RESEARCH ARTICLE

Evaluating Growth Performance and Feed Cost Economics of Japanese Quails Fed with Varying Levels of Guar Meal

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Abstract

A study was conducted to evaluate the inclusion of guar meal (GM) as a partial replacement for soybean meal (SBM) in Japanese quail diets. 150-day-old chicks were randomly assigned to five dietary treatments: T_1 (0% GM), T_2 (2% GM), T_3 (4% GM), T_4 (6% GM) and T_5 (8% GM), with three replicates per treatment (10 birds each). Feed intake, body weight gain (BWG), and feed conversion ratio (FCR) were recorded weekly, and cost-effectiveness was assessed based on current local market prices. Results revealed that BWG significantly improved ($p<0.01$) with GM inclusion, peaking at 6% (T_4) before declining at 8% (T_5). Feed intake increased linearly with GM levels but showed no significant differences between treatments ($p>0.05$). FCR was significantly better ($p<0.01$) in quails fed 6% GM (T_4) compared to the control (T_1), although efficiency declined at 8% GM (T_5). The performance index (PI) and Protein efficiency ratio (PER) followed a similar trend, with T_4 exhibiting the highest PI, PER values. Economic analysis indicated that diets containing up to 6% GM were cost-effective compared to the control, without compromising growth performance. In conclusion, guar meal can be incorporated into quail diets at levels up to 6% as a cost-effective alternative to soybean meal, enhancing growth performance and feed efficiency. Higher inclusion levels (≥8%) are not recommended due to adverse effects on performance metrics.

Key words: Cost economics, Feed efficiency, Growth performance, Guar meal, Japanese Quails.

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Introduction

Enhancing profitability in poultry production relies on reducing feed costs, which constitute about 60-70% of total expenses. Poultry farming depends on feed with balanced energy and crude protein (CP) levels. Traditionally, soybean meal (SBM) has been the main protein source due to its amino acid profile and protein content. However, its escalating cost and scarcity, especially in developing countries, have spurred research into alternative protein sources to reduce dependency on conventional ingredients. Finding cost-effective substitutes is essential for sustainable poultry farming. In addition, the growing concern over environmental sustainability and the carbon footprint of traditional feed ingredients further emphasizes the need for viable alternative feed ingredients.

Among the promising alternative feed ingredients is guar meal (GM), a byproduct derived from the drought resistant annual legume guar plant (*Cyamopsis tetragonoloba*) originated in Africa and is abundantly produced in India and Pakistan (Pach and Nagel, 2018). Guar meal (GM) is a byproduct of the guar gum industry which is produced by mechanically separating the endosperm from germ and hull of guar seeds (Janampet *et al*., 2016; Reddy *et al*., 2017). The guar plant, mainly cultivated for guar gum, produces guar meal (GM) as a protein-rich byproduct for poultry feed, containing approximately 88% true protein (Lee *et al*., 2003, 2005). GM offers moderate energy (2005.29 Kcal/kg raw), comparable to standard protein sources like SBM. Its amino acid profile, notably high in methionine and phosphorus, enhances its value for poultry broilers and layers.

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The Japanese quail (*Coturnix japonica*), with its hardy nature, adaptability and closer genetic ties to its wild ancestry, shows greater resistance to anti-nutritional factors, allowing it to tolerate a broader range of feed ingredients. This study seeks to examine the feasibility of incorporating guar meal into quail diets as a reliable alternative protein source. The research will assess the nutritional composition, benefits associated with guar meal, with a particular focus on its impact on poultry performance in quail diets. The results of this investigation could offer valuable insights into how guar meal might contribute to more cost effective and sustainable quail production practices.

Materials and Methods

Experimental Design

The experimental work was carried out in Livestock Farm Complex, NTR College of Veterinary Science, Gannavaram. Day old 150 chicks of Japanese quail procured from Reddy farms, Guntur, Andhra Pradesh were randomly divided in to five dietary treatments (30 birds each) with three replicates (10 birds each). The experiment was carried out for 35 days. Guar meal (GM) was included at 0% (T_1), 2% (T_2), 4% (T_3), 6% (T_4) and 8% (T_5) in iso-nitrogenous (24% CP) and iso-caloric (2900 kcal/kg ME) diets, ensuring consistent nutrient profiles in quail diets to meet the nutrient requirements (NRC, 1994). The proximate and ingredient composition (%) of quail experimental diets are shown in Table 1.

Growth Performance

The chicks were all raised under identical management conditions. They had unrestricted access to feed and water throughout the experimental period. Weekly records were kept of their feed intake and live body weight gains. From these records, the body weight gain and feed conversion ratio were calculated. The proximate composition of the diets was analysed in accordance with the methods outlined by AOAC (2007).

Table 1: Proximate and Ingredient composition of Quail diets

Constituent	T_1 (0.0)	T_2 (2.0)	T_3 (4.0)	T_4 (6.0)	T_5 (8.0)	Cost/kg (Rs)
Maize	51.60	51.40	51.50	51.50	51.60	25.50
DORB	3.60	3.80	4.10	4.30	4.40	17.00
Soybean meal	42.5	40.2	37.9	35.7	33.5	49.00
Guar meal	0.00	2.00	4.00	6.00	8.00	44.00
DCP	0	0.30	0.36	0.23	0.23	42.50
Shell grit	1.40	1.38	1.20	1.30	1.30	07.00
Trace min mix	0.20	0.20	0.20	0.20	0.20	215.00
Salt	0.30	0.30	0.30	0.30	0.30	5.00
Lysine	0.02	0.04	0.06	0.09	0.09	220
DL-Methionine	0.1	0.1	0.1	0.1	0.1	380
VitAB_2D_3	0.02	0.02	0.02	0.02	0.02	500
Choline chloride	0.2	0.2	0.2	0.2	0.2	110
Coccidiostat	0.05	0.05	0.05	0.05	0.05	460
Antibiotic	0.01	0.01	0.01	0.01	0.01	670
Total	100	100	100	100	100	-
Feed cost/kg (₹)	**37.53**	**37.44**	**37.32**	**37.18**	**37.02**	-
Dry matter	89.13	90.66	89.15	89.89	90.35	-
Organic matter	91.71	91.46	91.82	91.85	91.61	-
Crude protein	24.07	24.01	24.00	24.00	24.00	-
Ether extract	2.25	2.73	2.98	3.02	3.15	-
Crude fibre	2.65	2.32	2.34	2.54	2.68	-
NFE	51.87	53.04	51.64	52.17	52.12	-
Total ash	8.28	8.53	8.17	8.14	8.38	-
Acid insoluble ash	5.94	4.68	5.63	6.69	7.20	
ME kcal/kg (calculated)	2912.55	2901.59	2902.33	2900.66	2900.49	-
Calorie protein ratio	121.00	120.84	120.93	120.86	120.85	-
Calcium (%)	0.89	0.85	0.96	0.97	0.99	-
Total phosphorus (%)	0.31	0.33	0.37	0.39	0.41	-

Premix contains vitamin AB_2D_3 (0.02 kg) each kg grams contain: Vit-B1 4 g, Vit-B6 8 g, Vit-B12 40 mg, Vit B3 -60 g, Vit-E 40 g, Calcium Pantotheonate-40 g; Trace minerals (0.2 kg) each kg contains: chelated manganese 90 g, chelated zinc 50 g, chelated copper 10 g, chelated chromium 125 mg chelated cobalt 2 g; iron 80 g, selenium 3g, molybdenum 0.0025 ppm and iodine 2 g; antibiotic (0.01 kg) and coccidiostat (0.05 kg).

Cost Economics

To evaluate the cost-effectiveness of the dietary treatments, the price figures were based on the current local market prices for ingredients and the selling prices of quails in the Vijayawada region, Andhra Pradesh. This economic analysis ensured that the cost implications of each dietary treatment were thoroughly considered. The standard equations were used to calculate the economic parameters. Feed cost per bird was arrived by considering feed intake medicines and miscellaneous.

$$\text{Feed cost per kg Gain} = \frac{\text{Feed cost per bird}}{\text{Unit of Gain}}$$

Statistical Analysis

The data was analyzed statistically as per Snedecor and Cochran, (1994) and tested for significance using one way ANOVA by using SPSS 24 software. The comparison of means was tested using Duncan's multiple range tests allowing for significant differences between the treatments at $p<0.05$.

Results and Discussion

Effect on Body Weight Gains

The body weight gains of Japanese quails during the experimental period are presented in Table 2. Body weight gain improved with inclusion of GM in the diets than control, showing a significant difference between treatments ($p<0.01$). The highest body weight gain was observed in quails fed with diet containing 6% GM (T_4), which was significantly higher ($p<0.01$) than control (T_1, 0% GM). These findings were consistent with previous studies of Rao *et al.* (2019) and Siva *et al.* (2018), who reported significantly higher BWG in birds fed up to 6% GM in broiler chicken. Similarly, Milczarek *et al.* (2023) observed that inclusion of 8% GM significantly ($p<0.05$) reduced BWG. Reddy *et al.* (2018) and El-Faham *et al.* (2017) noted BWG reduction at GM levels exceeded 10%, suggesting that excessive GM inclusion impairs growth due to increased intestinal viscosity and poor nutrient absorption.

In contrast to the present findings, Rajasekhar *et al.* (2020) reported a decrease in BWG at 4% and 6% GM in broilers. While, Peng *et al.* (2020) observed reduced BWG at 3% GM compared to 6% and 9% in ducks. Wankhede *et al.* (2019) found improved BWG at 12.5% GM and Khalifa *et al.* (2017), El-Marsy *et al.* (2017) and Pashamwar *et al.* (2018) noted reduced BWG at GM levels exceeding 5% in broiler chicken.

Effect on Feed Intake

Feed intake (FI) of quails fed varying levels of guar meal (GM) is presented in Table 2. FI increased linearly from T_1 to T_5 with higher GM inclusion, with the lowest intake in T_1 and the highest in T_5. Although the increase in FI with GM supplementation (2-8%) was not statistically significant ($p>0.05$), a slight positive effect was observed. These results aligned with Youssef and El-Garby (2018), who reported increased FI up to 10% GM in laying hens, Similarly, El-Marsy *et al.* (2017), Nasrala *et al.* (2015) (Anshas chicks), and Mishra *et al.* (2013) observed increased FI in broilers with higher levels of GM inclusion. Hassan (2013) and Mishra *et al.* (2013) linked increased FI to reduced starch digestibility from GM, leading to compensatory feed consumption in laying hens and broilers.

In contrast, Tyagi *et al.* (2014) found reduced FI in egg-laying quails at higher GM levels, and Salma *et al.* (2015) and Hassan (2013) observed decreased FI in broilers and laying hens with more than 5% GM. Rao *et al.* (2019) observed reduced FI with increasing GM levels, suggesting that the effect of GM on FI depends on inclusion level, processing, and dietary energy balance.

Effect on Feed Conversion Ratio (FCR)

As guar meal levels increased up to 6%, FCR generally improved, with quails in T_4 showing significantly better feed efficiency ($p<0.01$) than T_1 and T_5. There was no significant difference ($p>0.05$) found between diets with 2%, 4% and 6% GM. However, at 8% GM (T_5), FCR increased to 3.20, indicating a decline in feed efficiency (Table 2). The results were in line with Rao *et al.* (2019), who reported an improved FCR at 6% GM inclusion compared to higher levels in broilers. The results are consistent with Milczarek *et al.* (2023), who observed increased FCR at 8% GM inclusion in broilers. Calisar (2020) reported progressively higher FCR values at 8%, 16% and 24% GM levels in laying hens. The higher FCR in the present study at 8% level of GM aligned with Wankhede *et al.* (2019), who attributed poor FCR in broilers at higher GM levels to high galactomannan content, which increases intestinal viscosity and impairs feed efficiency.

In contrast to these findings, Haribhau *et al.* (2020) and Youssef and El-Garby (2018) observed no adverse effect on FCR at GM levels up to 10% in broilers and laying hens, respectively. Salma *et al.* (2015) suggested that GM could be incorporated up to 25% without negatively affecting broiler performance.

Effect on Performance Index (PI)

The performance index (PI) values of Japanese quails are presented in Table 2. Based on the feed conversion ratio and body weight gains, PI values ranged from 55.58 g (T_1, 0% GM) to 61.69 g (T_4, 6% GM). The PI was significantly higher ($p<0.01$) in quails fed 6% GM (T_4) and lower in those in the T_1 (0% GM) and T_5 groups. There was no significant difference ($p>0.05$) observed between T_1 and T_5. These findings aligned with Salma *et al.* (2015), who observed a positive impact of low GM supplementation in broiler diets on performance index, but contradict Tyagi *et al.* (2011), who reported no adverse effects on broilers at 10% GM inclusion.

Table 2: Effect of guar meal at varying levels in diets on growth performance of Japanese quails (Mean± SEM, n=3)

Treatment	Body weight gain (g)	Feed intake (g)	Feed conversion ratio	Performance index (g)	Protein efficiency ratio
T_1 (0 % GM)	175.43^{a}±1.24	553.65±3.30	3.15^{bc}±0.19	55.58^{a}±0.68	1.31^{ab}±0.00
T_2 (2 % GM)	179.96^{ab}±0.92	556.93±5.30	3.09^{ab}±0.29	58.12^{ab}±0.69	1.34^{ab}±0.01
T_3 (4 % GM)	182.96^{bc}±1.04	563.65±2.84	3.08^{ab}±0.22	59.35^{bc}±0.72	1.35^{ab}±0.00
T_4 (6 % GM)	187.53^{d}±1.01	570.58±7.77	3.04^{a}±0.31	61.69^{c}±0.58	1.36^{b}±0.01
T_5 (8 % GM)	178.90^{ab}±1.06	573.62±8.69	3.20^{c}±0.36	55.80^{a}±0.60	1.29^{a}±0.01
SEM	1.16	3.06	0.18	0.85	0.008
P value	0.000**	0.171	0.017**	0.000**	0.016**

^{abcd}Values in column bearing different superscripts differ significantly, **p<0.01

Table 3: Effect of guar meal at varying levels in diets of Japanese quails on cost economics (Mean ± SEM, n=3)

Treatment	Body weight gain (g)	Feed intake (g)	Feed cost per bird (₹)	Feed cost per kg gain (₹)
T_1 (0 % GM)	175.43^{a}±1.24	553.65±3.30	20.77±0.12	118.44^{b}±0.73
T_2 (2 % GM)	179.96^{ab}±0.92	556.93±5.30	20.85±0.19	115.86^{ab}±1.12
T_3 (4 % GM)	182.96^{bc}±1.04	563.65±2.84	21.03±0.10	114.97^{ab}±0.85
T_4 (6 % GM)	187.53^{d}±1.01	570.58±7.77	21.21±0.28	113.11^{a}±1.17
T_5 (8 % GM)	178.90^{ab}±1.06	573.62±8.69	21.23±0.32	118.69^{b}±1.34
SEM	1.16	3.06	0.98	0.019
p	0.000**	0.171	0.528	0.000**

^{abcd}Values in column bearing different superscripts differ significantly, **p<0.01.

Effect on Protein Efficiency Ratio (PER)

The protein efficiency ratios (PER) of quails during the experimental period ranged from 1.29 to 1.36 (Table 2). It varied significantly (p<0.01) among different treatments, with highest value observed in T_4 (1.36) and lowest value in T_5 (1.29). These findings aligned with Salma *et al.* (2015), who suggested that low levels of guar korma supplementation in broiler diets were more effective in improving performance indices and protein efficiency ratios.

Cost economics

The cost economics in Japanese quails fed diets with varying levels of guar meal (GM) are shown in Table 3. Feed cost per bird ranged from ₹ 20.77 to ₹ 21.23 across the treatment groups, with no statistically significant differences observed (p > 0.05). However, a notable statistically significant reduction (p < 0.01) in feed cost per kg body weight gain was recorded in the T_2, T_3 and T_4 groups compared to the control (T_1), with T_4 (6% GM) showed most cost-effective performance. Conversely, T_5 (8% GM) recorded the highest cost per kg gain, indicating a possible decline in feed efficiency at higher inclusion levels.

Conclusion

The present study indicated that inclusion of guar meal up to 6% in the diet of Japanese quails had resulted in improved performance of quails as revealed from increased body weight gains, improved FCR with low feed cost/kg gain.

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