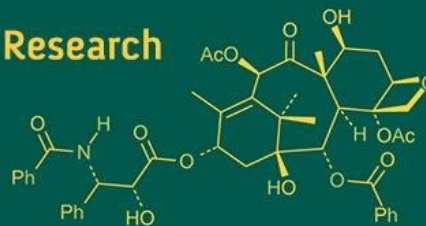


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Manju Lata

Assistant Professor,
Department of Animal
Nutrition, College of
Veterinary and Animal
Sciences, G.B. Pant University
of Agriculture and Technology,
Pantnagar, Udham Singh
Nagar, Uttarakhand, India

Bidhan C Mondal

Professor & Head, Department
of Animal Nutrition, College of
Veterinary and Animal
Sciences, G.B. Pant University
of Agriculture and Technology,
Pantnagar, Udham Singh
Nagar, Uttarakhand, India

Corresponding Author:**Manju Lata**

Assistant Professor,
Department of Animal
Nutrition, College of
Veterinary and Animal
Sciences, G.B. Pant University
of Agriculture and Technology,
Pantnagar, Udham Singh
Nagar, Uttarakhand, India

Nutrient composition and sensory attributes of meat influenced by dietary inclusion of drumstick (*Moringa oleifera* Lam.) leaf meal in broiler Japanese Quail

Manju Lata and Bidhan C Mondal

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Abstract

A feeding trial was conducted to discern the influence of dietary incorporation of *Moringa oleifera* leaf meal on carcass trait assessments i.e. chemical composition, sensory characteristics and processing losses of meat in broiler Japanese quail. A total 288 day-old Japanese quail chicks were randomly distributed into eight treatments of 36 Japanese quail chicks per treatment with three replicates of 12 quail in each. Japanese quail of treatment T₁ (control group) were fed a basal diet (starter and finisher), whereas in treatment group T₂ basal diet was incorporated with Vitamin C @200 mg/kg, T₃ basal diet was incorporated with Vitamin E @10 IU/kg, and in diets T₄, T₅, T₆, T₇, and T₈, the basal diet was incorporated with 1.0%, 3.0%, 5.0%, 7.0% and 9.0% *Moringa oleifera* leaf meal, respectively. Results showed that non-significant ($P \geq 0.05$) difference were noticed in average crude protein, ether extract and total ash (%DM basis) percentage of broiler Japanese quail meat (breast and thigh muscles) in different treatments groups when broiler Japanese quail was fed diet with different levels of *Moringa oleifera* leaf meal. But significantly ($P \leq 0.05$) improvement in sensory characteristics viz., appearance, flavour, juiciness, texture, tenderness and overall acceptability of meat of Japanese quail birds as compared to control. It can be concluded that 3.0% drumstick (*Moringa oleifera*) leaf meal can be incorporated in feed for improvement of nutrient composition of meat and sensory evaluation of meat in broiler Japanese quail.

Keywords: Sensory characteristics, Japanese quail, drumstick, breast and thigh muscle

1. Introduction

The poultry sector is experiencing rapid expansion, driven by the escalating global demand to address the nutritional requirements of an ever-growing population. Among various poultry species, commercial quail farming has emerged as a promising area of growth, with a rising adoption in Asia, Europe, and more recently, Africa (RSPCA, 2011) [20]. The quail, scientifically known as *Coturnix coturnix japonica* (family: Phasianidae, genus: Coturnix Bonnatere), is a small-sized bird commonly referred to as "bater" in Hindi. Quail meat has garnered attention due to its impressive nutritional profile, rich in antioxidants, proteins, minerals, and vitamins, as documented by Bao *et al.* (2020) [4]. This growing recognition is contributing to the expansion of quail farming, especially in response to the global shift toward alternative protein sources. As consumer interest shifts towards high-protein, locally sourced food options, quail farming represents a promising avenue to meet the rising demand for sustainable, nutrient-dense alternatives. Given the rising global demand for alternative protein sources, quail farming presents an opportunity to meet this need with locally available, high-protein alternatives.

In pursuit of cost-effective protein sources for poultry nutrition, the leaf meal derived from the tropical browse plant, drumstick leaf meal emerges as a promising candidate. Drumstick tree is also known as *Moringa oleifera* Lam. belongs to the species of the genus *Moringa* of the family Moringaceae. *Moringa oleifera* is a tropical tree indigenous to the lower parts of the Himalaya mountain range. It is now spread throughout tropical regions in Africa, Asia, and Southern-America (Dubey *et al.*, 2013) [8]. The tree is one of the 13 known species of the single genus Moringaceae family, classified in the order of Brassicales (Razis *et al.*, 2014) [19], and has earned the name "Miracle tree" due to its versatile properties. Renowned for its robust nutritional profile, drumstick leaf meal boasts substantial levels of crude protein ranging from 22% to 30%, alongside essential amino

acids, minerals, phenolic compounds and vitamins (Lata *et al.* 2024; Lu *et al.* 2016) [17, 18]. These also include many fatty acids, flavonoids, glucosinolates, terpenes, alkaloids, saponins, and sterols (Abd Rani *et al.*, 2018) [1]. The current study was conducted to evaluate the effect of dietary incorporation of drumstick (*Moringa oleifera* Lam.) leaf meal on chemical composition, processing losses and sensory characteristics of meat in broiler Japanese quail.

2. Materials and Methods

2.1 Experimental Location

The present research study was conducted to discern the effect of dietary incorporation of drumstick (*Moringa oleifera* Lam.) leaf meal on chemical composition, processing losses and sensory characteristics of meat in broiler Japanese quail. The entire study was conducted at Instructional Poultry Farm (I.P.F.) and Department of Animal Nutrition, College of Veterinary and Animal Sciences, G.B. Pant University of Agriculture and Technology, Pantnagar located at latitude of 28°53'24" North, longitude of 77°34'27" East at an altitude of 243.84 meters above Mean Sea Level.

2.2 Preparation of Drumstick Leaf Meal and Procurement of Feed Ingredients

Drumstick leaves were harvested preferably young ones from the trees in the local area of Pantnagar and then separated from the twigs manually before oven drying. The leaves were then kept into hot air oven at 50 °C for 3-4 hours to make them crispy for easy blending. The dried leaves were then run through a hammer mill sieve with a size of 4-5mm to produce the drumstick leaf meal and then stored in air tight polythene bags in a cool and dry place to prevent it from moisture. Feed ingredients required for the formulation of the experimental ration were procured from the feed unit and all the ingredients were ground in feed mill

before mixing at feed unit of the Instructional Poultry Farm (IPF), GBPUAT, Pantnagar. An α -tocopherol (Evion-400) and Vitamin C required for the feeding trial was procured from local market Pantnagar.

2.3 Experimental Design, Treatments and Housing Management

For this feeding experiment two hundred and eighty-eight (288 Nos.), day-old Japanese quail chicks were randomly distributed into eight dietary treatment groups. Each treatment comprised of three replicates consisting of 12 Japanese quails per replicate. The eight dietary treatments were T₁ (Basal diet), T₂ (Basal diet with vitamin C @ 200 mg/kg), T₃ (Basal diet with vitamin E @ 10 IU/kg), T₄ (Basal diet with 1% MOLM), T₅ (Basal diet with 3% MOLM), T₆ (Basal diet with 5% MOLM), T₇ (Basal diet with 7% MOLM) and T₈ (Basal diet with 9% MOLM). For the experiment, two types of basal diets were prepared to meet the nutrient requirement of Japanese quail, *i.e.*, starter (0-3 weeks) and finisher (3-6 weeks) as per ICAR (2013). Japanese quail were reared in a cage system using standard management and health care practices. The experimental diets and clean drinking water were supplied to the birds *ad libitum* throughout the study period. Prior to the commencement of the experiment, the birds were weighed at the beginning of the study to obtain their initial body weights and thereafter they were individually weighed to the nearest gram at weekly intervals during the experimental period. Feed intake was recorded daily. Feed conversion ratio was calculated by dividing the feed intake by weight gain and other routine quail birds management practices were carried out. Throughout the feeding trial, adequate light (for 18 hours) and proper ventilation was provided to the all quail chicks. The experiment was conducted in strict compliance with the guidelines of 'Institutional Animal Ethics Committee (IAEC)', GBPUAT, Pantnagar, India.



Picture 1: Feeding Trial

2.4 Carcass traits

For carcass trait assessments, two representative Japanese quail chicks from each replicate of all treatment groups were

euthanized at the conclusion of the 6th week of the experimental trial to evaluate chemical composition, processing losses and sensory characteristics of meat in

broiler Japanese quail. A 12-hour fasting period was enforced prior to slaughter. Prior to the slaughter procedure, each quail was weighed individually. The euthanasia process involved cervical dislocation to ensure humane treatment of the birds. Following dislocation, complete exsanguinations was performed by making an incision in the jugular vein to facilitate thorough blood drainage.

2.5 Chemical Composition of Meat

The representative meat samples from breast and thigh muscles were collected during slaughtering; there proximate analysis (moisture, crude protein, ether extract and total ash percentage) on %DM basis was performed at Animal Nutrition department, C.V.A.Sc., Pantnagar as per AOAC (2005).

2.6 Sensory evaluation of meat

The sensory quality of meat samples was evaluated by meat descriptive analysis method (Keeton and feeding, 1984). The quail meat from each replicate of all groups was boiled by addition of 1.5% salt solution and served warm to panelist for sensory evaluation. A sensory panel (semi trained) of eight judges drawn from post graduate students and teaching staff of College of Veterinary and Animal Sciences evaluated the meat for different attributes viz., appearance, flavour, texture, juiciness and overall acceptability. An 8-point hedonic scale was used for sensory evaluation. The samples were presented in random order and panelists were requested to rate their assessment of colour, flavour, texture, juiciness and overall acceptability on an 8-point hedonic scale. A score of 5 or below was considered a limit of acceptability for all sensory attributes tested.

2.7 Processing Losses

a) Feather loss

$$\text{Feather loss (\%)} = \frac{\text{Defeathered weight (g)}}{\text{Pre-slaughtered live weight (g)}} \times 100$$

b) Blood

$$\text{Blood loss (\%)} = \frac{\text{Weight of bird after blood loss (g)}}{\text{Pre-slaughtered live weight (g)}} \times 100$$

c) Head

$$\text{Head (\%)} = \frac{\text{Weight of head (g)}}{\text{Pre-slaughtered live weight (g)}} \times 100$$

d) Shank

$$\text{Shank (\%)} = \frac{\text{Weight of shank (g)}}{\text{Pre-slaughtered live weight (g)}} \times 100$$

2.8 Statistical Analysis

The data were presented as means $\pm$ standard error (SE). Statistical analysis was conducted using SPSS version 20. ANOVA, followed by Duncan's Multiple Range test was used for multiple comparisons. Statistical differences were determined at the 5% level of significance.

3. Results and Discussion

3.1 Proximate composition (%DM basis) of basal experimental diets

The proximate composition (%DM basis) of basal experimental diets fed to Japanese quail starter and finisher chicks is presented in Table No. 1.

Basal diet was formulated iso-nitrogenous and iso-caloric for Japanese quail chick starter and finisher to meet out the nutritional requirements as per ICAR (2013) recommendation. The organic matter content of starter and finisher diet was noticed as 93.65 and 94.87 percent, respectively. The crude protein content of diet was found as 25.49 and 21.76 percent, respectively, whereas ether extract of representative diet was 3.43 and 3.78 percent, respectively. Crude fiber proportion was estimated 5.76 and 4.98 percent in both the diets. The nitrogen free extract content of starter and finisher diet was 58.97 and 64.35 percent, respectively. The total ash percent was recorded in corresponding diets as 6.35 and 5.13 percent, respectively. The acid insoluble ash percent was recorded in corresponding diet as 1.43 and 1.18, percent respectively. Total carbohydrate content of both the diets was 64.73 and 69.33 percent, respectively. The calcium percent was recorded in starter and finisher diet as 1.24 and 1.18 percent, respectively. The phosphorus percent was recorded in corresponding diets as 0.65 and 0.57 percent, respectively.

Table 1: Chemical composition (%DM basis) of experimental diet fed to Japanese quail chicks

Attributes	Japanese quail	
	Starter (0-3 weeks)	Finisher (3-6 weeks)
Organic matter	93.65	94.87
Crude protein	25.49	21.76
Ether extract	3.43	3.78
Crude fiber	5.76	4.98
Total ash	6.35	5.13
Acid insoluble ash	1.43	1.18
Nitrogen free extract	58.97	64.35
Total carbohydrate	64.73	69.33
Calcium	1.24	1.18
Total Phosphorus	0.65	0.57
Metabolisable Energy (kcal/kg) Calculated	2851.50	2954.03

The findings of current investigation corroborated with the findings of Hamad *et al.* (2018) as they conducted an experiment on Japanese quail birds and basal diet (contained about 3000 kcal ME, and 24% CP) was formulated according to the recommended requirement of NRC, (1994). Also Khalifa *et al.* (2018) formulated iso-nitrogenous (24%

crude protein) and iso-caloric (2900 ME/kg of diet) to supply Japanese quail birds requirements according to NRC, (1994).

3.2 Chemical Composition of Meat (Breast and Thigh Muscles):

The average crude protein, ether extract and total

ash (%DM basis) percentage of broiler Japanese quail meat (breast and thigh muscles) in different treatments groups are presented in Table No. 2. The results were observed that the nutrient composition of breast and thigh muscles in terms of crude protein, ether extract and total ash percentage (on %

DM basis) were differed non-significantly ($P \geq 0.05$) different amongst different treatment groups of broiler Japanese quail fed diet with *Moringa oleifera* leaf meal at 42 days of experimental period.

Table 2: Nutrient composition (% DM basis) in meat (breast and thigh muscles) of broiler Japanese quail during finisher phase (at 6 weeks of age) fed diets incorporated with drumstick (*Moringa oleifera*) leaf meal

Attributes	Treatments									SEm	P-Value
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈			
Breast Muscles											
Crude protein	83.66±0.74	83.18±7.03	83.93±9.28	85.51±12.16	84.85±2.46	84.87±2.56	83.10±0.64	83.37±1.25	1.811	1.000	
Ether extract	12.07±0.67	11.22±0.42	11.19±1.12	10.06±0.45	9.17±0.16	9.67±0.42	10.96±0.62	10.20±1.40	0.292	0.217	
Total ash	5.32±0.05	5.68±0.26	5.67±0.39	5.91±0.12	6.04±0.33	6.11±0.48	5.28±0.05	5.25±0.52	0.118	0.405	
Thigh Muscles											
Crude protein	73.10±0.15	73.18±1.11	73.93±3.61	75.17±1.91	76.14±1.03	74.52±0.92	72.43±0.65	72.37±1.98	0.577	0.752	
Ether extract	18.41±0.77	18.30±0.48	18.53±0.51	17.06±2.22	14.34±0.83	17.01±0.75	17.63±0.29	17.53±0.07	0.383	0.112	
Total ash	6.27±0.56	6.24±0.51	6.20±0.19	6.31±0.22	6.43±0.37	6.08±0.46	5.98±0.43	5.95±0.37	0.126	0.989	

{T₁: Control; T₂: Basal diet with Vitamin C (200 mg/kg); T₃: Basal diet with Vitamin E (10 IU/kg); T₄: Basal diet with 1% MOLM; T₅: Basal diet with 3% MOLM; T₆: Basal diet with 5% MOLM; T₇: Basal diet with 7% MOLM; T₈: Basal diet with 9% MOLM}

The present study results showed that average moisture percentage, crude protein, ether extract, and total ash content in breast and thigh muscle were did not significantly ($P \geq 0.05$) influenced by the incorporation of *Moringa oleifera* leaf meal fed in diet of Japanese quail broiler birds at 42 days of experimental period. But statistically ether extract content was lower in 3% MOLM incorporated in diet of birds. Contradictory results were observed by Harshini *et al.* (2022) [12] reported that inclusion of *Moringa oleifera* leaf powder at 5 to 15% level showed increased in the crude protein content and decreased in crude fat content of meat of Kadaknath chicken. However, Gnanaraj *et al.* (2020) [10] found the lower values of crude protein and total ash content of meat upon feeding *M. oleifera* leaf powder to Kadaknath, Nicobari, and Naked neck chicken. Similarly Zanu *et al.* (2012) [21] found that the crude protein content of meat was significantly ($P \leq 0.05$) reduced and crude fat content was increased at 15% MOLM supplementation in diet of broiler chicken. Probable mechanism for reduction of fat in muscles

might be due to the presence of polyphenols, flavonoids, alkaloids properties of *Moringa* leaf meal.

3.3 Sensory Characteristics of breast muscles

The sensory characteristics viz., appearance, flavour, juiciness, texture, tenderness and overall acceptability of meat of Japanese quail birds of different treatment groups due to incorporation of *Moringa oleifera* leaf meal in the diet are shown in Table No.3, Figure 1 and Picture 2.

Results observed that a significant ($P \leq 0.05$) difference was observed in the appearance of meat of the broiler Japanese quail birds fed diet with different level of *Moringa oleifera* leaf meal during feeding trial. Significantly ($P \leq 0.05$) higher value was noticed in T₅ (7.51) group and lower value in T₁ (5.76) group. However, values were noted to be statistically similar in T₂, T₄, T₆, T₇ and T₈ treatment group. Non-significant ($P \geq 0.05$) difference was observed in the flavour of meat of the broiler Japanese quail fed diet with different level of *Moringa oleifera* leaf meal during 42th days of study period.

Table 3: Average values of sensory evaluation of meat (breast muscle) of broiler Japanese quail during finisher phase (at 6 weeks of age) fed diets incorporated with *Moringa olifera* leaf meal

Attributes	Treatments								SEM	P- Value
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈		
Appearance*	5.76±0.37 ^c	6.45±0.05 ^b	6.28±0.08 ^{bc}	6.78±0.12 ^b	7.51±0.14 ^a	6.63±0.07 ^b	6.48±0.14 ^b	6.31±0.16 ^b	0.109	0.011
Flavor	5.54±0.18	5.94±0.34	5.81±0.44	6.51±0.33	7.08±0.48	6.60±0.29	6.58±0.51	6.41±0.88	0.144	0.126
Juiciness*	5.13±0.31 ^c	5.58±0.08 ^{abc}	5.34±0.03 ^{bc}	6.67±0.08 ^{ab}	6.95±0.29 ^a	6.86±0.29 ^a	6.78±0.48 ^a	6.38±0.94 ^{abc}	0.190	0.028
Texture*	6.58±0.08 ^{bc}	6.10±0.14 ^c	6.81±0.47 ^{bc}	7.10±0.19 ^b	7.90±0.05 ^a	6.43±0.06 ^{bc}	6.40±0.18 ^{bc}	6.55±0.20 ^{bc}	0.125	0.001
Tenderness*	5.86±0.36 ^c	6.94±0.29 ^{ab}	6.54±0.10 ^{bc}	6.96±0.34 ^{ab}	7.58±0.08 ^a	6.99±0.26 ^{ab}	6.68±0.03 ^b	6.33±0.08 ^{bc}	0.121	0.004
Overall acceptability*	6.08±0.96 ^b	5.83±0.33 ^b	5.44±0.24 ^b	6.25±0.38 ^b	7.85±0.10 ^a	5.91±0.33 ^b	5.95±0.36 ^b	6.19±0.05 ^b	0.189	0.045

{T₁: Control; T₂: Basal diet with Vitamin C (200 mg/kg); T₃: Basal diet with Vitamin E (10 IU/kg); T₄: Basal diet with 1% MOLM; T₅: Basal diet with 3% MOLM; T₆: Basal diet with 5% MOLM; T₇: Basal diet with 7% MOLM; T₈: Basal diet with 9% MOLM}

Means with different superscripts (a, b, c) in a row differ significantly ($P \leq 0.05$) from each other; * significant

The juiciness of meat of J. quail birds were observed as 5.13±0.31, 5.58±0.08, 5.34±0.03, 6.67±0.08, 6.95±0.29, 6.86±0.29, 6.78±0.48, and 6.38±0.94 hedonic scale value for T₁, T₂, T₃, T₄, T₅, T₆, T₇ and T₈ treatment group respectively. Significantly ($P \leq 0.05$) more juiciness of meat in T₅ (6.95) group was noted as compared to T₁ (5.13) group respectively. Similarly, significant ($P \leq 0.05$) differences in texture of meat were observed when J. quail

broiler birds were offered incremental level of MOLM in their diet. The texture of meat of Japanese quail chicks were observed as 6.58±0.08, 6.10±0.14, 6.81±0.47, 7.10±0.19, 7.90±0.05, 6.43±0.06, 6.40±0.18, and 6.55±0.20 hedonic scale value for T₁, T₂, T₃, T₄, T₅, T₆, T₇ and T₈ treatment group respectively. Significantly ($P \leq 0.05$) more texture of meat was seen in T₅ group as compared to other treatment groups. Also significant ($P \leq 0.05$) differences in tenderness of meat were observed when J. quail birds were offered incremental level of MOLM in their diet and significantly

($P \leq 0.05$) more tenderness of meat in T_5 (7.58 ± 0.08) group was observed as compared to control (T_1) (5.86 ± 0.36) group. However, values were noted to be statistically similar in T_2 , T_4 , and T_6 treatment group. So overall acceptability of

Japanese quail meat was significantly ($P \leq 0.05$) affected by *Moringa oleifera* leaf meal inclusion in diet during this feeding trial.



Picture 2: Sensory evaluation of meat

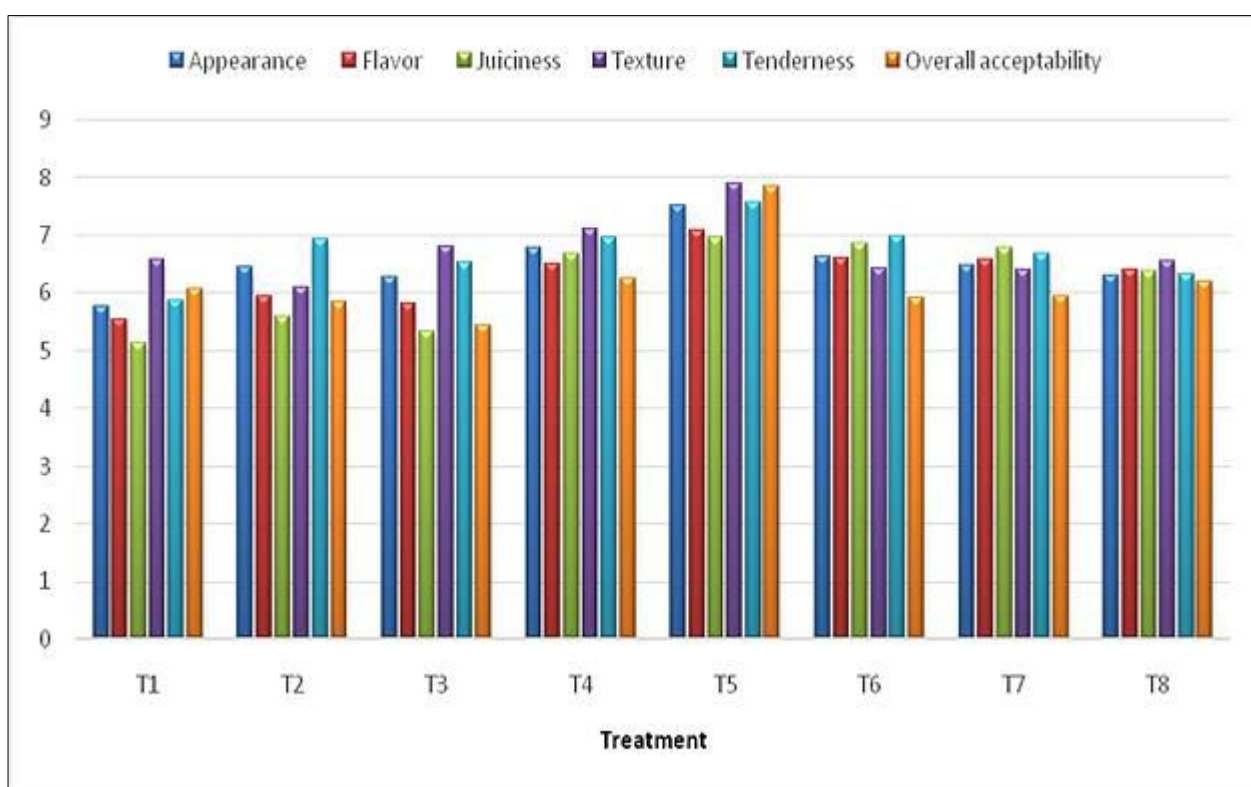


Fig 1: Average values of sensory evaluation of meat (breast muscle) of broiler Japanese quail during finisher phase (at 6 weeks of age) fed diets incorporated with *Moringa oleifera* leaf meal

In the present study, the physical characteristics viz., appearance, flavour, juiciness, texture, tenderness and overall acceptability of meat was significantly ($P \leq 0.05$) influenced by incorporation with different level of *Moringa oleifera* leaf meal (1.0, 3.0, 5.0, 7.0 and 9.0%) during this study period. Although incorporation of MOLM at 3.0% in diet of birds resulted in better overall acceptability of meat among all the treatment groups. This study was agreement with Harshini *et al.* (2022) [12] reported that inclusion of *Moringa oleifera* leaf powder at 5 to 15% level showed superior values for texture, juiciness, and overall acceptability upon organoleptic evaluation on an 8-point

hedonic scale by the sensory Panel. Similar findings were reported by Biswas *et al.* (2015) [5] in broiler chicken supplemented 0.5 to 2% *M. oleifera* leaf powder in the basal diet.

3.4 Processing Parameters

The processing parameters viz., feather weight, head weight, shank weight and abdominal fat weight of Japanese quail of different treatment groups due to incorporation of *Moringa oleifera* leaf meal in the diet are shown in Table No. 4 and expressed as percent of pre-slaughter live weight basis. The results obtained that a non-significant ($P \geq 0.05$) difference

was found in processing parameters viz., feather weight, head weight, shank weight and abdominal fat weight of the

Japanese quail fed diet incorporated with different level of *Moringa oleifera* leaf meal during 42th days of study period.

Table 4: Average values of processing parameters (% live weight) of Japanese quail during finisher phase (at 6 weeks of age) fed diets incorporated with *Moringa oleifera* leaf meal

Attributes	Treatments									P- Value
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	SEm	
Feather weight	5.05±0.24	5.60±0.41	5.47±0.08	5.66±0.58	5.34±0.19	5.42±0.34	6.13±0.57	5.85±0.25	0.127	0.622
Head weight	4.22±0.18	4.73±0.05	4.85±0.15	4.43±0.25	4.44±0.26	4.37±0.34	4.28±0.39	4.18±0.34	0.092	0.619
Shank weight	1.19±0.05	1.30±0.01	1.28±0.02	1.22±0.21	1.24±0.19	1.20±0.05	1.15±0.12	1.16±0.07	0.035	0.979
Abdominal fat weight	0.36±0.01	0.36±0.02	0.36±0.03	0.33±0.01	0.31±0.01	0.32±0.01	0.32±0.01	0.34±0.01	0.008	0.410

{T₁: Control; T₂: Basal diet with Vitamin C (200 mg/kg); T₃: Basal diet with Vitamin E (10 IU/kg); T₄: Basal diet with 1% MOLM; T₅: Basal diet with 3% MOLM; T₆: Basal diet with 5% MOLM; T₇: Basal diet with 7% MOLM; T₈: Basal diet with 9% MOLM}

In the present study, none of the parameters of processing losses were influenced by incremental level of MOLM incorporation in Japanese quail fed diet for 42 day of feeding trial. The outcomes of current study are in agreement of Zanu *et al.* (2012)^[21] reported that none of the parameter measured for processing losses in broiler chicken fed diets containing 5.0, 10.0, and 15.0% *Moringa* leaf meal was altered. But Aderinola *et al.* (2013)^[2] who reported that supplementation of *Moringa oleifera* leaf in broiler diets, decreased abdominal fat deposition and the utilization of MOLM in broiler diet could be adopted to produce broiler meat with low fat deposition. Similarly, Kout Elkloub *et al.* (2015) reported that MOLM significantly reduced abdominal fat in Japanese quail, and indicated that 0.2, 0.4 or 0.6% MOLM improved the proportion of spleen without significant differences as compared with control group. Likewise, Cui *et al.* (2018)^[7] found that the dietary supplementation of *Moringa oleifera* leaf in broiler chicken had decreased abdominal fat linearly.

4. Conclusion

Based on the findings of the research, it can be concluded that 3% drumstick (*Moringa oleifera*) leaf meal can be incorporated in feed for improvement of carcass characteristics; such sensory evaluation, and nutrient composition of meat of the broiler Japanese quail.

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Conflict of Interest: None.

Disclaimer (Artificial Intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (Chat GPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

Competing Interests

Author has declared that no competing interests exist.

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