

Comparative Economics of *Moringa oleifera* Leaf Meal Feeding in Rhode Island Red Laying Chicken

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Abstract

An experiment was conducted to evaluate the effect of Moringa oleifera leaf meal (MOLM) on feed intake, feed conversion ratio (FCR), egg production and economics in Rhode Island Red (RIR) layers. One hundred and eighty (180) 24-week-old, Rhode Island Red layer birds were randomly distributed into 4 groups with 3 replicates of 15 birds in each replicate. T1 (Control: Basal diet), T2 (1% MOLM in basal diet), T3 (3% MOLM in basal diet), and T4 (5% MOLM in basal diet) were the treatments. The findings showed that hens supplemented with MOLM had a lower average daily feed intake per bird (g/day) ($P < 0.05$). The FCR did not differ statistically across the groups. In comparison to T1, the average hen day egg production (HDEP) and hen house egg production (HHEP) % of the experiment were significantly ($P < 0.05$) higher in T3 and T4 groups. The current study discovered that whereas the total feed cost per bird was much lower in the MOLM-fed groups, the addition of MOLM had no effect on the overall feed intake per bird. Additionally, MOLM fed groups that laid more eggs have greater net returns on feed costs and higher receipts from egg sales. Without having a negative impact, feeding birds Moringa oleifera leaf meal increased their productivity and cost-effectiveness.

Keywords: Economy, Egg, Moringa leaf meal, Rhode Island Red.

Introduction

Since the poultry industry is a key source of the highest quality animal protein, it is essential for social and economic security in both developed and emerging nations. The availability of ingredients and rising feed costs are two major obstacles that tend to impede the growth of the poultry business. The difficulty facing the poultry production industries in developed nations is a 60–70% increase in feed costs (Tesfaye *et al.*, 2016). The ongoing increase in demand for raw feed materials that would meet the needs of farmers, less expensive, locally accessible and less competitive substitutes for specific elements in poultry feed, particularly protein sources, has created an urgent need to conduct a thorough investigation into the use of the inexpensive and high-quality alternative feed sources from native plant species (Gadzirayi *et al.*, 2012). Poultry feed no longer contains antibiotic growth promoters, which raised feed productivity, efficiency and profit (Fallah *et al.*, 2013).

Leguminous tree leaves and other inexpensive, locally accessible non-conventional feedstuffs are increasingly being used in place of conventional resources in the composition of poultry diets due to the current situation of escalating feed resource prices. Phytobiotics, which Windisch *et al.* (2008) define as plant-derived compounds added to feed to improve farm animals' performance, are one such substitute. *Moringa oleifera* leaves may be the best substitute protein source in this case. Adding *Moringa oleifera* leaves to livestock feed may be beneficial due to their high nutrient content. The main nutrient-dense components of *Moringa oleifera* leaves are protein, vitamin B complexes, vitamin C, beta-carotene, vitamin K, and manganese (Leone *et al.*, 2015). Despite the great nutritional value of *Moringa oleifera*, little is known about how adding *Moringa oleifera* leaf meal (MOLM) affects layer bird performance. It is expected that feeding *Moringa oleifera* leaves to laying hens will improve economic efficiency and productivity.

Materials and Methods

Location of Experiment

In collaboration with the Department of Animal Nutrition, College of Veterinary Science & Animal Husbandry, Kamdhenu University, Junagadh, the experiment was conducted at the Livestock Farm Complex. At latitude 21°29' N, longitude 70°26' E, and elevation 60 meters above mean sea level, it is situated in Junagadh, Gujarat. Junagadh has a dry, tropical climate.

Experimental Birds

At 24 weeks of age, 180 RIR laying hens were divided equally among four dietary treatments. Each dietary treatment included 45 birds with three replicates of 15 birds each. The study was conducted using a completely randomized design (CRD) with three replications. In accordance with article 13 of the CPSCEA regulations established by the Indian government, the Institutional Animal Ethics Committee (IAEC) accepted the study under sanction letter number KU-JVC-IAEC-SA-96-2022. Animal welfare was given careful consideration throughout the entire investigation. The experimental birds were housed in a standard cage arrangement. To boost feed intake and laying, light bulbs were added to the lighting system to extend the lighting duration to 16 hours each day. Standard vaccination schedule was followed. Strict and comprehensive hygienic procedures were implemented.

Experimental Feed Formulation

MOLM was added to four experimental diets: T₁ (Control: Basal diet); T₂: 1% MOLM in basal diet; T₃: 3% MOLM in basal diet; and T₄: 5% MOLM in basal diet (Table 1). Ad libitum feed was provided twice daily at 9:00 AM and 5:00 PM in weighed quantities. At least twice a day, the diets were manually turned and mixed in the feeder. All experimental birds had unlimited access to clean, fresh drinking water. The proximate composition of representative samples of feeds and feces was examined using AOAC standard procedures (2023).

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	45
Soyabean DOC	27.7	26.7	24.7	22.7
Deoiled Rice Bran	6.41	6.41	9.81	14.8
<i>Moringa oleifera</i> leaf meal (MOLM)	0	1	3	5
Calcite Powder	3	3	3	3
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
DM %	89.5	89.3	89.3	89.8
OM %	93	93	92.9	92.8
CP %	18	18.4	18.6	18.3
CF %	8.17	8.01	7.92	7.94
EE %	3.45	3.51	3.67	3.8
NFE %	63.4	63	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

Parameters/Observations Studied

Feed intake of each replicate was recorded daily. In order to compute weekly/daily feed intake (g), the amount of feed ingested each bird was calculated as the difference between the feed offered and leftovers. A unit of feed consumed per unit of egg weight was used to calculate the feed conversion ratio on a weekly basis (Abou-Elezz *et al.*, 2011).

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

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 each day were noted and summarized. The following formula was used to calculate the percentage of hen-day egg production (HDEP) and hen-housed egg production (HHEP).

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

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

Eggs were weighed weekly immediately after collection and average egg weight was computed by dividing the total egg weight to the number of eggs.

The current market prices for feed, supplements and eggs were used to assess the economics of egg production. The return over feed cost was computed as the difference between the feed expenses incurred per bird during the trial period and the selling of eggs in order to determine the profitability of feeding MOLM. The institutional and purchase prices of feed (₹ 33.06, 33.15, 33.06, and 32.58 per kg in the T₁, T₂, T₃ and T₄ groups, respectively) and the selling price of eggs (₹ 6.00/egg) were taken into account when calculating the economics of feeding in this

study. The market price of MOLM (₹ 75/kg) was taken into consideration for supplements.

Statistical Analysis

According to methods recommended by Snedecor and Cochran (1994), the data generated during the experiment were collected and statistically analyzed using the Chi-square test for frequency data and analysis of variance (ANOVA) for mean comparison. The Tukey test was used to assess pairwise mean differences between groups.

Results and Discussion

Production Performance

Findings of productive performance as affected by MOLM addition are presented in Table 2. According to the current findings, the T₁, T₂, T₃ and T₄ groups' average daily feed consumption per experimental bird was 116.16±0.44, 114.2±0.36, 112.88±0.55, and 111.3±0.85 g, respectively.

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	116.16± 0.44 ^A	114.2± 0.36 ^B	112.88± 0.55 ^{BC}	111.3± 0.85 ^C	3.1	0.001
FCR	2.94±0.03	2.86±0.03	2.93±0.01	2.91±0.05	0.25	0.96
HDEP %	69.08±1.88 ^B	73.76±1.50 ^{AB}	75.67±1.71 ^A	79.17±1.15 ^A	4.97	0.002
HHEP %	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 bearing different superscripts in a row differ significantly ($P < 0.05$).

According to the current study, hens in T₁ had a significantly higher total average feed consumption per bird (g/day) than hens in T₂, T₃ and T₄ ($P < 0.05$). The average feed intake per bird (g/day) was higher ($P < 0.05$) in T₂ hens than in T₄ hens, but there was no significant difference ($P > 0.05$) between T₃ and T₂ and T₄ hens. For the T₁, T₂, T₃ and T₄ groups, the overall average FCR was 2.94±0.03, 2.86±0.03, 2.93±0.01 and 2.91±0.05, respectively. There was no statistically significant difference in FCR between or within the groups in the current investigation. Hens in T₂ had the lowest overall average FCR. However, there were no statistically significant differences ($P > 0.05$) between the groups.

The T₁, T₂, T₃ and T₄ groups had average monthly hen day egg production (HDEP) percentages of 69.08±1.88, 73.76±1.50, 75.67±1.71 and 79.17±1.15, respectively. The T₃ and T₄ groups' values were numerically greater than those of the T₂ group and significantly ($P < 0.05$) higher than those of the T₁ group. The T₁, T₂, T₃ and T₄ groups' average monthly HHEP% values were 65.96±2.11, 72.13±1.79, 74.44±1.91, and 78.74±1.28, respectively. From T₁ to T₄, the levels were progressively raised, and in comparison, to the control, T₃ and T₄ had significantly higher values. T₃ did not significantly differ from T₂ and T₄. Additionally, T₄'s value was much higher than T₂'s. In the current study, all dietary regimens showed an increase in laying percentages with age.

In the current study, chickens fed with MOLM had a lower average daily feed intake per bird (g/day) ($P < 0.05$). The feed conversion ratio (FCR) did not differ statistically across the groups. In comparison to T₁, the average HDEP% and HHEP% of the experiment were significantly ($P < 0.05$) higher in the T₃ and T₄ groups. Diet containing MOLM, layers may produce more eggs due to the improved balanced nutritional supply it provides. MOLM contains a number of amino acids, including lysine and methionine, which may supply the amount of nutrients required for increased synthesis. This was similar to the results of Raphael *et al.* (2015), who found that feed intake was decreased when 5% and 10% MOLM were added to the laying hen diet. Because leaf meal has a high fiber content and a bitter taste, they attributed the significant decrease in feed consumption to an increase in leaf meal. According to Olugbemi *et al.* (2010), the feed conversion ratio was unaffected by adding 5% and 10% MOLM to the laying hen diet. According to certain findings, MOLM tends to boost layer birds' egg production (Ebenebe *et al.*, 2013; Raphael *et al.*, 2015).

In contrast to the current study, Sharmin *et al.* (2021) found that laying hens fed diets containing 1.5% MOLM had significantly higher average daily feed consumption than hens fed diets containing 0%, 0.5%, and 1% MOLM. Hens fed a diet containing MOLM at 0, 5 and 10% of the diet had a non-significant impact on laying percentage, according

to Olugbemi *et al.* (2010). When compared to a diet free of MOLM, Abu and Akangbe (2017) also discovered that the addition of 0, 1 and 5% MOLM to the diet of Japanese quails had no significant impact on HDEP%.

Economic Analysis

The amount of feed consumed and the average cost of the ingredients used in the experiment were used to calculate the cost of feeding the birds. The entire cost of feed was deducted from the actual income received from the selling of eggs in order to determine the net return over feed cost. The economics of feeding MOLM to the Rhode Island Red chickens used in the experiment are shown in detail in Table 3. The findings showed a non-significant difference ($P>0.05$) in feed cost per kilogram and total feed intake per bird across all treatments. Compared to T_4 , T_1 's total feed cost per bird was significantly greater. In contrast, the total feed cost per bird for T_2 and T_3 was not significantly different from that of T_1 and T_4 . T_4 had the highest total egg production per bird, whereas T_1 had the lowest. The amount of eggs produced by each bird rose linearly with the MOLM level ($P>0.05$).

Similarly, egg sale receipts were higher ($P<0.05$) for T_4 and lowest for T_1 . All treatment showed a non-significant difference ($P>0.05$). For T_1 , T_2 , T_3 and T_4 , the net return over feed cost was determined to be 29.6 ± 2.56 , 47.6 ± 4.46 , 83.7 ± 1.22 , and 112 ± 7.34 ₹. For all the treatments, there was a non-significant difference ($P>0.05$). Additionally, using T_1 as a reference point allowed for the determination of net return over control. When compared to T_1 , the net return above control was higher for T_4 and lowest for T_3 , followed by T_2 . The cost of economics was significantly impacted in the current investigation by the inclusion of MOLM to the feed. T_1 was used as a reference point to calculate net return over control. When compared to T_1 , the net return above control was higher for T_4 and lowest for T_3 , followed by T_2 . Ultimately T_2 , T_3 , and T_4 obtained an extra 17.9, 54.1, and 82.8 ₹ per bird, respectively.

When *Moringa oleifera* leaves were added to the diets, Thuy and Ha (2022) and Swain *et al.* (2017) also obtained the lowest feed cost for unit egg production and increased egg mass production. According to controversial research by Paguia *et al.* (2014) and Tesfaye *et al.* (2016), adding *Moringa oleifera* leaves to the layer ration significantly increased the feed cost/kg of generated eggs ($P>0.01$) without changing the return over feed cost.

Table 3: 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	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	7.9	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 ($P<0.05$).

Conclusion

Based on the findings of the present study, it can be concluded that inclusion of *Moringa oleifera* leaf meal in the diet of Rhode Island Red laying hens improved their overall productivity and economic returns. The birds fed *Moringa oleifera* leaf meal showed better egg production, along with higher returns from egg sales and net return over feed cost. Overall, the inclusion of *Moringa oleifera* leaf meal showed a positive effect on both production performance and the economic efficiency of Rhode Island Red laying hens

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Contribution by Authors

All the authors contributed equally to writing the manuscript. The final manuscript was read by all authors and consented to publication.

Conflict of Interests

There is no conflict of interest.

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