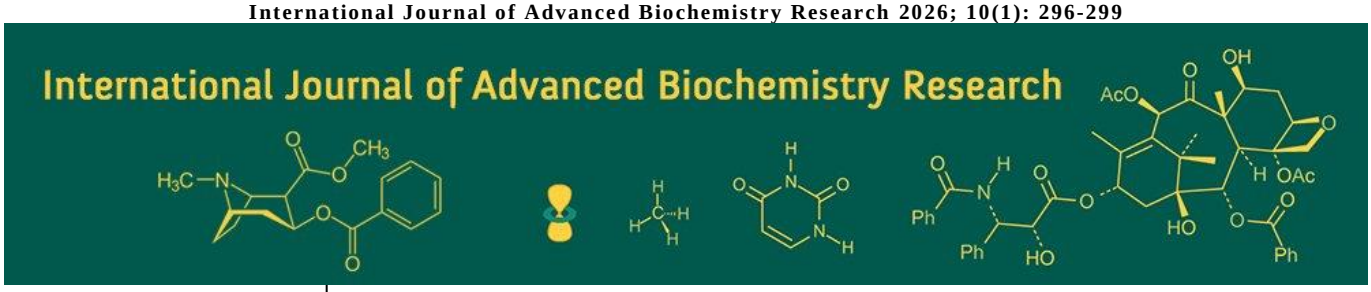

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Makbul A Shekh
Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, KU, Anand, Gujarat, India

Rutvi U Patel
Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, KU, Anand, Gujarat, India

Yogesh G Patel
Department of Livestock Production Management, College of Veterinary Science and Animal Husbandry, KU, Anand, Gujarat, India

Akash M Sutariya
Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, KU, Anand, Gujarat, India

Drashti R Patel
Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, KU, Anand, Gujarat, India

Himanshu Agrawal
Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, KU, Anand, Gujarat, India

Corresponding Author:
Rutvi U Patel
Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, KU, Anand, Gujarat, India

Effect of dietary inclusion of *Moringa oleifera* leaf powder on economics of commercial broiler chicken

Makbul A Shekh, Rutvi U Patel, Yogesh G Patel, Akash M Sutariya, Drashti R Patel and Himanshu Agrawal

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Abstract
Poultry production efficiently meets the rising global demand for animal protein but increasing feed costs and restrictions on antibiotic growth promoters have driven interest in natural feed additives. *Moringa oleifera* leaf powder (MOLP), rich in nutrients and bioactive compounds, has emerged as a promising alternative. This study evaluated the effects of different dietary levels of MOLP on growth performance, feed efficiency, livability and economic returns in broiler chickens. The experiment was conducted at the Poultry Research Station, College of Veterinary Science and Animal Husbandry, KU, Anand, using 160-day-old broiler chicks allotted to five treatments: T_1 (0% MOLP), T_2 (0.5%), T_3 (1%), T_4 (1.5%) and T_5 (2%), with four replicates of eight birds each. The 42-day feeding trial included starter, grower and finisher phases, with iso-caloric and iso-nitrogenous diets formulated as per BIS (2024). Data were analyzed using a completely randomized design. Total feed cost per bird did not differ significantly among treatments. However, feed cost per kilogram live weight was significantly lower in T_3, T_4 and T_5 compared to the control. Return over feed cost (ROFC) per bird and per kilogram live weight was highest in the 1.5% MOLP group (T_4), showing improvements of 42.7% and 26.4%, respectively, over the control. In conclusion, dietary inclusion of 1.5% *Moringa oleifera* leaf powder enhanced profitability in broiler chickens.

Keywords: Broiler, commercial, economics, *Moringa oleifera*

Introduction
India, with a population of 1.44 billion, has focused on development through improved nutrition, health and living standards. Increased incomes have resulted in higher consumption of eggs and poultry meat. India's poultry population reached 851.81 million in 2019, marking a 16.8% increase over the previous census (DAHD, 2019) [4]. During 2023-24, total meat production was 10.25 million tonnes, ranking India fifth globally, with poultry meat contributing 5.018 million tonnes (48.96%). However, per capita meat availability (7.39 kg/year) remains below the ICMR recommendation of 10.95 kg (BAHS, 2024) [2].
Poultry production plays a vital socio-economic role in developing countries as an affordable source of animal protein (Olwande *et al.*, 2010; Melesse *et al.*, 2013) [14, 12]. Feed accounts for 60-70% of broiler production costs, making feed efficiency and cost reduction critical for profitability (Biswas *et al.*, 2015) [3]. *Moringa oleifera* is a highly nutritious plant rich in proteins, vitamins, minerals and bioactive compounds, with low levels of antinutritional factors (Fahey, 2005; Aregheore, 2002; Makkar and Becker, 1996; Kumar *et al.*, 2010) [5, 1, 11, 8]. Its use in poultry diets can improve digestibility, suppress harmful microbes and support optimal growth performance (Gaia, 2005) [6]. Additionally, MOLP's affordability and local availability make it an economical alternative feed additive for small-scale farmers.
Thus, the experiment is planned to study the effect of dietary inclusion of *Moringa oleifera* leaf powder on economics of commercial broiler chicken and aims to determine the optimal inclusion levels of MOLP (0.5%, 1%, 1.5% and 2%).

Materials and Methods
The experiment was conducted to assess the effects of dietary inclusion of *Moringa oleifera* leaf powder (MOLP) on growth performance, nutrient retention, carcass traits, livability and economics in commercial broiler chickens.

Ethical approval was obtained from the Institutional Animal Ethics Committee, College of Veterinary Science and Animal Husbandry, KU, Anand, Gujarat. A total of 160-day-old commercial broiler chicks were procured, wing-banded, weighed and randomly allotted to five dietary treatments, each with four replicates of eight birds. The six-week feeding trial consisted of five iso-caloric and iso-nitrogenous diets formulated as per BIS (2024) standards. The control group (T_1) received a basal diet without MOLP, while T_2, T_3, T_4 and T_5 diets contained 0.5%, 1%, 1.5% and 2% MOLP, respectively.

Moringa oleifera leaves were locally sourced, air-dried, ground and sieved to prepare MOLP. The experiment was conducted in three phases starter (0-10 days), grower (11-21 days) and finisher (22-42 days) with ad libitum feeding provided throughout the study.

Cost of Feeding

The feed cost per kilogram of live broiler weight was calculated for each dietary treatment. The average feed intake recorded during the starter, grower and finisher phases for each treatment was multiplied by the corresponding cost of production for each type of feed to determine the phase-wise feed expenditure. The cumulative sum of feed costs across all phases provided the total feed cost for each treatment. The total feed cost per treatment was then divided by the average live body weight of birds in that treatment to obtain the cost of feed per kilogram of live broiler. All costs were expressed in Indian Rupees (₹). The details of feed production costs and ingredient costs are presented in Table 1 and Table 2, respectively.

Return Over Feed Cost (ROFC)

The economic efficiency of each treatment group was evaluated on a replicate basis. At the conclusion of the experiment, the return over feed cost (ROFC) was computed using the following formula, taking into account the selling price of broilers at ₹91 per kilogram of live body weight and the actual feed cost of each treatment ration presented in Table 2.

ROFC (₹) = Income from sale of birds on live weight basis − Feed cost

Table 1: Cost of production (Rs./100 kg) of various feeds used in the experiment

Sr. No.	Treatment	Cost (Rs./100kg)		
		Broiler Starter	Broiler Grower	Broiler Finisher
1.	T_1	3786.00	3775.00	3743.00
2.	T_2	3785.00	3774.00	3742.00
3.	T_3	3784.00	3772.00	3741.00
4.	T_4	3784.00	3771.00	3739.00
5.	T_5	3782.00	3770.00	3734.00

The final feed cost of per treatment was calculated by considering the rent, supervision charges and interest on feed production cost.

Table 2: Costs of individual ingredients used in feed

Sr. No.	Ingredients	Cost/kg
1	Maize	26.34
2	Soyabean DOC	30.80
3	MOLP	12.00
4	Calcite Powder	4.50
5	DCP	60.00
6	Vitamins	580.00
7	Vitamin-B12	115.20
8	Trace Minerals	74.55
9	Choline Chloride-60%	120.00
10	Lysine	220.00
11	Methionine	275.00
12	L-Threonine	200.00
13	Phytase-5000	148.05
14	Enzymes	145.60
15	Salt	5.00
16	Livertonic	112.55
17	Immunomodulator	436.80
18	Toxin Binder	59.32
19	Emulsifier	184.00
20	Probiotic	162.12
21	Anticoccidial	162.75
22	Oil	176.66

Statistical Analysis

The data obtained from various experimental observations and chemical analyses were subjected to statistical evaluation. Analyses were conducted following a Completely Randomized Design (CRD), as described by Snedecor and Cochran (2014). Means of replicates within each treatment were considered for the analysis. Statistical computations were performed using the Statistical Package for the Social Sciences (SPSS, Versions 27.0) at 95% significant level using Duncan's level of significance values.

Results and Discussion

Effect on economics

Cost of Feeding

The average feed consumption during the starter, grower and finisher phases for each treatment was multiplied by the production cost of the respective feed type to determine the period-wise feed expenditure per bird. Summing the costs across all phases provided the total feed cost per treatment per bird. Dividing this total by the average body weight of birds in each treatment yielded the feed cost per kilogram of live broiler bird which is expressed in Indian Rupees.

The total feed cost per bird and the cost of feed (Rs.) per kilogram of live broiler were calculated for each treatment to assess feed expenditure and efficiency. The total feed cost per bird in T_1, T_2, T_3, T_4 and T_5 was 136.65±3.90, 139.44±4.47, 142.80±1.75, 140.72±1.85 and 135.32±3.87 Rs., respectively. Statistical analysis revealed no significant difference ($p>0.05$) among treatments, indicating that total feed expenditure per bird was comparable across all dietary groups.

The findings of the present study are in agreement with those of Verma *et al.* (2025) [17] and Shabnam (2023) [15] who observed a gradual increase in total feed cost with higher inclusion levels of moringa-based products.

The cost of feed (Rs.) per kilogram of live broiler bird differed significantly ($p<0.05$) among the treatments. The highest feed cost was observed in the control group (T_1) at 68.07±1.33 Rs./kg, indicating comparatively lower feed efficiency. Birds in T_3, T_4, and T_5 recorded significantly lower ($p<0.05$) feed costs of 64.30±0.82, 62.01±1.44, and 64.34±0.64 Rs./kg, respectively, demonstrating improved feed utilization. Treatment T_2 had an intermediate feed cost of 66.02±1.26 Rs./kg and was statistically comparable ($p>0.05$) to control group.

Consistent with this, Londhe (2022) [9] reported a progressive decline in feed cost per kilogram of live weight gain (from ₹82.18 to ₹77.47) with increasing levels of *Moringa* supplementation (1.5%), suggesting a direct correlation between inclusion rate and cost reduction. Comparable findings were also presented by Harshini *et al.* (2022) [7], who demonstrated that inclusion of up to 15% *Moringa oleifera* dried leaf powder significantly ($p<0.05$) decreased feed cost per kilogram of body weight gain in Kadaknath chickens. Verma (2021) [16] documented a significant reduction ($p<0.05$) in feed cost per kilogram of live weight in broilers supplemented with 1-2% *Moringa oleifera* leaf powder. Likewise, More (2016) [13] noted that incorporating up to 2% *Moringa oleifera* leaf meal reduced feed cost per kilogram of live weight gain. Furthermore, Makanjuola *et al.* (2014) [10] recorded a substantial reduction ($p<0.05$) in both feed cost per bird and cost per weight gain with *Moringa oleifera* leaf meal inclusion, particularly at moderate level (400 g/100 kg feed).

Return Over Feed Cost (ROFC)

The Return Over Feed Cost (ROFC) was calculated by subtracting the total feed cost per bird (Rs./bird) from the income generated through the sale of birds at 91 Rs./kg live weight in the local market, providing the ROFC in terms of Rs./bird. To determine ROFC per kilogram of live broiler, the ROFC per bird was divided by the average body weight of the birds in each treatment. The calculated values for ROFC are presented in Table 3.

The income generated from selling broilers at 91 Rs./Kg did not differ significantly ($p>0.05$) among treatments, with values of 183.07±7.90, 192.55±8.34, 202.19±3.64, 206.99±7.06 and 191.52±6.36 Rs. for T_1, T_2, T_3, T_4, and T_5, respectively. Although statistical significance was not observed, birds in T_4 exhibited the highest income, indicating numerically better returns associated with this 1.5% MOLP inclusion treatment.

The ROFC Rs./bird was 46.42±4.49, 53.11±4.60, 59.39±2.71, 66.27±5.60 and 56.19±2.84 Rs. in T_1, T_2, T_3, T_4 and T_5, respectively. The highest ROFC was observed in T_4, which was significantly greater ($p<0.05$) than the control, whereas T_2, T_3, and T_5 were statistically comparable ($p>0.05$) but numerically higher than T_1 group. Similarly, ROFC per kilogram of live broiler differed with values of 22.93±1.33, 24.98±1.26, 26.70±0.82, 28.99±1.44 and 26.66±0.64 Rs./kg for T_1, T_2, T_3, T_4 and T_5, respectively. The significantly higher ($p<0.05$) economic return per kilogram was recorded in T_3, T_4, and T_5 groups.

Table 3: Return over feed cost (ROFC) of experimental broilers

Treatment	T_1 (Control)	T_2	T_3	T_4	T_5	SEM	P Value
Total feed cost (Rs./bird)	136.65±3.90	139.44±4.47	142.80±1.75	140.72±1.85	135.32±3.87	1.48	0.539
Body weight(g)	2011.74^{a}±58.11	2115.92^{ab}±60.27	2221.82^{b}±57.75	2274.66^{b}±56.54	2104.57^{ab}±55.51	26.50	0.014
Cost of feed (Rs./kg bird)	68.07^{c}±1.33	66.02^{bc}±1.26	64.30^{ab}±0.82	62.01^{a}±1.44	64.34^{ab}±0.64	0.65	0.023
Income from selling of birds (91 Rs./kg bird)	183.07±7.90	192.55±8.34	202.19±3.64	206.99±7.06	191.52±6.36	3.34	0.165
ROFC (Rs./bird)	46.42^{a}±4.49	53.11^{ab}±4.60	59.39^{ab}±2.71	66.27^{b}±5.60	56.19^{ab}±2.84	2.25	0.049
ROFC (Rs./kg bird)	22.93^{a}±1.33	24.98^{ab}±1.26	26.70^{bc}±0.82	28.99^{c}±1.44	26.66^{bc}±0.64	0.65	0.023

The means bearing different superscripts in the same row differ significantly ($p<0.05$).

Comparable findings were reported by Verma *et al.* (2025) [17], who found that broilers supplemented with 1.5% *Moringa oleifera* aqueous extract achieved the highest profitability (₹26.79 per bird). In agreement, Shabnam (2023) [15] reported a substantial increase in profit per bird (₹71.19) in broilers fed 5% Moringa-supplemented in pellet diets compared with the antibiotic-based control (₹58.31), indicating that *Moringa oleifera* can economically substitute synthetic growth-promoting antibiotics. Similarly, Londhe (2022) [9] observed a progressive rise in net profit/bird in the 1.5% moringa-fed group. Consistent results were also reported by Verma (2021) [16], who noted significantly higher ($p<0.001$) profit per bird (₹53.61) and per kilogram live weight (₹23.70) in broilers supplemented with 1.5% moringa leaf powder compared to the unsupplemented control (₹38.13 and ₹17.70, respectively).

However, the present findings contrast with those of More (2016) [13], who documented monetary losses across all treatments due to the lower market price per kilogram of live weight, a loss of ₹25, ₹18, ₹16, and ₹20 per bird was observed in T_0 (0%), T_1 (1%), T_2 (2%) and T_3 (3%), respectively. Nevertheless, the loss in MOLM-supplemented groups was considerably lower compared to the control group.

Conclusions

The cost of feed (Rs.) per kilogram live weight was lower ($p<0.05$) and ROFC (Rs./Kg broiler bird) was higher ($p<0.05$) in birds fed 1, 1.5 and 2% MOLP inclusion groups. Overall, inclusion of 1.5% Moringa oleifera leaf powder in broiler diets increased return over feed cost by per bird and per kg broiler bird were 42.7% and 26.4%, respectively over the control group, making it the most effective and economical level for improving profitability.

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Conflict of Interest: None

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