Dietary influence of *Moringa oleifera* leaf meal on performance traits in Rhode Island Red laying hens

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Abstract

The present investigation was carried out to study the influence of *Moringa oleifera* leaf meal (MOLM) on performance traits, nutrient utilization and cost of economy of Rhode Island Red (RIR) layers. One hundred and eighty, 24-week-old Rhode Island Red layer birds were randomly allotted to four dietary treatments with 15 birds in each treatment. The treatments were T_1 (Control: Basal diet); T_2: 1% MOLM in basal diet; T_3: 3% MOLM in basal diet; T_4: 5% MOLM in basal diet. The results revealed that average daily feed intake per bird (g/day) was lower ($P<0.05$) for hens supplemented with MOLM. No statistical difference for feed conversion ratio (FCR) was noticed between groups. The average hen day egg production (HDEP) % and hen house egg production (HHEP) % of experiment were significantly ($P<0.05$) higher in T_3 and T_4 groups as compared to T_1. Addition of MOLM at different level in diet for Rhode Island Red hens had non-significant ($P>0.05$) effect on nutrients digestibility. The current study found that while the addition of MOLM did not affect the overall feed intake per bird, but total feed cost per bird was significantly lower in the MOLM-fed groups. Furthermore, MOLM fed groups that laid more eggs generate higher receipt from egg sales and a higher net return on feed cost. Feeding *Moringa oleifera* leaf meal to birds improved their production performance, and cost of economy without adverse effects on nutrient utilization.

Key words: Economy, Egg, Moringa leaf meal, Rhode Island Red

Introduction

Poultry industry is crucial for social and economic security in both advanced and developing countries since it is a major source of the greatest quality animal protein. By lowering manufacturing and marketing costs, the development of vertically integrated chicken organizations has decreased consumer prices. The accessibility of ingredients and the growing cost of feed are two major factors that tend to limit the growth of the poultry industry. The difficulty facing the poultry production industries in developed nations is the 60–70% increase in feed costs (Tesfaye *et al.,* 2018). An urgent necessity to conduct a thorough investigation into the use of the affordable and good-quality alternative feed sources from native plant origin is developed due to the ongoing rise in the demand for raw feed ingredients that would satisfy the requirements of animal, farmers, less expensive, locally accessible and less competitive substitutes for particular elements in poultry feed, mainly protein sources (Gadzirayi *et al.,* 2012; Vaghamashi *et al*., 2025). Addition of antibiotic growth promoters to feed, which increased feed productivity, efficiency and financial gain, has been eliminated from poultry feed (Fallah *et al.,* 2013).

Alternative locally accessible and inexpensive non-traditional feed resources, such as leguminous tree leaves, are more and more being used as alternatives to conventional means in the computation of poultry diets as a result of the current situation of escalating feed resource prices. Phytobiotics, which Getahun *et al.* (2025) define as plant-derived compounds added to feed to increase farm animal performance, are one such option. The greatest alternative protein source in this situation might be *Moringa oleifera* leaves. Because *Moringa oleifera* leaves are so nutrient-dense, supplementing livestock feed with them may be advantageous. Among the vital elements found in *Moringa oleifera* leaves, protein, beta-carotene, vitamin K, vitamin B complexes, vitamin C and manganese are the most nutrient-dense components (Leone *et al.,* 2015). Despite *Moringa oleifera*'s high nutritional content, there is less information available regarding the impact of adding *Moringa oleifera* leaf meal (MOLM) on performance of layer birds. Therefore, the present study was undertaken to evaluate the effects of dietary supplementation of Moringa oleifera leaf meal at different levels on production performance, nutrient utilization and economics of Rhode Island Red laying hens.

Materials and methods

Location of experiment

The study was carried out at Livestock Farm Complex, College of Veterinary Science & Animal Husbandry, Kamdhenu University, Junagadh, in collaboration with, Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, Kamdhenu University, Junagadh. It is located in Junagadh, Gujarat (latitude 21°29' N, longitude 70°26' E and altitude 60 meters above the mean sea level). The climate in Junagadh is tropical and arid.

Experimental birds

The experiment was carried out on 180 RIR laying hens at Livestock Farm Complex (LFC), College of Veterinary Science & A.H., Kamdhenu University, Junagadh. A total of one hundred eighty, RIR laying hens at the age of 24th weeks were equally distributed into four dietary treatments. There were 45 hens in each dietary treatments taking three replicates of fifteen birds in each treatment. Completely randomized design (CRD) with three replications was applied in carrying out the investigation. The study was permitted by Institutional Animal Ethics Committee (IAEC) under sanction letter-number KU-JVC-IAEC-SA-96-2022 as per article 13 of CPSCEA rules enacted by the Government of India. Throughout the study, animal welfare was given full consideration.

Standard cage system was used for housing experimental birds. Light bulbs were arranged for the lighting to increase the lighting duration to 16 h per day in order to increase feed intake and production. Standard vaccination schedule was followed. Strict and thorough sanitary measures were adopted.

Experimental feed formulation

Moringa oleifera leaf meal were procured from local market and the procurement cost of MOLM was ₹75 per kg. Four experimental diets were prepared with MOLM as T_1 (Control: Basal diet); T_2: 1% MOLM in basal diet; T_3: 3% MOLM in basal diet; T_4: 5% MOLM in basal diet (Table 1). Feed was given ad libitum in known quantity bis in die at 9:00 AM and 5:00 PM. Fresh and clean, drinking water was provided to all experimental birds ad libitum. Representative samples of feeds and droppings were analyzed for proximate composition by standard methods of AOAC (2023).

Parameters/observations studied

Feed consumption of each replicate was recorded daily. In order to calculate weekly/daily feed intake (g), the variance between the quantity of feed offered and the quantity left over was calculated for each bird. Feed conversion ratio was determined weekly as a unit feed consumed per unit egg weight (Abou-Elezz et al., 2011).

$$\text{FCR} = \frac{\text{Feed intake per week (g)}}{\text{Avg.egg wt.per week (g) X No.of egg laid per week}}$$

Two times a day, at 9:00 and 17:00, eggs were collected. At the end of the period, the total of the two collections and the number of birds alive every day were noted and compiled. The following formula was used to calculate the percentages of hen-day egg production (HDEP) and hen-housed egg production (HHEP).

$$\%\text{HDEP} = \frac{\text{Total no.of eggs produced}}{\text{Total no.of hens present on that day}} \text{ X } 100$$

$$\%\text{HHEP} = \frac{\text{Total no.of eggs produced}}{\text{Number of hens originally housed}} \text{ X } 100$$

Every week after being collected, the eggs were weighed, and the mean weight was determined by dividing the combined weight by the total number of eggs.

For nutrient digestibility/metabolizability, a metabolism trial was carried out at the end of experiment. The corresponding treatment diets were fed to each bird separately. To ascertain the nutrient utilization, data on the amount of feed provided, leftover and excreta void was recorded during the collection time. Every 24 hours at 8:00 AM, the amount of excreta that each bird voids was gathered and weighed. For the purpose of estimating nitrogen, a quarter of the excreta was kept in a measured amount of concentrated sulfuric acid. The dry matter content of the remaining excreta was calculated. The resulting dry material was then combined, crushed and stored for further analysis. Following a five-day collection period, the dried samples were combined, powdered to filter through a 2.0 mm sieve and then kept at room temperature in airtight glass bottles for further analysis. Similarly, feed samples were provided and leftover residue from each bird at the end of metabolic trial were stored and analyzed. Kjeldahl's method AOAC (2023) was used to determine the amount of nitrogen from feed, leftovers and acid-excreta.

Economics of egg production was calculated according to prevailing market rate of feeds, supplements and eggs. The return over feed cost, which is the difference among the feed expenses per bird during the trial period and the sale of eggs, was computed to determine the profitability of feeding MOLM. For calculation of economics of feeding in present study, institutional and purchase prices of feed (₹ 33.06, 33.15, 33.06 and 32.58 per kg in the T_1, T_2, T_3 and T_4 groups, respectively) and selling price of egg (₹ 6.00/egg) was considered, while for supplements market price of MOLM (₹ 75/kg); was taken into consideration.

Statistical analysis

The data generated during the experiment were collected and statistically analyzed by Chi-square test for frequency data and analysis of variance (ANOVA) for comparison of mean as per procedures suggested by Snedecor and Cochran (1994). Pairwise differences in group means were compared using the Tukey test.

Table 1: Ingredient and nutrient composition of the experimental diets

Ingredients (%)	T_1	T_2	T_3	T_4
Ingredient composition (% DM basis)				
Maize	53.4	53.4	50.0	45.0
Soyabean DOC	27.7	26.7	24.7	22.7
Deoiled Rice Bran	6.41	6.41	9.81	14.8
Moringa oleifera leaf meal (MOLM)	0	1.0	3.0	5.0
Calcite Powder	3.0	3.0	3.0	3.0
Limestone	6.9	6.9	6.9	6.9
DCP	1.63	1.63	1.63	1.63
Salt	0.3	0.3	0.3	0.3
Premix (Vitamins, Enzymes etc.)	0.66	0.66	0.66	0.66
Total %	100	100	100	100
Calculated nutrient composition				
ME (Kcal/kg)	2613	2616	2622	2629
Dry matter %	89.5	89.3	89.3	89.8
Organic matter %	93.0	93.0	92.9	92.8
Crude protein %	18.0	18.4	18.6	18.3
Crude fibre %	8.17	8.01	7.92	7.94
Ether extract %	3.45	3.51	3.67	3.8
Nitrogen-free extract %	63.4	63.0	62.6	62.7
Total Ash %	6.92	6.95	7.1	7.2
Silica %	1.11	1.22	1.16	1.19
Calcium %	3.05	3.21	3.28	3.36
Phosphorus %	0.38	0.39	0.39	0.4

Results and discussion

Production performance

Results of productive performance as affected by MOLM addition are outlined in Table 2. From the present results, it is observed that the overall means of daily feed intake per experimental bird were 116.16± 0.44, 114.2± 0.36, 112.88± 0.55 and 111.3± 0.85 g in T_1, T_2, T_3 and T_4 groups, respectively.

In the current study, it was found that overall average feed intake per bird (g/day) was higher ($P<0.05$) for hens in T_1 than hens in T_2, T_3 and T_4. Hens in T_2 had higher ($P<0.05$) average feed intake per bird (g/day) than hens in T_4, however, T_3 did not significantly differ ($P>0.05$) with T_2 and T_4.

In the current study, no statistical difference was observed for FCR between groups or within group. Overall average FCR was lowest for hens in T_2. But, there was no statistical differences ($P>0.05$) among the groups.

Values of average monthly hen day egg production (HDEP) % were significantly ($P<0.05$) more in T_3 and T_4 groups as compared to T_1 group and numerically higher than T_2 group. Average values of monthly HHEP% were gradually increased from T_1 to T_4 and have significantly higher values in T_3 and T_4 as compared to control. The T_3 was non-significant different from T_2 and T_4. T_4 also showed significantly higher value than T_2. In the present investigation, an increase in laying percentages with advancement of age was noted in all dietary treatments.

In the present study, average daily feed intake per bird (g/day) was lower ($P<0.05$) for hens supplemented with MOLM. No statistical difference for feed conversion ratio (FCR) was witnessed between groups. The average HDEP % and HHEP % of experiment were significantly ($P<0.05$) higher in T_3 and T_4 groups as compared to $T_{1.}$ Improved balanced nutritional supply provided by MOLM in the diet may be the cause of the greater egg production in layers given the diet containing MOLM. Lysine, methionine, and a variety of other amino acids are present in MOLM, which may provide the necessary quantity of nutrients for improved production. . This was similar to the findings of Raphael *et al.* (2015) noted that addition of 5% and 10% MOLM to the laying hen diet reduced feed consumption. They attributed the significant decline in feed intake with increasing amount of leaf meal due to its high fibre content as well bitter taste. Rajesh *et al.* (2022) noted that addition of 5% MOLM to the laying hen diet had non-significant effect on feed conversion ratio. There are reports that MOLM tends to increase egg production in layer birds (Ebenebe *et al.*, 2013; Raphael *et al.,* 2015).

Contrary to the present study, Sharmin *et al.* (2021) observed that average daily feed consumption of laying hens fed diets containing 1.5% MOLM was significantly higher than that of the hens fed diet with 0%, 0.5% and 1% MOLM. Shen *et al.* (2021) showed a significant reduction on laying % of hens that fed a diet having MOLM at 2.5, 5, 7.5 and 10% of the diet. Abu and Akangbe (2017) also found that addition of 0, 1 and 5% MOLM Japanese quails' diet had no significant effect on HDEP % when compared to a diet free of MOLM.

Nutrients digestibility/metabolizability

Results for average nutrients digestibility/metabolizability (%) by birds fed experimental diet during metabolism trial are shown in Table 3 and indicated that addition of MOLM at different levels in diet of Rhode Island Red hens had no significant ($P>0.05$) effect on nutrients digestibility.

Table 2: Effects of dietary treatment on production parameters of RIR laying hen

Parameter	T_1	T_2	T_3	T_4	SEM	P-value
Feed Intake, g/day	116± 0.44^{A}	114± 0.36^{B}	112± 0.55^{BC}	111± 0.85^{C}	3.10	0.001
Feed conversion ratio	2.94±0.03	2.86±0.03	2.93±0.01	2.91±0.05	0.25	0.96
Hen-day egg production %	69.08±1.88^{B}	73.76±1.50^{AB}	75.67±1.71^{A}	79.17±1.15^{A}	4.97	0.002
Hen-housed egg production %	65.96±2.11^{C}	72.13±1.79^{BC}	74.44±1.91^{AB}	78.74±1.28^{A}	5.83	0.003

Means with different superscripts within the same row are significantly different ($P<0.05$).

Table 3: Effects of feeding various concentration of MOLM on nutrients digestibility/metabolizability (%) of Rhode Island Red hens

Parameters	T_1	T_2	T_3	T_4	SEM	P-value
Organic matter	76.97 ±1.70	76.41 ±1.30	76.31 ±0.40	75.03 ±2.13	2.64	0.83
Dry matter	68.99 ±2.36	65.8 ±1.79	67.03 ±1.43	66.12 ±2.95	3.83	0.74
Ether extract	85.18 ±2.09	89.69 ±0.86	92.10 ±0.57	90.67 ±3.77	3.84	0.22
Crude fibre	31.04 ±2.08	29.12 ±1.51	29.62 ±1.61	29.89 ±1.23	2.84	0.86
Nitrogen free extract	88.44 ±1.99	87.43 ±1.14	86.34 ±1.22	84.73 ±1.23	2.97	0.50
Metabolizable Nitrogen (g/d)	1.54 ±0.30	1.76 ±0.25	1.87 ±0.19	1.50 ±0.27	0.16	0.75

In spite of the lower feed intake of the MOLM fed birds, MOLM addition in diet of Rhode Island Red hens had non-significant (P>0.05) effect on nutrients digestibility. Ether extract digestibility and metabolizable nitrogen were numerically higher in MOLM supplemented groups than control. Likewise, crude fibre and nitrogen free extract digestibility were numerically lower in MOLM supplemented groups than control. But statistically non-significant effect of MOLM supplementation was observed on nutrient digestibility at all levels.

Findings in the present study was in line with Gakuya *et al.* (2014), who reported similar results on response to 0, 7.5, 15 and 30% levels of MOLM in diets in broiler chickens. However, birds fed diet containing 30% MOLM had significantly (P>0.05) lesser dry matter digestibility. Siti *et al.* (2019) observed that administering 4-6% of the powdered *Moringa oleifera* leaves to laying hens enhanced the digestibility of both dry matter and organic matter.

Economic analysis

The expenditure of feeding birds was determined using information on the amount of feed consumed and average price of the ingredients used during the experiment. To calculate the net return over feed cost, the total feed cost was subtracted from the actual income earned from the sale of eggs. Table 4 present detailed information on economics of feeding MOLM to the experimental Rhode Island Red hens during experiment. T_1 had significantly higher total feed cost per bird than T_4. Whereas, T_2 and T_3 had non-significant difference with T_1 and T_4 in total feed cost per bird. Higher number of total egg production per bird was recorded in T_4 and lowest in T_1. Total egg production per bird was linearly increased with level of MOLM (P>0.05). Similarly, receipt obtained from egg sale was higher (P<0.05) for T_4 and lowest for T_1.

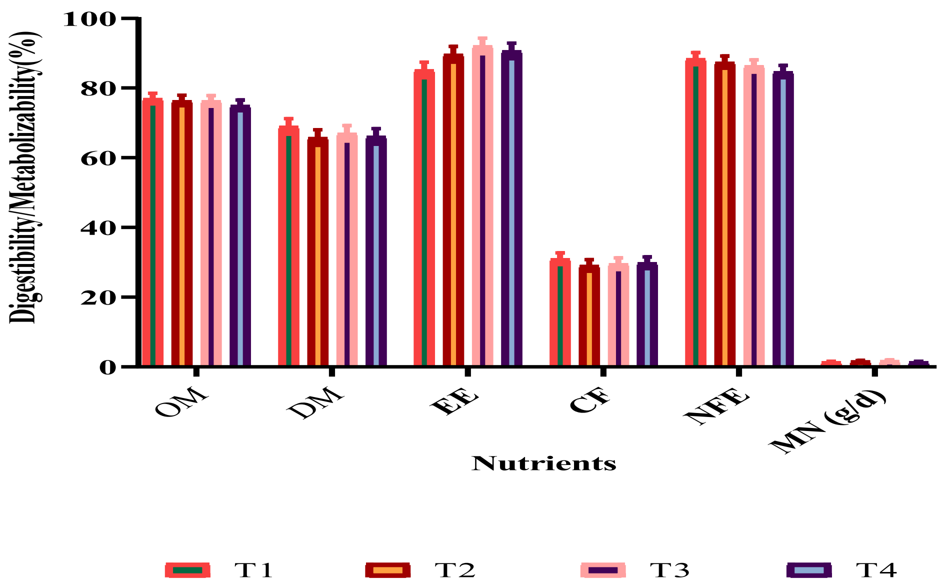

Fig. 1: Effects of feeding various concentartion of MOLM on nutrients digestibility/metabolizability (%)

Table 4: Comparative economics of feeding MOLM to Rhode Island Red hens during the experimental period

Particulars		T_1	T_2	T_3	T_4	SEM	P-value
Total feed intake (kg/bird)		13.8±0.14	13.5±0.07	13.4±0.09	13.2±0.17	0.22	0.06
Feed cost (₹/kg)		33	33.1	33	32.8	-	-
Total feed cost per bird (₹)		457±4.90^{A}	450±2.32^{AB}	444±3.16^{AB}	435±5.74^{B}	7.36	0.03
Total egg production (per bird)		81.1±0.96	83.0±1.12	87.9±6.69	91.2±1.50	6.07	0.23
Receipt from sale of egg (₹/bird) (@₹6/egg)		486±5.8	498±6.74	527±40.1	547±9.0	34.46	0.23
Net return over feed cost per bird (₹)		29.6±2.56^{C}	47.6±4.46^{C}	83.7±1.22^{B}	112±7.34^{A}	7.90	0.0001
Net return over control	(₹/bird)		17.9±2.21^{C}	54.1±3.63^{B}	82.8±7.50^{A}	8.62	0.0001
	(%)		60.7	182	279	-	-

Means bearing different superscripts in a row differ significantly (P<0.05).

In the present study, the addition of MOLM in the feed produced significant effect on cost of economics. Net return over control was also determined by taking T1 as reference point. Net return over control was higher for T_4 and lowest for T_3 followed by T_2 when compared with T_1. At the end, T_2, T_3 and T_4 obtained additional income of 17.9, 54.1 and 82.8 ₹ per bird, respectively. Thuy and Ha (2022) and Swain *et al.* (2017) also obtained lowest feed cost for unit egg production and higher egg mass production with *Moringa oleifera* leaves inclusion in the diets. Controversially, Paguia *et al.* (2014) and Tesfaye *et al.* (2018) observed that inclusion of *Moringa oleifera* leaves in the layer ration significantly raised feed cost/kg of generated eggs (P>0.01) without change in return over feed cost.

Conclusion

Based on the results of the current study, it can be concluded that addition of *Moringa oleifera* leaf meal in the diet of Rhode Island Red laying hens improved production performance and laid more eggs generate higher receipt from egg sales and a higher net return on feed cost. Feeding *Moringa oleifera* leaf meal to birds improved cost of economy without adverse effects on nutrient utilization.

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