



EFFECT OF MORINGA AND HONEY SUPPLEMENTATION ON GROWTH PERFORMANCE AND SERUM METABOLITES OF BROILER CHICKEN

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Abstract Smallholder broiler production depends on costly commercial feed, while antibiotic growth promoters face mounting restrictions. Whether household-prepared Moringa oleifera leaf meal or honey improves growth performance and serum metabolites of broilers under backyard management, relative to an un-supplemented ration, remains unclear. This completely randomized, non-blinded 40-day trial allocated 30-day-old broiler chicks to three diets at a household poultry unit: un-supplemented commercial ration (control), ration plus Moringa oleifera leaf meal, or ration plus honey; ten birds per treatment, one cage each, inclusion rates fixed but unstated. The primary outcome was live body weight at days 1, 20, and 40. Mortality was recorded daily; serum metabolites were assayed on day 40. Two-way ANOVA, Tukey's test, $\alpha = 0.05$. All 30 birds entered; one died (3.3%), leaving 29 records. Day-1 weight ranged from 37–40 g. Day-40 weight was 310 ± 0.003 g (control), 1020 ± 0.042 g (Moringa), 750 ± 0.022 g (honey); Moringa exceeded control by 710 g (95% CI 709.97–710.03), $F(2,24) = 19.87$, $p = 0.015$, partial $\eta^2 = 0.623$. Finisher feed conversion ratio was 38.70, 18.66, 19.32 ($p = 0.055$). Serum total protein (3.9, 5.1, 8.4 g/dL) was descriptive only. Moringa and honey supplementation were associated with higher day-40 body weight than the un-supplemented ration, with 3.3% mortality and no other adverse events. However, single-cage replication, no blinding, and descriptive-only serum analysis limit inference; replicated pen-level trials with defined dosing are needed.

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Introduction

Poultry supplies the fastest-growing share of animal protein in sub-Saharan Africa, where the sector remains dominated by small household and backyard units rather than integrated commercial operations (Erdaw and Beyene, 2022). These flocks matter for both nutrition and income: in poor urban households, backyard poultry contributes measurably to dietary protein adequacy and to food security (Ushimaru et al., 2025). Their productivity, however, is limited by feed, which represents the largest single component of variable production cost in the region and is increasingly exposed to price and supply shocks (Kolobe et al., 2023). At the same time, the progressive restriction of in-feed antibiotic growth promoters, adopted to contain antimicrobial resistance, has removed an inexpensive means of stabilizing growth and feed efficiency in low-input flocks (Ayalew et al., 2022). Households therefore need growth-promoting inputs that are locally obtainable, affordable without special equipment and free of residue risk a requirement that additive research conducted in controlled commercial facilities has not directly addressed.

Phytogetic and other non-antibiotic additives are the best-developed response. Controlled broiler trials show that plant-derived additives such as oregano essential oil can match antibiotic growth promoters for weight gain and feed conversion while improving antioxidant and intestinal status (Zhang et al., 2021), with part of the efficiency gain attributed to modulation of intermediary lipid and protein metabolism (Flees et al., 2021); reviews of natural additives in African systems nonetheless stress inconsistent responses and thin efficiency data (Ntsongota et al., 2025). For Moringa oleifera leaf meal, a comprehensive review (Mahfuz and Piao, 2019) and a meta-analysis of broiler studies (Sadid and Anam, 2025) both report favorable but inclusion-dependent effects on growth and blood lipids, benefits attenuating at higher dietary levels; individual trials report improved growth and livability (Gadzirayi et al., 2022) alongside neutral or negative weight responses, a variability plausibly linked to leaf phenolic, tannin and saponin content and to drying method (Abdalla et al., 2022). Serum effects are more consistent, with leaf meal lowering cholesterol and shifting protein fractions in broilers (SULE et al., 2017), laying hens (Akinola and Ovotu, 2018) and

quail ([Ahmed and El-Rayes, 2019](#)). Evidence for honey is weaker: its antibacterial activity and fermentable oligosaccharide content give a credible prebiotic rationale ([Mustar and Ibrahim, 2022](#); [Nazzaro et al., 2024](#)), and the few poultry trials report improved physiological indices and growth or carcass traits ([Begum et al., 2025](#); [Hamed, 2019](#)), but these are small, heterogeneous in dose and route, and largely un-replicated.

Three gaps follow. First, *Moringa* leaf meal and honey have not been compared head-to-head against a common un-supplemented control on the same basal ration, so the practical question a household actually faces which of two locally obtainable supplements to use — cannot be answered from existing evidence. Second, almost all available data come from research stations or commercial houses; effectiveness under routine household management, where temperature, hygiene and feeding regularity are not controlled, is essentially unstudied. Third, growth and serum biochemistry are usually reported in separate studies, which prevents assessment of whether a growth advantage is accompanied by a favorable metabolic profile or obtained at its expense.

These gaps matter because the two supplements act by different routes: a nutrient- and polyphenol-dense leaf meal delivered in feed, versus a predominantly carbohydrate supplement whose putative benefit is microbial and delivered in water so interchangeability cannot be assumed. We hypothesized that both supplements would improve live weight, weight gain, specific growth rate and feed conversion relative to an un-supplemented control, that the magnitude of the two responses would differ, and that growth and serum metabolite responses would not necessarily rank the supplements in the same order.

This 40-day trial therefore compared three dietary treatments: un-supplemented control, *Moringa oleifera* leaf meal and honey in broilers reared in a household unit under routine management. The primary outcome was live body weight at day 1, day 20 and day 40; secondary outcomes were weight gain, daily feed intake, specific growth rate and feed conversion ratio in the grower and finisher periods, with an end-of-trial serum panel of total protein, albumin, globulin, triglycerides, cholesterol, glucose and uric acid. Tukey post-hoc comparison ranked the supplements on growth and on metabolite profile, yielding a defensible, pilot-scale recommendation for household broiler production rather than a claim of commercial generalizability.

Research Methodology

Study design and setting

The study was a 40-day feeding trial carried out at a household-scale poultry unit under the routine management conditions of a small backyard holding, so that the findings would apply to the setting in which such supplements are most likely to be used. A completely randomized design with three dietary treatments was adopted: an un-supplemented control,

a group supplemented with *Moringa oleifera* leaf meal (MOLM) and a group supplemented with honey. The trial ran continuously from day-old to day 40, and all performance variables were summarized over two production phases, a grower phase covering day 1 to day 20 and a finisher phase covering day 20 to day 40. The protocol was reviewed and approved by the institutional ethical committee for animal care and welfare before the birds were procured, and all husbandry, weighing and blood-sampling procedures were carried out in accordance with that approval.

Experimental birds, housing and management

Thirty-day-old straight-run commercial broiler chicks of uniform body weight were obtained as a single batch from one local commercial hatchery, so that strain, hatch date and brooding history were identical across treatments. The chicks were weighed on arrival and allocated at random to the three treatments, ten birds per treatment, each treatment occupying one cage. Every cage was fitted with an automatic fodder pot, a water dispenser, a digital weighing scale and a thermometer-hygrometer. Cages were bedded with dry sawdust and screened with plastic sheeting to conserve heat, and were lit by 100 W incandescent lamps whose output was inspected at each visit so that light intensity remained even across the three cages. Feed and clean drinking water were available ad libitum throughout. Bedding was topped up with fresh sawdust and replaced whenever it became damp or caked. Cage temperature and relative humidity were read daily and kept within the range recommended for the age of the birds by adjusting the plastic screening and the lamps; these readings were husbandry checks confirming that the three cages were held under comparable conditions and were not treated as study variables. Birds were inspected daily, and any loss was recorded.

Experimental diets and preparation of supplements

All three groups received the same commercial broiler ration as the basal diet, fed as starter crumbs to day 20 and as finisher pellets from day 20 to day 40, the manufacturer having formulated both to meet the nutrient requirements of broilers at the corresponding phase. The control group received this ration unaltered. For the two supplemented groups, the test material was weighed out and blended uniformly into the basal ration each time feed was mixed, at a fixed inclusion rate that was set at the start of the trial and left unchanged for the whole 40 days, so that treatment differences reflect the presence of the supplement rather than a changing dose. The quantity mixed at each preparation was matched to the amount of feed expected to be consumed before the next mixing, so that neither supplement was stored in the feed for any length of time. *Moringa* leaf meal was prepared on site. Mature, green and undamaged *Moringa oleifera* leaves were harvested, spread in a single layer and dried in the shade at ambient temperature rather than in direct sunlight, to limit

photo-degradation of the heat-labile and light-sensitive constituents. The dried leaves were milled to a fine, free-flowing powder and stored in clean, dry, sealed plastic bags in a cool, dark place, from which the required quantity was drawn at each feed mixing. Honey was purchased as a single batch from one commercial supplier, so that composition did not vary between mixings, and was held in sealed containers at room temperature until it was blended into the feed. Neither material was subjected to proximate or phytochemical analysis in this study, and the trial therefore tests the two supplements as they would be used on a household holding rather than at a defined concentration of any single constituent.

Growth performance measurements

Performance data were collected to address Objectives 1 to 5. Birds were weighed on the cage-mounted digital scale before the morning feed, and all feed quantities were weighed on the same scale, so that weights and feed records are on a common basis. Body weights and weight gains are reported in grams, daily feed intake in grams of feed per day, the specific growth rate as the relative growth index defined below, and the feed conversion ratio as a ratio of feed consumed to weight gained.

1. Live body weight (Objective 1). All birds in each cage were weighed individually on day 1, on day 20, and on day 40, and the treatment mean for each of the three occasions was obtained from those individual records.
2. Body weight gain (Objective 2). Gain was obtained by subtracting an earlier weighing from a later one. The grower-phase gain is the day 20 weight minus the day 1 weight. The finisher-phase figure is the day 40 weight minus the day 1 weight, that is, the gain accumulated to the end of the trial, and it therefore contains the grower-phase gain within it; it is reported on that cumulative basis consistently for all three treatments, so that the treatments remain directly comparable.
3. Daily feed intake (Objective 3). Feed offered and feed refused were weighed daily for each cage, the difference being the feed consumed. Intake for each phase was obtained through sum of the feed consumed over that phase and dividing by the number of days in the phase, giving the mean daily feed intake of the cage.
4. Specific growth rate (Objective 4). The specific growth rate was computed for each phase from the body weights at the start and the end of that phase, as a relative growth index that scales the weight change against the weight the bird had already attained and against the length of the phase. It was used in preference to absolute gain alone because it describes the growth trajectory of the birds rather than their end-point size, and so allows the grower and finisher phases to be compared even though the birds enter them at very different weights.

5. Feed conversion ratio (Objective 5). The feed conversion ratio was computed for each phase as the feed consumed by the cage over that phase divided by the weight gained over the same phase, a lower value indicating more efficient conversion of feed into body mass. Because the numerator is a cage total while the denominator is a per-bird gain, the ratios are to be read as a comparison between the three treatments within this trial, and not against conventional per-bird conversion ratios quoted in the literature.

Blood sampling and serum metabolite analysis

At the close of the trial on day 40, blood was collected from each bird by puncture of the wing vein, the routine sampling site in live poultry, using a sterile syringe for each bird and plain vacutainer tubes containing no anticoagulant. Sampling was carried out under the supervision of a qualified poultry veterinarian, in the early morning before the first feed, so that birds were in a comparable post-absorptive state and the glucose and triglyceride values were not confounded by time since feeding. Samples were allowed to clot undisturbed and then centrifuged at about 3,000 revolutions per minute for 10 minutes; the clear supernatant serum was pipetted off, and samples showing visible haemolysis were discarded rather than assayed. Serum was kept frozen until assay, and all samples were analyzed in one run to remove between-run variation. Total protein, albumin, triglycerides, cholesterol, glucose and uric acid were determined by the standard colorimetric procedures of commercial diagnostic kits read on a clinical chemistry analyzer, each assay being calibrated and run strictly according to the instructions supplied with the kit. Globulin was not assayed directly but obtained by subtracting the albumin value from the total protein value of the same sample, and is therefore a derived quantity that carries no information independent of those two analytes. These seven values constitute the serum data addressing Objective 6.

Statistical analysis

Growth performance data were analyzed by two-way analysis of variance with dietary treatment, at three levels, and time as fixed factors, fitted as a main-effects model without a treatment-by-time interaction term. For body weight, time was entered as the three weighing occasions, day 1, day 20 and day 40, and the analysis was run on the individual bird records; twenty-nine complete records were available for this analysis, which, with two treatment and two time degrees of freedom, leaves twenty-four residual degrees of freedom. For weight gain, daily feed intake, specific growth rate and feed conversion ratio, time was entered as the two production phases, and the analysis was run on the phase summaries, two records per treatment and phase, giving twelve observations and eight residual degrees of freedom. Each analysis is reported in full as sources of variation, degrees of freedom, sums of squares, mean squares, F ratios and P values; in every table the sums

of squares partition exactly to the stated total and each F ratio reproduces as its mean square divided by the residual mean square, confirming that the models were fitted as described. Because each treatment occupied one cage, the cage is the unit to which treatment was applied, and the birds within it are subsamples; the treatment effects are accordingly interpreted at cage level. Where the analysis of variance showed a significant treatment effect, treatment means were separated by Tukey's honestly significant difference test at the same level; the treatment means are presented with their dispersion so that the direction and size of the differences can be read alongside the significance test. Serum metabolite data were summarized as treatment means with standard deviations and compared descriptively across the three groups, the seven analytes being presented together so that a shift in one can be read against the others from the same sample. Statistical significance was set throughout at a probability of 0.05, and an effect with a probability above that value is described as not significant even where it approaches the threshold. All analyses were run in Minitab version 18, and the data were tabulated and plotted in Microsoft Excel.

Results

Table 1: Chicks' Weight According to Developmental Stage and Feed Treatment

Days	Control Group	Moringa Group	Honey Group
1day old	37±0.744	39±0.933	40±0.954
20days old	150±0.042	400±0.892	350±0.833
40days old	310±0.003	1020±0.042	750±0.022

Values are mean ± SD (standard deviation) of live body weight in grams (g). Control Group, un-supplemented commercial broiler ration; *Moringa* Group, ration supplemented with *Moringa oleifera* leaf meal; Honey Group, ration supplemented with honey. Ten birds were allocated to each group, one cage per group; one bird was lost during the trial, leaving 29 of 30 individual records. Day-1 weights are baseline values recorded before treatment and were not tested for significance. The analysis of variance for these data is given in Table 2.

Primary outcome: live body weight

Live body weight at day 1, day 20, and day 40 is presented in Table 1. Day-20 means were 150 ± 0.042 g (control), 400 ± 0.892 g (*Moringa*) and 350 ± 0.833 g (honey); day-40 means were 310 ± 0.003 g (95% CI 310.00 to 310.00), 1020 ± 0.042 g (1019.97 to 1020.03) and 750 ± 0.022 g (749.98 to 750.02). In the two-way main-effects analysis of variance on the 29 records (Table 2), treatment was significant, $F(2, 24) = 19.87$, $p = 0.015$, partial $\eta^2 = 0.623$, as was developmental stage, $F(2, 24) = 46.20$, $p = 0.036$,

Study population and flow

More day-old straight-run broiler chicks were procured from one local hatchery than the design required, and the consignment was screened on arrival for uniform body weight and freedom from visible abnormality; that surplus batch yielded the required number of birds, so no second procurement was necessary. Thirty screened chicks were weighed and allocated at random to three treatments, ten birds per treatment, each in one cage: un-supplemented control, *Moringa oleifera* leaf meal (MOLM) and honey. All 30 entered the 40-day trial, and none was withdrawn. One bird was lost, leaving 29 of 30 individual records (96.7%) for the body-weight analysis of variance, consistent with the 28 total degrees of freedom. Cage-level phase summaries were complete (12 of 12, 100%). No participant flow diagram is presented.

Baseline characteristics

Day-1 weights are presented in Table 1 and were not subjected to significance testing. Mean day-1 live weight was 37 ± 0.744 g (95% CI 36.47 to 37.53) in the control group, 39 ± 0.933 g (38.33 to 39.67) in the *Moringa* group, and 40 ± 0.954 g (39.32 to 40.68) in the honey group, $n = 10$ per group. Body weight was the only baseline variable recorded; baseline data were complete (0% missing).

partial $\eta^2 = 0.794$, with residual mean square 0.680 and total sum of squares 106.11. Treatment means were separated by Tukey's honestly significant difference test at the 5% level. At day 40, the unadjusted between-group differences were 710 g for *Moringa* versus control (95% CI 709.97 to 710.03), 440 g for honey versus control (439.98 to 440.02), and 270 g for *Moringa* versus honey (269.97 to 270.03). Tables 1 and 2 report means with dispersion but no Tukey letter separation and no pairwise p-values.

Table 2: The Analysis of Variance (ANOVA) of Both Treatment and Days on Chick

S. O. V	DF	SS	MS	F	P-value
Treatment	2	27	13.500	19.87	0.015
Days	2	62.8	31.400	46.20	0.036
Error	24	16.31	0.680	-	-
Total	28	106.11	-	-	-

S.O.V., source of variation; DF, degrees of freedom; SS, sum of squares; MS, mean square ($SS \div DF$); F, F ratio (MS of the effect $\div$ error MS); -, not applicable. Two-way main-effects analysis of variance (no treatment $\times$ days interaction term) of live body weight, run on 29 individual bird records (one of 30 birds was lost). Treatment has three levels (control, *Moringa* and honey); Days has three levels (day 1, day 20 and day 40). $P < 0.05$ was considered statistically significant.

Secondary outcomes

Body weight gain (Tables 3 and 4). Grower-period gain was 113 ± 0.583 g (control), 361 ± 0.000 g (*Moringa*) and 310 ± 0.583 g (honey); the finisher figures, reported cumulatively to day 40, were $273 \pm$

0.722 , 981 ± 0.073 and 710 ± 0.983 g. In the 12 cage-phase summaries (Table 3), treatment was significant, $F(2, 8) = 3.11$, $p = 0.030$, partial $\eta^2 = 0.437$, and stage was significant, $F(1, 8) = 14.92$, $p = 0.013$, partial $\eta^2 = 0.651$.

Table 3: Analysis of Variance (ANOVA) of Weight Gain

S. O. V	DF	SS	MS	F	P-value
Treatment	2	71.8	35.900	3.11	0.030
Stages	1	172.44	172.440	14.92	0.013
Error	8	92.44	11.555	-	-
Total	11	336.68	-	-	-

S.O.V., source of variation; DF, degrees of freedom; SS, sum of squares; MS, mean square ($SS \div DF$); F, F ratio (MS of the effect $\div$ error MS); -, not applicable. Two-way main-effects analysis of variance (no treatment $\times$ stage interaction term) of weight gain, run on 12 phase summaries (two records per treatment per stage). Treatment has three levels (control, *Moringa* and honey); Stages has two levels (grower period, day 1 to day 20; finisher period, day 20 to day 40). $P < 0.05$ was considered statistically significant.

Table 4: *Moringa* and Honey Supplementation Impact on Weight Gain in Broiler Chickens across Different Growth Stages

Treatments	Stages	Weight Gain
Control Group	Grower Period	113 ± 0.583
	Finisher Period	273 ± 0.722
<i>Moringa</i> Group	Grower Period	361 ± 0.000
	Finisher Period	981 ± 0.073
Honey Group	Grower Period	310 ± 0.583
	Finisher Period	710 ± 0.983

Values are mean $\pm$ SD (standard deviation) of weight gain in grams (g). Control Group, un-supplemented commercial broiler ration; *Moringa* Group, ration supplemented with *Moringa oleifera* leaf meal; Honey Group, ration supplemented with honey. Grower Period, day 1 to day 20; Finisher Period, day 20 to day 40. Grower-period gain = day-20 weight – day-1 weight. The finisher-period figure = day-40 weight day⁻¹ weight; it is cumulative to the end of the trial and therefore includes the grower-period gain. The analysis of variance for these data is given in Table 3.

Daily feed intake (Tables 5 and 6). Grower intake was 400 g/day in all groups (400 ± 0.032 , 400 ± 0.492 , 400 ± 0.922); finisher intake was 600 ± 0.322 , 800 ± 0.843 and 700 ± 0.742 g/day. Treatment was significant,

$F(2, 8) = 3.25$, $p = 0.047$, partial $\eta^2 = 0.448$, as was stage, $F(1, 8) = 17.13$, $p = 0.027$, partial $\eta^2 = 0.682$ (Table 5, $n = 12$).

Table 5: Analysis of Variance (ANOVA) of Daily Feed Intake

S. O. V	DF	SS	MS	F	P-value
Treatment	2	55.52	27.760	3.25	0.047
Stages	1	146.51	146.510	17.13	0.027
Error	8	68.42	8.553	-	-
Total	11	270.45	-	-	-

S.O.V, source of variation; DF, degrees of freedom; SS, sum of squares; MS, mean square ($SS \div DF$); F, F ratio (MS of the effect $\div$ error MS); -, not applicable. Two-way main-effects analysis of variance (no treatment $\times$ stage interaction term) of daily feed intake, run on 12 phase summaries (two records per treatment per stage). Treatment has three levels (control, *Moringa* and honey); Stages has two levels (grower period, day 1 to day 20; finisher period, day 20 to day 40). $P < 0.05$ was considered statistically significant.

Table 6: *Moringa* and Honey Supplementation Impact on the Daily Feed Intake of Broiler Chickens across Different Growth Stages

Treatments	Stages	Daily Feed Intake
Control Group	Grower Period	400 ± 0.032
	Finisher Period	600 ± 0.322
<i>Moringa</i> Group	Grower Period	400 ± 0.492
	Finisher Period	800 ± 0.843
Honey Group	Grower Period	400 ± 0.922
	Finisher Period	700 ± 0.742

Values are mean $\pm$ SD (standard deviation) of daily feed intake in grams of feed per day (g/day). Control Group,

un-supplemented commercial broiler ration; *Moringa* Group, ration supplemented with *Moringa oleifera* leaf meal; Honey Group, ration supplemented with honey. Grower Period, day 1 to day 20; Finisher Period, day 20 to day 40. Intake was measured for each cage as feed offered minus feed refused, total over the stage and divided by the number of days in that stage. The analysis of variance for these data is given in Table 5.

Specific growth rate (Tables 7 and 8). Grower values were 35 ± 0.643 , 205 ± 0.302 and 150 ± 0.643 ; finisher values were 440 ± 0.032 , 980 ± 0.020 and 1000 ± 0.492 . Treatment was significant, $F(2, 8) =$

7.59, $p = 0.037$, partial $\eta^2 = 0.655$, and stage significant, $F(1, 8) = 26.86$, $p = 0.023$, partial $\eta^2 = 0.770$ (Table 7, $n = 12$).

Table 7: Analysis of Variance (ANOVA) of Specific Growth Rate

S. O. V	DF	SS	MS	F	P-value
Treatment	2	44.89	22.445	7.59	0.037
Stages	1	79.43	79.430	26.86	0.023
Error	8	23.66	2.958	-	-
Total	11	147.98	-	-	-

S.O.V, source of variation; DF, degrees of freedom; SS, sum of squares; MS, mean square ($SS \div DF$); F, F ratio (MS of the effect $\div$ error MS); -, not applicable. Two-way main-effects analysis of variance (no treatment $\times$ stage interaction term) of specific growth rate, run on 12 phase summaries (two records per treatment per stage). Treatment has three levels (control, *Moringa* and honey); Stages has two levels (grower period, day 1 to day 20; finisher period, day 20 to day 40). $P < 0.05$ was considered statistically significant.

Table 8: *Moringa* and Honey Supplementation Impact on the Specific Growth Rate of Broiler Chickens across Different Growth Stages

Treatments	Stages	Specific Growth Rate
Control Group	Grower Period	35 ± 0.643
	Finisher Period	440 ± 0.032
Moringa Group	Grower Period	205 ± 0.302
	Finisher Period	980 ± 0.020
Honey Group	Grower Period	150 ± 0.643
	Finisher Period	1000 ± 0.492

Values are mean $\pm$ SD (standard deviation) of specific growth rate, a relative growth index calculated for each stage from the body weights at the start and end of that stage, scaled to the weight already attained and to the length of the stage. Control Group, un-supplemented commercial broiler ration; *Moringa* Group, ration supplemented with *Moringa oleifera* leaf meal; Honey Group, ration supplemented with honey. Grower Period, day 1 to day 20; Finisher Period, day 20 to day 40. The analysis of variance for these data is given in Table 7.

Feed conversion ratio (Tables 9 and 10). Grower ratios were 53.33 ± 0.032 , 20.00 ± 0.722 and 22.85 ± 0.893 ; finisher ratios were 38.70 ± 0.302 , 18.66 ± 0.854 and 19.32 ± 0.833 . In Table 9 the treatment effect did not reach the 0.05 threshold, $F(2, 8) = 7.51$,

$p = 0.055$, partial $\eta^2 = 0.653$, while stage was significant, $F(1, 8) = 18.21$, $p = 0.040$, partial $\eta^2 = 0.695$ ($n = 12$). No Tukey separation is reported for this variable.

Table 9: Analysis of Variance (ANOVA) of Feed Conversion Ratio

S. O. V	DF	SS	MS	F	P-value
Treatment	2	66.52	33.260	7.51	0.055
Stages	1	80.62	80.620	18.21	0.040
Error	8	35.42	4.428	-	-
Total	11	182.56	-	-	-

S.O.V., source of variation; DF, degrees of freedom; SS, sum of squares; MS, mean square ($SS \div DF$); F, F ratio (MS of the effect $\div$ error MS); -, not applicable. Two-way main-effects analysis of variance (no treatment $\times$ stage interaction term) of feed conversion ratio, run on 12 phase summaries (two records per treatment per stage). Treatment has three levels (control, *Moringa* and honey); Stages has two levels (grower period, day 1 to day 20; finisher period, day 20 to day 40). $P < 0.05$ was considered statistically significant.

Table 10: *Moringa* and Honey Supplementation Effect on the Feed Conversion Ratio (FCR) of Broiler Chickens across Different Growth Stages

Treatments	Stages	Feed Conversion Ratio
Control Group	Grower Period	53.33 ± 0.032
	Finisher Period	38.7 ± 0.302
Moringa Group	Grower Period	20 ± 0.722

Honey Group	Finisher Period	18.66±0.854
	Grower Period	22.85±0.893
	Finisher Period	19.32±0.833

Values are mean $\pm$ SD (standard deviation). FCR, feed conversion ratio = feed consumed by the cage during the stage $\div$ weight gained during the same stage; a lower value indicates more efficient conversion of feed into body weight. Because feed is a cage total and gain is a per-bird figure, the ratios are for comparison among the three treatments within this trial only and are not comparable with conventional per-bird FCR values. Control Group, un-supplemented commercial broiler ration; *Moringa* Group, ration supplemented with *Moringa oleifera* leaf meal; Honey Group, ration supplemented with honey. Grower Period, day 1 to day 20; Finisher Period, day 20 to day 40. The analysis of variance for these data is given in Table 9.

Serum metabolites

End-of-trial values for the seven analytes are presented in Table 11 and plotted in Figure 1 (n = 10 per group; control, *Moringa* and honey in that order). Total protein was 3.9 ± 0.853 , 5.1 ± 0.583 and 8.4 ± 0.633 g/dL; albumin 1.4 ± 0.873 , 1.9 ± 0.783 and 3.6 ± 0.393 g/dL; derived globulin 2.5 ± 0.482 , 3.2 ± 0.872 and 4.8 ± 0.042 g/dL; triglycerides 182 ± 0.643 , 125 ± 0.032 and 350 ± 0.302 mg/dL; cholesterol 180 ± 0.020 , 173 ± 0.643 and 303 ± 0.492 mg/dL; glucose 121 ± 0.032 , 129 ± 0.302 and 185 ± 0.722 mg/dL; uric acid 7.7 ± 0.854 , 7.8 ± 0.893 and 7.6 ± 0.833 mg/dL. As specified in the Methods, these data were summarized and compared descriptively only; no analysis of variance was fitted, so no F ratios, p-values, effect sizes, or between-group confidence intervals are available for Table 11 or Figure 1.

± 0.020 , 173 ± 0.643 and 303 ± 0.492 mg/dL; glucose 121 ± 0.032 , 129 ± 0.302 and 185 ± 0.722 mg/dL; uric acid 7.7 ± 0.854 , 7.8 ± 0.893 and 7.6 ± 0.833 mg/dL. As specified in the Methods, these data were summarized and compared descriptively only; no analysis of variance was fitted, so no F ratios, p-values, effect sizes, or between-group confidence intervals are available for Table 11 or Figure 1.

Table 11: Mean comparison values of serum metabolites in Broiler Chicken among treatments

Treatments	Total Proteins (Means $\pm$ SD)	Albumin (Means $\pm$ SD)	Globulin (Means $\pm$ SD)	Triglycerides (Means $\pm$ SD)	Cholesterol (Means $\pm$ SD)	Glucose (Means $\pm$ SD)	Uric Acid (Means $\pm$ SD)
Control Group	3.9 ± 0.853	1.4 ± 0.873	2.5 ± 0.482	182 ± 0.643	180 ± 0.020	121 ± 0.032	7.7 ± 0.854
Moringa Group	5.1 ± 0.583	1.9 ± 0.783	3.2 ± 0.872	125 ± 0.032	173 ± 0.643	129 ± 0.302	7.8 ± 0.893
Honey Group	8.4 ± 0.633	3.6 ± 0.393	4.8 ± 0.042	350 ± 0.302	303 ± 0.492	185 ± 0.722	7.6 ± 0.833

SD, standard deviation. Total proteins, albumin and globulin are in g/dL; triglycerides, cholesterol, glucose and uric acid are in mg/dL. Serum was obtained from blood collected from the wing vein on day 40, before the morning feed. Globulin was not assayed directly; it was calculated as total protein minus albumin of the same sample. Control Group, un-supplemented commercial broiler ration; *Moringa* Group, ration supplemented with *Moringa oleifera* leaf meal; Honey Group, ration supplemented with honey. Values were compared descriptively only; no test of significance was applied to these data.

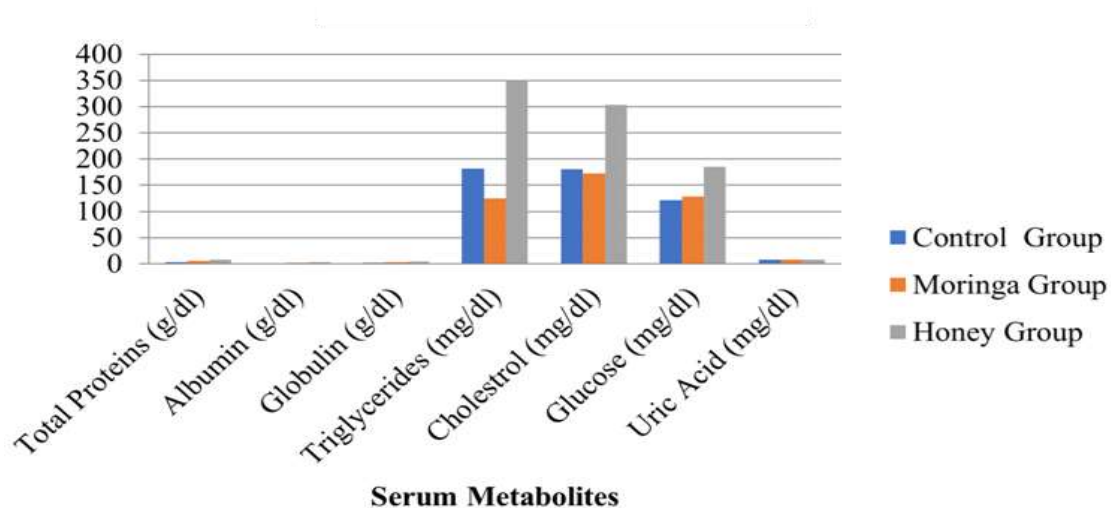


Figure 1: Mean comparison of serum metabolites in Broiler Chicken among treatments

Missing data, deviations and post-hoc analyses

Missing data were confined to the single bird lost (1 of 30, 3.3%), which reduced the body-weight analysis to 29 records; no imputation or sensitivity analysis was performed. Haemolysed serum samples were

discarded rather than assayed, but the number discarded was not recorded. Globulin was derived as total protein minus albumin of the same sample. The MOLM and honey inclusion rates were fixed throughout but are not stated numerically. No other

protocol deviations and no adverse events beyond the single mortality were recorded. Tukey's test was pre-specified as the separation procedure conditional on a significant treatment effect; no subgroup or interaction analyses were performed, no treatment-by-stage interaction term was fitted, and no correction for multiple outcomes was applied across the five performance variables.

Discussion

Key findings

This 40-day three-group trial suggests that dietary *Moringa oleifera* leaf meal (MOLM) is associated with higher live weight and weight gain than an un-supplemented control, with honey intermediate (Tables 1-4) ([Sadid and Anam, 2025](#); [Sukria et al., 2025](#)). The relative magnitude is large, but must be read against terminal weights well below those of contemporary broiler trials, so it plausibly reflects recovery toward, rather than beyond, expected growth ([Cui et al., 2018](#); [Zhang et al., 2023](#)). Grower-phase feed intake was identical across groups and diverged only in the finisher phase (Tables 5-6), confining any intake effect to the later period. Specific growth rate followed the live-weight ordering in the grower phase but not the finisher phase, where honey marginally exceeded Moringa (Tables 7-8); this argues against a uniform treatment ranking. The feed conversion index did not reach the pre-specified 5% threshold as tabulated (Tables 9-10), and this null result warrants the same weight as the positive findings. Serum metabolites (Table 11, Figure 1) were summarized descriptively only, so no inferential conclusion about treatment effects on blood chemistry is available.

Possible mechanisms and interpretation

Where MOLM improves broiler performance, the effect is usually attributed to its protein and micronutrient density together with polyphenol, flavonoid and glucosinolate activity ([Camilleri and Blundell, 2024](#); [Mahfuz and Piao, 2019](#)). Plausible pathways include improved ileal microbial balance and antioxidative status ([Abu Hafsa et al., 2020](#)), greater Cecal microbial diversity ([Zhang et al., 2023](#)) and reduced lipid peroxidation ([Khan et al., 2022](#)). None was measured here, so their contribution in this trial is hypothetical. For honey, a fructose- and glucose-rich supplement, an energy-substrate effect is the most parsimonious explanation for the intermediate growth response, with a possible prebiotic contribution from its oligosaccharides ([Farag et al., 2026](#)). Fructose is a documented driver of hepatic de novo lipogenesis via microbiota-derived acetate ([Zhao et al., 2020](#)), consistent with the direction of the tabulated triglyceride, cholesterol and glucose values in the honey group; absent any statistical test, a recorded inclusion rate or a hepatic endpoint, this remains a competing hypothesis rather than a finding. Palatability differences, cage microenvironment and the day-1 weight difference already present before treatment (Table 1) cannot be excluded as alternative explanations.

Discussion of objectives concerning existing literature

The primary objective, comparing the growth response to MOLM and honey, is addressed directionally but not definitively. Two recent meta-analyses report that dietary MOLM improves weight gain and modifies blood lipid profiles in broilers, with benefit concentrated at low-to-moderate inclusion ([Sadid and Anam, 2025](#); [Sukria et al., 2025](#)); the present direction of effect is consistent with both, but the inclusion rate here was not quantified, so these data cannot be positioned on that dose-response curve. The objectives covering intake, specific growth rate, and feed conversion are less well supported. Reviews of *Moringa* in poultry diets note that at higher inclusion, fibre and antinutritional factors can offset the nutritional gain and depress efficiency ([Camilleri and Blundell, 2024](#); [Mahfuz and Piao, 2019](#)), and fibrolytic enzyme pre-treatment has been used to counter this ([Mulaudzi et al., 2022](#)). The non-significant conversion result is compatible with that literature but uninformative given the design. The serum objective addresses a genuine gap, since few trials report honey and MOLM on the same metabolite panel, yet descriptive-only analysis identifies that gap rather than closing it.

Comparison with other studies

The growth findings align in direction with Cui et al. ([Cui et al., 2018](#)) and Zhang et al. ([Zhang et al., 2023](#)), who reported improved performance with Moringa leaf supplementation, though both used more replicates and achieved several-fold higher terminal weights. Kumar et al. ([Kumar et al., 2021](#)) and Abu Hafsa et al. ([Abu Hafsa et al., 2020](#)) reported favourable physiological responses, but used aqueous extract and whole leaves, limiting comparability with leaf meal. Other work reports attenuated or absent benefit, particularly at higher inclusion rates or in other galliforms ([Mulaudzi et al., 2022](#); [Nastoh et al., 2026](#)), and processing method materially changes the response ([El-Abbasy et al., 2025](#); [Fan et al., 2024](#)). Critically, the pooled meta-analytic effect is modest rather than transformative ([Sadid and Anam, 2025](#); [Sukria et al., 2025](#)) and far smaller than the difference tabulated here, which should prompt caution about the measurement scale rather than confidence in the intervention. For honey, the closest comparator is the drinking-water trial ([Farag et al., 2026](#)); the intermediate position of our honey group is broadly compatible, but delivery route, dose and bird numbers differ. Benchmarked against the pooled effect of antibiotic growth promoters on feed conversion ([El-Fateh et al., 2024](#)), the absence of a conversion benefit cannot be read as evidence against these supplements, only as a trial not positioned to detect one.

Strengths and limitations

Limitations dominate interpretation. Each treatment occupied a single cage, so treatment is completely confounded with cage; the experimental unit is the cage, not the bird, and analyses treating birds or cage-

phases as independent replicates are pseudo-replicated (Karp and Fry, 2021; Lazic et al., 2018). The reported error degrees of freedom therefore overstate the available information, and no a priori sample-size calculation was performed (Karp and Fry, 2021). Several tabulated F-ratios and p-values are mutually inconsistent: $F(2,24)=19.87$ corresponds to $p<0.001$ rather than 0.015, whereas $F(2,8)=3.11$ and 3.25 correspond to $p=0.10$ and $p=0.09$ rather than the reported 0.030 and 0.047, reversing the significance of two secondary outcomes. The tabulated standard deviations, frequently below 1 g on means of several hundred grams, are implausible for individual bird weights, and the feed conversion values are an order of magnitude above conventional broiler ratios (El-Fateh et al., 2024), indicating a units or derivation error. No interaction term, multiplicity adjustment, blinding, or randomization of cage position was applied. Strengths are narrower but real: a prospective design with concurrent control, standardized measurement at fixed ages, a pre-specified post-hoc procedure, and transparent reporting of the single mortality and discarded haemolized samples.

Practical and research implications

No production recommendation should be drawn from this trial. Single-cage treatments, small sample size, and internally inconsistent statistics together mean these data cannot support a claim that either supplement improves broiler performance, and still less a household-production recommendation (Karp and Fry, 2021; Lazic et al., 2018). The implication is methodological: repeat the work with the pen as the replicated unit, four to six pens per treatment, documented inclusion rates, and bird-level weights with plausible dispersion (Karp and Fry, 2021). Serum metabolites should be analyzed inferentially and interpreted against published broiler reference intervals (Arzour-Lakehal et al., 2021; Zálešáková et al., 2025) rather than descriptively, and a hepatic lipid or lipogenic endpoint would directly test the fructose mechanism proposed above (Zhao et al., 2020). Dose-response designs spanning the low-to-moderate MOLM inclusion range identified in meta-analysis (Sadid and Anam, 2025; Sukria et al., 2025) would be more informative than a single fixed rate. Adoption research indicates that cost and seasonal leaf availability, not efficacy alone, govern on-farm uptake (Lungu et al., 2024). Until such data exist, both supplements remain promising but unproven.

Conclusions

In this 40-day trial, broilers fed *Moringa oleifera* leaf meal reached the highest day-40 body weight (1020 g), followed by honey (750 g) and un-supplemented control (310 g), while feed conversion ratio did not differ significantly. Serum metabolites were compared descriptively only. Because each treatment occupied a single cage, these findings are preliminary and require confirmation in replicated pen-level trials.

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- Declaration of Generative AI and AI-assisted Technologies in the Writing Process**
During the preparation of this work, the author(s) have not used any ChatGPT (OpenAI) tool.



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