leaves have higher amounts of all amino acids than are required for children, according to FAO reference protein levels (Makkar and Becker, 1996). Methionine and cysteine contents in raw moringa leaves and extracted moringa leaves are 14.14 and 8.36 mg g^{-1} of DMI, respectively, while non fat dry milk and dry whole milk contain 12.41 and 9.03 mg g^{-1} (methionine + cysteine), respectively (Ferreira et al., 2008), which are less than levels in moringa raw and extracted leaves. Moreover, moringa dry leaves and fresh pods are also a good source of amino acids. Arginine, valine, and leucine contents were found higher in moringa dry leaves and fresh pods, while serine, glutamate, aspartate, proline, glycine, and alanine could not be detected in these moringa parts (Fuglie, 2000).

Moringa oleifera, otherwise regarded as a “miracle tree” has been used in the treatment of numerous diseases including heart disease and obesity due to its hypocholesterolemic property (Olugbemi et al., 2010) also reported this quality. *Moringa oleifera* leaves have the calcium equivalent of

4 glasses of milk, 3 times the iron of spinach, 4 times the amount of vitamin A in carrot, and 2 times protein in milk. The leaves of *Moringa* are good source of protein, vitamins A, B and C and minerals such as calcium and iron (Dahot, 1988). The leaves of moringa has high protein content which is between 20-33% on a dry weight basis, the protein is of high quality having significant qualities of all the essential amino acid as reported by Foidl and Paull (2008).

The anti-microbial properties of the *Moringa oleifera* seed extracts may be due to lipophilic compounds. These compounds may attach to the cytoplasmic membrane. He 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 (Jabeen et al., 2008). By epidemiological studies (Chumark et al., 2008) specified that *Moringa oleifera* leaves are a good source of nutrition and display anti-tumor, anti-inflammatory, anti-ulcer, anti-atherosclerotic and anti-convulsant activities. Sreelatha and Padma (2009) observed that both phenolic and flavonoid compound present in moringa leaf affect lipid oxidation potential and fatty acid composition. Antioxidant activity of leaf is also due to higher amount of polyphenols present in leaf. Verma et al. (2009) worked on in vitro and in vivo antioxidant properties of different fractions of *Moringa oleifera* leaves and reported that properties like anti-inflammatory, hepatoprotective and antioxidant were linked to the presence of carotenoids, vitamins, minerals, amino acids, sterols, glycosides, alkaloids, flavanoids and phenolics. Since the leaves being rich in nutrients, so pregnant women and lactating mothers use the powdered leaves to enhance their children's nourishment, principally in under developed countries where malnutrition is common (Sudha et al., 2010). *Moringa oleifera* leaves abound in vital nutritional minerals namely magnesium, copper, vanadium, chlorine, aluminum, manganese, calcium, sodium, potassium and devoid of potential toxic elements such as mercury, cadmium, and arsenic (Donkor et al., 2013).

Moringa as Fodder and Additives for Livestock and Poultry Feeding

Various research reports and reviews have highlighted the importance of trees and shrubs being used as livestock fodder or in supplementing the low-value fodders or rations in the dry season. As mentioned previously, the moringa leaves, fresh pods, seeds, and roots are being widely and increasingly used by humans and animals because of their higher contents of essential nutrients. Moringa trees are used for diverse purposes because they are easy to maintain once their roots have developed and established (moringa trees have a deep tap root system when they are grown from seeds, and an adventitious root system when they are grown from stem cuttings). Its roots penetrate deep into soil to search for water and nutrients, which enables moringa trees to tolerate severe conditions. Aside from the features of its root system, this species has a fast growing habit, a low requirement of maintenance in late stages, reduced necessity of fertilizers and irrigation, and a high capacity to re-sprout after harvesting. Relatively low requirements for irrigation makes moringa superior to some other livestock meals like soybean, cotton seed cake, and range grasses, which require relatively high irrigation to avoid reduced livestock production (Benavides, 1994). Soybean, for instance, requires intensive irrigation, which makes it too difficult to cultivate for small livestock farmers.

Du et al. (2007) worked on the effect of dietary supplementation of *Moringa oleifera* on growth performance, blood characteristics and immune response in broilers and they observed that no significant depression in growth performance of 3 weeks old broilers that were fed on diets substituted with 0.5, 1.0, 2.0 and 3.0% levels of *M. oleifera* leaf meal. However, Kakengi et al. (2007) worked on the effect of *Moringa oleifera* leaf meal as a substitute for sunflower seed meal on performance of laying hens and he declared that addition of 10% and 20% *Moringa oleifera* leaf meal to the laying hen diet, as a substitute for sunflower seed meal, significantly increased 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 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.

Atuahene et al. (2008) worked on preliminary study of the effect of feeding *Moringa Oleifera* leaf meal as a feed ingredient on the growth performance of broiler chickens and found no significant effect of diets containing moringa leaf meal at 0%, 2.5%, 5%, and 7.5% levels on feed intake of broiler chickens. Moreover, Otuma and Onu (2008) found that there is decrease in weight gain of birds fed with higher concentration of MOLM as compared to lower concentration despite the higher crude protein content may be due to higher crude fibre content which may impair nutrient digestion and absorption. Juniar et al. (2008) worked on the effect of *Moringa oleifera* leaf meal in feed on broiler production performance and reported that the inclusion of *Moringa oleifera* leaf meal at amounts up to 10% did not produce significant effects on feed consumption, body weight, feed conversion ratio, carcass weight, production efficiency factor, and income over feed cost.

Olugbemi et al. (2010) observed the reduction in performance of broiler at inclusion level of MOLM beyond 5% in feed, the final weight; FCR and ADG on the other hand were not significantly

affected. However, in another study Olegbemi et al. (2010) worked on the effect of *Moringa oleifera* inclusion in cassava based diets fed to broiler chickens and found that feed intake, feed conversion ratio and laying percentage, yolk colour were not influenced by the inclusion of MOLM except for general acceptability at the rate of 10% MOLM. Moreover, Olugbemi et al. (2010) worked on the effect of MOLM inclusion in cassava based diets fed to broiler chickens and he found that increasing inclusion level of leaf meals in broiler diets results in depressed body weight gain and FCR. He also worked on evaluation of *Moringa oleifera* leaf meal inclusion in cassava chip based diets fed to laying birds and observed that the 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.

Banjo (2012) revealed that the effect of *Moringa oleifera* leaf meal used was pronounced in the weight gain of the birds and it is also concluded that broilers can tolerate *Moringa oleifera* leaf meal up to 3% birds of inclusion without adverse effect on their growth. He also found that the inclusion of various levels of *Moringa oleifera* did not significantly enhance feed intake and feed conversion. The feed conversion ratio of the birds was significantly improved in all the treatments, while the diets produced no significant impact on the protein efficiency ratio of the broiler birds. Moreover, Gadzirayi et al. (2012) worked on the performance of broiler chickens fed on mature *Moringa oleifera* leaf meal as a protein supplement to soyabean meal and he reported that included MOLM at 20% as protein supplement in broiler diets and discovered that the birds had similar weight with those fed the conventional commercial feed. However, Melesse (2012) worked on the feeding value of deseeded pods from *Moringa stenopetala* and *Moringa oleifera* as evaluated by chemical analyses and in vitro gas production studied its performance on the layer chicks and reported that there was significant ($P<0.05$) increase in feed and crude protein intake, average weight gain, feed efficiency and protein efficiency when compared to a control diet. He also reported that deseeded pods of *Moringa oleifera* tree could be used as an alternative, cheap source of home grown energy supplements for low quality crop residues of tropical livestock while using the seeds for human consumption.

Tesfaye et al. (2013) worked on MOLM as an alternative protein feed ingredient in broiler ration and found that there was significantly increase in feed intake, organs weight, weight gain, FCR organs weight, intestine length with supplemented groups as compared to the control group when they used *Moringa oleifera* leaf meal supplementation in broilers diet. Donkor et al. (2013) worked on the estimating the nutritional value of the leaves of *Moringa oleifera* on poultry and he found that the feeding of poultry with maize meal formulated with *Moringa oleifera* leaf powder can lead to increase in body weight, bright coloration of their combs, wattles, beaks and legs as well as general increase in activity of the birds. However, Akhouri et al. (2013) worked on *Moringa oleifera* leaf extract imposes better feed utilization in broiler chicks and reported that supplementation of *Moringa oleifera* leaf extract in the diet of broiler can be usefully used as an effective feed supplement for its supporting results in relation to feed conversion efficiency and body weight gain in the broilers. It is able to use potentially earlier than mass immunization of the broilers for immunomodulators property like levamisole.

Safa (2014) worked on the effect of feeding different levels of *Moringa oleifera* leaf meal on the performance and carcass quality of broiler chicks and he found that treatment effect on average final body weight, body weight gain, total feed intake, feed conversion ratio were significant. Birds fed on MOLM gained significantly higher weight and superior feed conversion ratio than birds fed the control diet. However, birds fed on (5% MOLM) diet showed heaviest body weight, highest total feed intake with the best feed conversion ratio. However, Nkukwana et al. (2014) worked on the effect of *Moringa oleifera* leaf meal on growth performance, apparent digestibility, digestive organ size and carcass yield in broiler chickens and observed that the effect of *Moringa oleifera* leaf supplementation on productive performance, intestinal integrity, digestive organ size, digestibility, bone breaking strength and bone ash content, as well as meat yield of broiler chickens throughout the production period. However, Divya et al. (2014) worked on the effect of dietary *Moringa oleifera* leaves powder on growth performance, blood chemistry, meat quality and gut microflora of broiler chicks and found that the addition of MOL powder at any level slightly decrease BW and feed intake on 21 and 42 d of age as compared to control, although the decrease was not significant. No significant difference was observed for FCR of the broiler chickens during the experiment. From finding of result he suggested that MOL powder could be a potential growth promoter for broiler. Khan et al. (2015) worked on the effect of *Moringa oleifera* leaf supplementation on intestine morphology and growth performance in broiler chickens and observed that the addition of *Moringa oleifera* leaf meal in the diet of the broilers significantly enhanced their weight gain as compared to the control group.

Hence, moringa leaves fulfill the dietary and nutritional requirements of livestock animals. Moreover, the mixing of moringa leaves with other fodders or grasses can also contribute towards better livestock performance and high yield of good quality products. It can safely be suggested here that moringa leaves are useful supplements for livestock that not only increase the output of products, but also their quality. In dry months, when no other fodder is available and the fodder quality is diminished due to harsh and severe climatic conditions, moringa leaves can be used as a substitute for commercial rations.

Conclusions

Moringa plant may be a good alternative for substituting commercial rations for livestock's, poultry and aquaculture operations. Its high nutritional quality and better biomass production, especially in dry periods, support its significance in livestock and poultry diet. However, it has several growth promoting essential nutrients, make it a good source of herbal additives for non-ruminant species as well as healthy meat production for human consumption. So, attention should be given for its incorporation in the diet of livestock and poultry production.

References

Akhouri S, Prasad A, Ganguly S (2013) *Moringa oleifera* leaf extract imposes better feed utilization in broiler chicks. J Biol Chem Res 30(2):447-450

Aregheore EM (2002) Intake and digestibility of *Moringa oleifera*-batiki grass mixtures by growing goats. Small Rumin Res 46:23-28

Atuahene CC, Attoh-Kotoku V, Fosu KD, Amissah SE, Sarfo FK, Mensah JJ (2008) Preliminary study of the effect of feeding *Moringa Oleifera* leaf meal as a feed ingredient on the growth performance of broiler chickens. *Proceedings of the 28th and 29th Ghana Animal Science Association* held at the University of Education, Winneba, Mmpong Campus 72-75

Banjo O (2012) Growth and Performance as affected by inclusion of *Moringa oleifera* leaf meal in Broiler chicks diet. J Biol Agric Hlthcare 2:35-38

Benavides J (1994) La investigación en árboles forrajeros. Árbolesy arbustos forrajeros de América Central (CATIE), Turrialba, Costa Rica.

Chandan RC (2006) History and consumption trends. In: Manufacturing Yogurt and Fermented Milks (Ed. Chandan RC). Blackwell Publishing, Ames, IA, USA, pp. 3-15

Chumark P, Khunawat P, Sanvarinda Y, Phornchira-silp S, Morales NP, Phivthong-Ngam L, Ratanacham-nong P, Srisawat S, Pongrapeeporn KU (2008) The *in Vitro* and *in Vivo* antioxidant properties, hypolipidaemic and antiatherosclerotic activities of water extract of *Moringa oleifera* Lam. Leaves. J Ethnoph 116(3):439-446

D'Mello JFP, Devendra C (1995) Tropical legumes in animal nutrition. CAB International, Wallingford, U.K.

Dahot MU (1988) Vitamin contents of flowers and seeds of *Moringa oleifera*. Biochemistry, 2122-2124

Divya, Mandal AB, Biswas A, Yadav AS, Biswas AK (2014) Effect of dietry *Moringa oleifera* leaves powder on growth performance, blood chemistry, meat quality and gut microflora of broiler chicks. Ani Nutri Feed Tech 14:349-357

Donkor AM, Glover RLK, Addae D, Kubi KA (2013) Estimating the nutritional value of the leaves of *Moringa oleifera* on poultry. Food Nutri Sci 4:1077-1083

Du PL, Lin PH, Yang RY, Hsu JC (2007) Effect of dietary supplementation of *Moringa oleifera* on growth performance, blood characteristics and immune response in broilers. J Chinese Soc Anim Sci 36(3):135-146

Ferreira PMP, Davi FF, Jose TAO, Ana FUC (2008) *Moringa oleifera*: bioactive compounds and nutritional potential. Rev Nutr 21:431-437

Foidl N, Paull R (2008) *Moringa oleifera* In: The Encyclopedia of Fruit and Nuts CABI, Oxfordshine, UK, pp. 509-512

Fuglie LJ (2000) The Miracle Tree: *Moringa oleifera*: Natural nutrition for the tropics. The multiple attributes of Moringa. Pp. 172

Fujihara T, Kakengi A, Shem M, Sarwatt S (2005) Can *Moringa oleifera* be used as a protein supplement for ruminants. Asian-Aus J Anim Sci 18:42

Gadzirayi CT, Masamha B, Mupangwa JF, Washaya S (2012) Performance of broiler chickens fed on mature *Moringa oleifera* leaf meal as a protein supplement to soyabean meal. Int J Poult Sci 11(1):5-10

Jabeen R, Shahid M, Jamil A, Ashraf M (2008) Microscopic evaluation of the antimicrobial activity of seed extracts of *Moringa oleifera*. Pak J Bot 40:1349-1358

Juniar I, Widodo E, Sjofjan O (2008) Effect of *Moringa oleifera* leaf meal in feed on broiler production performance. *J Ilm Peter Braw,* 18:238-242

Kakengi A, Kaijage J, Sarwatt S, Mutayoba S, Shem M, Fujihara T (2007) Effect of *Moringa oleifera* leaf meal as a substitute for sunflower seed meal on performance of laying hens in Tanzania. Livest Res Rural Develop 19:120

Khan I, Zaneb H, Masood S, Faseeh H, Rehman UR, Shah M, Abbas G, Din S, Yasir H, Yousaf MS and Shaheen K (2015) Effect of *Moringa oleifera* leaf supplementation on intestine morphology and growth performance in broiler chickens. Scholar's Adv Anim Vet Res 2(1):25-31

Makkar HPS, Becker K (1996) Nutritional value and nutritional components of whole and extracted *Moringa oleifera* leaves. Ani Feed Sci Tech 63:211-228

Mathur B (2006) Moringa for cattle fodder and plant growth. Trees Life J http://www.tfljournal.org/staticpages/index.php.

Melesse A, Tiruneh W, Negesse T (2012) Effects of feeding *Moringa stenopetala* leaf meal on nutrient intake and growth performance of Rhode Island Red chicks under tropical climate. Trop Subtrop Agroeco 14:485-492

Mendieta AB, Sporndly R, Sanchez NR, Sporndly E (2011) Moringa (*Moringa oleifera*) leaf meal as a source of protein in locally produced concentrates for dairy cows fed low protein diets in tropical areas. Livestock Sci 137:10-17

Nkukwana T, Muchenje V, Pieterse E, Masika P, Mabusela T, Hoffman L, Dzama K (2014) Effect of *Moringa oleifera* leaf meal on growth performance, apparent digestibility, digestive organ size and carcass yield in broiler chickens. Livestock Sci 161:139-146

Olugbemi TS, Mutayoba SK, Lekule FP (2010) Evaluation of *Moringa oleifera* leaf meal inclusion in cassava chip base diets fed to laying birds available at http://www.lrdd.org/lrrd 22/6/olu-of 221184m.

Otuma MO, Onu PN (2008) Utilization of heat-treated sheep dropping in the diets of broiler finisher chicks. Inter J Poult Sci 8(10):995-998

Safa MAELT (2014) Effect of feeding different levels of *Moringa oleifera* leaf meal on the performance and carcass quality of broiler chicks. Int J Sci Res 2319-7064

Sanchez NR, Stig L, Inger L (2006) Biomass production and chemical composition of *Moringa oleifera* under different management regimes in Nicaragua. Agrofores Sys 66:231-242

Soliva CR, Kreuzer M, Foidl N, Foidl G, Machmuller A, Hess HD (2005) Feeding value of whole and extracted *Moringa oleifera* leaves for ruminants and their effects on ruminal fermentation in vitro. Anim Feed Sci Technol 118:47-62

Sreelatha S, Padma PR (2009) Antioxidant activity and total content of *Moringa oleifera* leaves in two stages of maturity. Plant Foods Human Nutri 64:303-311

Sudha P, Asdaq SM, Dhamingi SS, Chandrakala GK (2010) Immuno-modulatory activity of methanolic leaf extract of *Moringa oleifera* in animals. Indian J Physio Pharm 54(2):133-140

Tesfaye E, Animut G, Urge M, Dessie T (2013) *Moringa olifera* leaf meal as an alternative protein feed ingredient in broiler ration. Int J Poult Sci 12:289-297

Thurber MD, Fahey JW (2009) Adoption of *Moringa oleifera* to combat under-nutrition viewed through the lens of the diffusion of innovations theory. Ecol Food Nutr 48:212-225

Verma AR, Vijayakumar M, Mathela CS, Rao CV (2009) *In vitro* and *in vivo* antioxidant properties of different fractions of *Moringa oleifera* leaves. Food Chem Toxicol 47:2196-2201