Growth Performance, Carcass traits, and Economic Implications of Replacing Soybean Meal with Moringa Leaf Meal in Japanese Quail Diets

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Abstract
This study evaluated the effects of partially or completely replacing soybean meal (SBM) with moringa leaf meal (MOLM) on growth performance, carcass characteristics, and feed cost in Japanese quail. A total of 60 unsexed quails with initial body weight of 22.7 g were randomly assigned to five diets: T1 (20% SBM, 0% MOLM), T2 (15% SBM, 5% MOLM), T3 (10% SBM, 10% MOLM), T4 (5% SBM, 15% MOLM), and T5 (0% SBM, 20% MOLM) with 12 quails per treatment, replicated four times in a Completely Randomized Design and study lasted for four weeks. The parameters evaluated included growth performance, carcass yield and organ weights, and cost analysis. The results showed that growth performance decreased significantly ($P<0.05$) with increasing MOLM inclusion, particularly at 15–20%. Birds fed 5% MOLM had comparable performance to control, whereas ≥10% inclusion depressed growth. Feed cost/kg declined as MOLM increased, but feed conversion ratio (FCR) and cost per unit weight gain worsened. Carcass traits followed similar trends, with lower dressing weight and breast yield at higher MOLM levels. The study therefore concluded that MOLM can partially replace SBM in quail diets at up to 5% without adverse effects on performance and profitability, while higher levels compromise growth efficiency despite lowering feed cost.

Keywords: Japanese quail, moringa leaf meal, soybean replacement, growth, carcass quality, feed cost

Description of problem

Poultry production is expanding rapidly due to rising global demand for high-quality animal protein. Japanese quail (*Coturnix japonica*), in particular, have gained prominence in research and commercial settings because of their short production cycle, high feed efficiency, and lean meat quality [13]. However, the cost of conventional protein sources, particularly soybean meal (SBM), presents a significant challenge to sustainable poultry feed formulation, especially in developing countries [10]. Efforts to reduce feed costs have encouraged the exploration of unconventional, locally available plant materials as partial replacements for SBM. One such alternative is moringa leaf meal (MOLM), derived from *Moringa oleifera*, a fast-growing multipurpose tree recognized for its high protein content, vitamins, and antioxidants [7]. Moringa leaves contain up to 25–30% crude protein on a dry matter basis and are rich in essential amino acids and minerals [3].

Despite its nutritional quality, the use of MOLM in monogastric diets is limited by the presence of fiber and anti-nutritional compounds such as tannins and saponins, which can reduce nutrient digestibility and growth performance when included at high levels [4, 11]. Some studies have shown that MOLM can replace up to 10–15% of conventional protein sources in broiler diets without adverse effects [5], but data on its effects in Japanese quail are still sparse and inconclusive. This study was conducted to evaluate the effects of replacing SBM with varying levels of MOLM (0–20%) on the growth performance, carcass characteristics, and economic returns of Japanese quail. The findings aim to determine the optimal inclusion level of MOLM that can reduce feed cost without compromising productivity.

Materials and Methods

The experiment was conducted at the poultry unit of the Animal Production Technology Department farm, Federal College of

Agriculture, Moor Plantation, Ibadan located at longitude 3'540E and latitude 7'230N in the humid zone of south western Nigeria (Oyo State) annual rainfall of 1564 mm and annual average temperature of 28.7^{0}C. 60 unsexed quails aged 2 weeks old with average weight of 22.68±0.01g were used for the study with 12 quails per treatment. The quail were housed in wooden cages that were raised from the floor. The feeding trial lasted for 4 weeks. Feed and water was provided ad-libitum throughout the experiment.

The Moringa leaf used was obtained from a farm within Ibadan metropolis of Oyo state. The *moringa oleifera* leaves were air-dried under shade for 5 days until it was crispy to touch while retaining its greenish color. The leaves were milled and incorporated into the formulated basal diets. Five experimental diets were prepared (T1–T5) with graded levels of MOLM replacing SBM (0, 5, 10, 15 and 20% respectively) (Table 1).

Data collection

Upon arrival, the quails were weighed to determine the initial body weight; then on weekly basis, the quails were weighed. The weight gain was calculated by subtracting the initial body weight from the final body weight. The record of feed consumed was taken. It was obtained by finding the difference between the amount of feed given to the animals and the remnants gotten each day. The average weekly feed intake was computed from the amount of the feed consumed on daily basis. The feed conversion ratio was calculated from the weight gained and the feed intake of the quail at the different treatments. Feed intake divided by weight gain. The prevailing market prices of ingredients used during the period of the study were used for the economic appraisal of the feeds. Economics of production was based on the feed cost per kg diet (Table 2).

Table 1: Gross Composition of the Experimental Diets

Ingredients	T1	T2	T3	T4	T5
Maize	49.00	49.00	49.00	49.00	49.00
Soybean	20.00	15.00	10.00	5.00	0.00
MOLM	0.00	5.00	10.00	15.00	20.00
Groundnut cake	18.00	18.00	18.00	18.00	18.00
Fish meal (65%)	4.00	4.00	4.00	4.00	4.00
Maize bran	3.25	3.25	3.25	3.25	3.25
Palm oil	2.00	2.00	2.00	2.00	2.00
Limestone	1.00	1.00	1.00	1.00	1.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10
Methionine	0.15	0.15	0.15	0.15	0.15
Total	100.00	100.00	100.00	100.00	100.00
Calculated analysis					
Crude protein (%)	24.25	23.56	22.88	22.19	21.51
ME (Kcal/kg)	2964.18	2843.18	2722.18	2601.17	2480.18
Calcium (%)	1.30	1.29	1.28	1.27	1.26
Available Phosphorus (%)	0.74	0.71	0.68	0.65	0.62
Crude fibre (%)	4.44	4.69	4.93	5.18	5.42

MOLM: Moringa leaf meal; ME: Metabolizable energy

At the end of the feeding trials, four quails from each treatment group were randomly selected after starving them for 12 hours. The quail were weighed individually to obtained slaughter weight and thereafter slaughter, bled, de-feather, dissected and emptied the digestive tract and weighed (dress weight). The carcass cut and organs (breast, thigh, wings, back, gizzard, liver, and heart) were weight immediately using sensitive weighing scale, expressed in grams and then percentage dressing weight. Dressing percentage were calculated thus: dressed weight divided by carcass weight, multiply by 100.

Experimental design and statistics Analysis
A Complete Randomized Design (CRD) was used for the research. The experiment consisted of five treatments which were replicated four times. All data were subjected to analysis of variance (ANOVA) using [9]. Differences between means were separated by the Tukey's HSD procedure of the same package at 95% confidence limit.

Result and Discussion
Table 2 shows the Growth performance and cost analysis of Japanese quail fed varying inclusion levels of moringa leaf meal (MOLM) as a replacement for soybean in their diet**.** All the parameters evaluated were significantly (P<0.05) influenced by the dietary inclusion of MOLM. The result shows that final weight, weight gain, and daily weight gain all declined significantly (P<0.05) as soybean was replaced by MOLM. Feed intake increased at higher MOLM inclusion (notably T4), leading to poorer feed conversion ratio (FCR). Diet cost/kg decreased with higher MOLM, but cost per unit weight gain increased, reflecting reduced efficiency.

Table 3 shows the carcass characteristics of Japanese quail fed varied inclusion levels of *moringa oleifera* leaf meal (MOLM) as a replacement for soybean in their diet. All the carcass characteristics evaluated were significantly (P<0.05) influenced by the dietary inclusion of MOLM except dressing percentage and head + neck percentage which were not significantly (P>0.05) different. Dressing weight, breast %, and giblet % declined at high MOLM levels. Abdominal fat decreased to zero in T5. Liver, heart, and gizzard weights decreased with higher MOLM.

Table 2: Growth performance and cost analysis of Japanese quail fed varying inclusion levels of moringa leaf meal (MOLM) as a replacement for soybean in their diet.

Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**±SEM**	**P-value**
Initial weight (g)	22.71	22.64	22.67	22.69	22.71	0.01	0.869
Final weight (g)	194.85^{a}	182.54^{b}	153.88^{c}	148.61^{d}	138.86^{e}	2.40	0.000
Weight gain (g)	172.14^{a}	159.90^{b}	131.21^{c}	125.92^{d}	116.15^{e}	2.41	0.000
Daily weight gain (g)	6.15^{a}	5.71^{b}	4.69^{c}	4.50^{d}	4.15^{e}	0.00	0.000
Feed intake (g)	464.24^{d}	471.24^{cd}	486.08^{bc}	535.64^{a}	498.12^{b}	50.10	0.000
Daily feed intake (g)	16.58^{d}	16.83^{cd}	17.36^{bc}	19.13^{a}	17.79^{b}	0.06	0.000
FCR	2.70^{d}	2.95^{c}	3.71^{b}	4.25^{a}	4.29^{a}	0.00	0.000
Feed cost/kg (₦)	855.20^{a}	820.20^{b}	785.20^{c}	750.20^{d}	715.20^{e}	0.00	-------
TCFC (₦)	397.02^{ab}	386.51^{bc}	381.67^{c}	401.84^{a}	356.26^{d}	31.60	0.000
Cost/weight gain (₦)	2306.35^{e}	2417.07^{d}	2909.13^{c}	3191.32^{a}	3067.27^{b}	1347.00	0.000

Means with different superscript in a row are significantly different at (p<0.05), FCR: feed conversion ratio; TCFC: total cost of feed consumed, T1: basal diet (20% SBM 0% MOLM), T2: diet containing 15% SBM, 5% MOLM, T3: diet containing 10% SBM, 10% MOLM, T4: diet containing 5% SBM 15% MOLM), T5: diet containing 0% SBM, 20% MOLM).

Table 3: Carcass characteristics of Japanese quail fed varying inclusion levels of moringa leaf meal (MOLM) as a replacement for soybean in their diet

Parameters	**T1**	**T2**	**T3**	**T4**	**T5**	**±SEM**	**P-value**
Live weight (g)	187.88^{a}	184.33^{ab}	172.86^{ab}	169.64^{ab}	163.55^{b}	92.50	0.014
Slaughter weight (g)	180.30^{a}	177.51^{a}	166.12^{ab}	163.58^{ab}	157.00^{b}	87.50	0.015
Dressing weight (g)	130.72^{a}	128.14^{ab}	116.40^{bc}	112.58^{c}	106.83^{c}	36.30	0.000
Dressing (%)	72.54	72.17	70.08	68.82	68.23	5.71	0.076
Breast (%)	35.87^{a}	35.86^{a}	35.24^{a}	33.94^{b}	33.64^{b}	0.16	0.000
Thigh + drumstick (%)	16.10^{a}	15.80^{ab}	15.30^{bc}	15.10^{c}	15.16^{c}	0.06	0.000

Wings + back (%)	12.60^{ab}	12.40^{bc}	12.20^{bc}	12.90^{a}	12.15^{c}	0.04	0.000
Head + neck (%)	2.94	2.92	2.92	2.91	2.89	0.00	0.462
Abdominal fat (%)	0.42^{a}	0.37^{b}	0.07^{c}	0.02^{d}	0.00^{e}	0.00	0.000
Gizzard (%)	2.00^{a}	1.88^{ab}	1.71^{b}	1.43^{c}	1.68^{b}	0.01	0.000
Liver (%)	2.17^{a}	2.15^{a}	1.92^{b}	1.81^{b}	1.87^{b}	0.01	0.000
Heart (%)	0.82^{a}	0.80^{a}	0.74^{ab}	0.71^{b}	0.71^{b}	0.00	0.003
Giblets (%)	4.99^{a}	4.88^{a}	4.37^{b}	3.95^{c}	4.26^{b}	0.01	0.000

Means with different superscript in a row are significantly different at ($p<0.05$)

The performance reduction observed in this study aligns with known lower digestibility of MOLM compared to soybean, particularly due to higher fiber and potential anti-nutritional compounds (e.g., tannins, saponins) or could be as a result of linearly dropped in Crude protein and metabolizable energy as MOLM replaced soybean, indicating that MOLM cannot fully replace SBM in quail diets. This agrees with findings in broilers and chickens, where MOLM inclusion beyond moderate levels reduced nutrient utilization and growth [2, 12]. Anti-nutritional factors present in MOLM likely impaired protein digestibility, leading to reduced performance [6]. Higher feed intake observed in MOLM-based diets could be due to their higher crude fiber content, consistent with [5]. However, the poor FCR suggests that increased intake did not translate into efficient utilization, making high MOLM inclusion economically unfavorable. Carcass yield reduction at ≥10% MOLM inclusion further highlights SBM's superior amino acid balance compared with MOLM. Nevertheless, the significant reduction in abdominal fat with MOLM inclusion supports the report of [8] that MOLM phytochemicals modulate lipid metabolism. This could be advantageous for producing leaner meat, which is increasingly demanded by health-conscious consumers. Moderate inclusion (5–10% MOLM) maintained acceptable growth and carcass traits, suggesting partial replacement is viable. Economically, although feed cost/kg declined with MOLM inclusion, the increase in cost per weight gain beyond 5% MOLM indicates diminishing profitability. Similar economic patterns were observed in MOLM-fed broilers and rabbits [1]. The reduction in growth performance and carcass characteristics followed the increase of MOLM in the diets observed in this study indicating possible nutrient limitations or anti-nutritional factors and could be as a result of linearly dropped in Crude protein and metabolizable energy as MOLM replaced soybean.

Conclusion and Applications

1. Replacing SBM with MOLM up to 5% maintains growth performance, carcass traits, or profitability
2. Higher MOLM inclusion (>10%) impairs growth, feed efficiency and carcass quality.
3. Use MOLM at ≤5% in quail diets.
4. Apply processing techniques to improve digestibility.
5. Future work should evaluate egg production and long-term health effects.

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