



Effect of powdered leaves of Tulsi (*Ocimum sanctum*) and Moringa (*Moringa oleifera*) as herbal feed additives and various bedding materials on Japanese quail growth

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ABSTRACT

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The purpose of the study was to compare how Japanese quail growth performance was affected by dietary supplements such as Moringa (*Moringa oleifera*) and Tulsi (*Ocimum sanctum*) leaf powder as herbal feed additives. A uniform distribution of three hundred and sixty commercially-day-old Japanese quail chicks was made to raise them on three distinct bedding materials, designated B1, B2, and B3, which were sand, sawdust, and wheat straw, respectively. The chicks raised on each bedding material group were then split evenly into three dietary treatment groups and one control group. As a result, a total of 12 treatment groups were created, each of which included two duplicates, each containing 15 birds. Each of the 12 treatment groups was created using the appropriate bedding material and food supplements. Body weight, body weight gain, feed consumption, and feed conversion ratio were all significantly impacted by the dietary treatment groups, which included either Tulsi alone or Tulsi and Moringa together. Only feed consumption was found to be significantly impacted by bedding materials. No interaction impact was seen on any of the performance parameters during the trial. Thus, the current study found that Tulsi supplementation alone improves Japanese quail performance overall in terms of growth, followed by the group supplemented with a combination of Tulsi and Moringa. When compared to sand, Japanese quail raised on wheat straw and sawdust performed better in this trial. Therefore, it can be said that adding Tulsi to the diet improves the overall growth performance of Japanese quail.

Keywords: Bedding material, Japanese quail, Moringa, Performance, Tulsi

INTRODUCTION

With the rampant misuse of antibiotics in poultry, there is increased amount of chemical residue that is passed on to humans through the consumption of poultry products and, it is causing huge losses to the farmers due to emergence of diseases which are tolerant to the antibiotics. When more than one herb is combined, it is generally referred to as “Polyherbal” which has proven to be highly effective with its medicinal properties like antibacterial, antiviral, antifungal, antiprotozoal, hepatoprotective actions etc. without any significant adverse effects. Moringa (*Moringa oleifera*) a well-known cultivated species of family Moringaceae, genus Moringa, which comes under order Brassicales is mostly referred to as miracle tree or horseradish tree. Different parts of the *M. oleifera* tree had been used for humans as well as animals in various countries. Castillo *et al.* (2018) assessed that *Moringa oleifera* (MOR) leaf powder has antibacterial, nutritional, and nutraceutical properties in addition to its growth-promoting effects on Japanese quails and found out that MOR inhibited the growth of gram-positive and gram-negative bacteria. Another dietary supplement is Tulsi (*Ocimum sanctum*) which is widely valued for its therapeutic properties and is regarded to as “queen of herbs” as it has well-established

beneficial effects on the health of humans as well as animals. Tulsi has been employed in the treatment of various illnesses like fever, bronchitis, arthritis, convulsions (Prakash and Gupta, 2005) as it acts as like expectorant, analgesic, anti-cancer, anti-asthmatic, anti-anaemic, di-phoretic, anti-diabetic, hepato-protective, hypo-tensive and hypo-lipidemic. The litter material of choice for bedding can also have a noteworthy impact on carcass quality and performance of bird (Garcia *et al.*, 2012). Depending upon the cost and availability of different litter materials viz. sawdust, sand, wheat straw, rice husk etc. farmers have the option to choose according to their budget and will encourage them to rear poultry for a longer period.

MATERIALS AND METHODS

The study was carried out at Poultry unit, Livestock Farm Complex, Department of Livestock Production and Management, College of Veterinary and Animal Science, Bikaner, RAJUVAS and the proximate analysis of feed and supplements was carried out at Department of Animal Nutrition, College of Veterinary and Animal Science, RAJUVAS, Bikaner, Rajasthan.

Experimental Design

Three hundred and sixty chicks of zero-day age were procured from Hatchery of “Central Poultry Development Organization” (Northern Region),

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Chandigarh for the research purpose. According to fully randomized design, the birds were allocated to twelve different treatment groups each having thirty (30) birds and every single treatment The group was subsequently separated into two (2) replicates, each of which included fifteen birds (Table 1). The experiment was carried out for a time period of six weeks (42 days) from 24th October to 4th December 2020.

Experimental feed along with their proximate composition

Birds were supplemented with Moringa (*Moringa oleifera*) leaf powder and Tulsi (*Ocimum sanctum*) leaf powder that was ready-made and commercially available at the rate of 0.5% alone as well in combination ((i.e., 0.5% Moringa leaf powder + 0.5% Tulsi powder) as per the various treatment groups. The proximate analysis of broiler starter and broiler finisher feed were carried out using standard method of analysis (AOAC, 2005) and are presented in the Table 2.

Proximate analysis of broiler starter and finisher rations were carried out using standard method of analysis (AOAC, 2005) and offered for first three weeks and for

the last 21 days of experiment, respectively. Throughout the trial, each group was given unlimited access to feed, and weekly feed consumption was noted for each group.

Table 2: Proximate composition of broiler starter and finisher ration

S.No.	Proximate Principle	Broiler starter	Broiler Finisher
1.	Dry Matter (%)	92.35	92.60
2.	Crude Protein (%)	21.6	19.5
3.	Ether Extract (%)	5.4	6.7
4.	Crude Fibre (%)	3.37	3.22
5.	Total Ash (%)	8.2	8.8
6.	Nitrogen Free Extract (%)	61.43	61.78

Management of Birds

Prior to the arrival of birds, old litter material from the brooder house was removed and thoroughly cleaned with suitable disinfectant solution. All circular feeders and waterers were washed and cleaned properly with disinfectant. On 5th day, fumigation of the experimental

Table1: Random distributions of Japanese Quail chicks into experimental groups

Bedding material	Treatment group	Treatment details	No. of chicks
B ₁ (Sand)	T ₁₀	T ₁₀ R ₁ Basal diet	15
		T ₁₀ R ₂ Basal Diet	15
	T ₁₁	T ₁₁ R ₁ Basal diet + 0.5% Moringa leaf powder	15
		T ₁₁ R ₂ Basal diet + 0.5% Moringa leaf powder	15
	T ₁₂	T ₁₂ R ₁ Basal diet + 0.5% Tulsi leaf powder	15
		T ₁₂ R ₂ Basal diet + 0.5% Tulsi leaf powder	15
	T ₁₃	T ₁₃ R ₁ Basal diet + 0.5% Moringa leaf powder + 0.5% Tulsi leaf powder	15
		T ₁₃ R ₂ Basal Diet + 0.5% Moringa leaf powder+ 0.5% Tulsi leaf powder	15
B ₂ (Sawdust)	T ₂₀	T ₂₀ R ₁ Basal diet	15
		T ₂₀ R ₂ Basal diet	15
	T ₂₁	T ₂₁ R ₁ Basal diet + 0.5% Moringa leaf powder	15
		T ₂₁ R ₂ Basal diet + 0.5% Moringa leaf powder	15
	T ₂₂	T ₂₂ R ₁ Basal diet + 0.5% Tulsi leaf powder	15
		T ₂₂ R ₂ Basal diet + 0.5% Tulsi leaf powder	15
	T ₂₃	T ₂₃ R ₁ Basal diet + 0.5% Moringa leaf powder + 0.5% Tulsi leaf powder	15
		T ₂₃ R ₂ Basal diet + 0.5% Moringa leaf powder + 0.5% Tulsi leaf powder	15
B ₃ (Wheat straw)	T ₃₀	T ₃₀ R ₁ Basal diet	15
		T ₃₀ R ₂ Basal diet	15
	T ₃₁	T ₃₁ R ₁ Basal diet + 0.5% Moringa leaf powder	15
		T ₃₁ R ₂ Basal diet + 0.5% Moringa leaf powder	15
	T ₃₂	T ₃₂ R ₁ Basal diet + 0.5% Tulsi leaf powder	15
		T ₃₂ R ₂ Basal diet + 0.5% Tulsi leaf powder	15
	T ₃₃	T ₃₃ R ₁ Basal diet + 0.5% Moringa leaf powder + 0.5% Tulsi leaf powder	15
		T ₃₃ R ₂ Basal diet + 0.5% Moringa leaf powder + 0.5% Tulsi leaf powder	15
TOTAL	360		

rooms was done using formaldehyde and KMnO_4 or a period of 24 hours, while performing this procedure all windows of the brooder house were closed. After 24 hours, brooder house was opened, and exhaust fans were used to allow the escape of smell and making it suitable for harboring chicks. New bedding material was laid on the floor and newspapers were widely spread in whole room. Brooder and chick guards were set up with lights switched on 24 hours prior to the arrival of chicks to maintain adequate temperature. At the entrance of the house foot bath with suitable disinfectant was arranged which helps in preventing the spread of disease. Standard management practices were followed during the investigation trial.

Ventilation: The brooder house was properly ventilated and devoid of drafts, because the drafts adversely affect growth and livability of birds. Adequate ventilation reduces dust, high moisture and excess ammonia from poultry house.

Parameters Studied

The parameters that were recorded during experimental trial are described below:

Weekly mean body weight: The chicks were weighed separately on the first day of the experiment and then every week for six weeks.

Average body weight gain: The weight of the bird obtained during the previous week was subtracted from the weight of the bird taken during the current week of the experimental trial to determine the weekly body weight gain. Additionally noted was the cumulative body weight gain during the trial period.

Weekly average feed consumption: Each bird's weekly feed intake was noted, and the average feed intake in grams per bird per week was computed by dividing the total feed intake by the number of birds in each pen. Every day, the amount of leftover feed in each pen was weighed and deducted from the total amount of feed the birds received. Additionally, the total amount of feed consumed during the trial period was noted.

Weekly feed conversion ratio: The entire amount of feed consumed divided by the total body weight gain of the bird during that week was used to determine the feed conversion ratio for each week.

$$\text{FCR (\%)} = \frac{\text{Average feed consumption (g) during the week}}{\text{Average body weight gain (g) during the week}} \times 100$$

Statistical Analysis

The experimental data recorded during experiment have been statistically examined utilizing the statistical package SPSS software Ver.20 and the factorial analysis of variance interaction design (Snedecor and Cochran, 1989). Duncan's Multiple Range Test was used to determine whether the means of the several experimental groups were of statistical significance (Duncan, 1955).

RESULTS AND DISCUSSION

The following presents the findings of the current study, which was conducted to determine the growth performance of Japanese quail by supplementing a variety of bedding materials with powdered Moringa (*Moringa oleifera*) and Tulsi (*Ocimum sanctum*) leaf powder.

Weekly average body weight

Effect of dietary supplementation: Weekly body weight (g/bird) means of Japanese quail as per various dietary treatment groups are presented in table 3. Mean sum of squares obtained with analysis of variance is given in table 6.

The results thus obtained indicate that Tulsi alone as well as combination of Tulsi and Moringa proved to be beneficial to Japanese quail in terms of total mean body weight, but highly potent effect was noticed in case of dietary supplementation of Tulsi alone. The statistical analysis of data revealed highly significant ($P \leq 0.01$) effect of incorporation of supplements on mean body weight of Japanese quail at completion of study at 6th week.

The results obtained were like the findings of Alom et al. (2015), Bhosale et al. (2015), and Biswas et al. (2017). Similarly, Khatun et al. (2013) reported that in all treatment groups supplementation with Tulsi (*Ocimum sanctum*) leaves extract @ 1ml, 2ml and 3ml/liter of drinking water resulted in significant ($P \leq 0.05$) increase in mean live weight when compared to control group. Regarding supplementation of Moringa the results of the present study were supported by Akhouri et al. (2014), Okafor et al. (2014), Minj et al. (2018), and Kouatcho et al. (2019).

Effect of different bedding materials: Weekly body weight (g/bird) mean of Japanese quail based on bedding materials in different groups is listed in table 4. These results were in close association with Hafeez et al. (2009) who concluded that any type of bedding material can be used among sand, sawdust or wheat straw. However, Mohammed et al. (2017) found that the performance of quail was not significantly impacted by the type of bedding used.

Interaction effect of dietary supplements and bedding materials: The average body weight of Japanese quail based on interaction between dietary supplements and different bedding materials, subjected to various treatment groups, weekly data has been documented and presented in table 5.

The statistical analysis of data revealed overall no effect of interaction between incorporation of dietary supplements & different bedding materials throughout the experiment. However, T₃₂ group reported the highest overall body weight (199.18 g/bird) at the end of experiment when compared to rest of the groups.

Table 3: Effect of dietary supplementation on body weight (g) at different weeks

Supplement effect	Age in weeks						
	Day old	1 st	2 nd	3 rd	4 th	5 th	6 th
T ₀	5.40	29.42 ^a	56.70 ^a	95.54 ^a	124.83 ^a	148.90 ^a	169.17 ^a
T ₁	5.51	30.59 ^{ab}	58.94 ^b	98.77 ^b	129.09 ^b	154.35 ^b	176.92 ^b
T ₂	5.39	31.35 ^b	61.26 ^c	105.24 ^d	140.04 ^d	170.46 ^d	197.64 ^d
T ₃	5.38	31.30 ^b	61.03 ^c	102.09 ^c	135.47 ^c	164.20 ^c	188.69 ^c
SEM	0.120	0.468	0.440	0.615	0.736	1.635	1.849

Table 4: Effect of bedding materials on body weight (g) at different weeks

Bedding effect	Age in weeks						
	Day old	1 st	2 nd	3 rd	4 th	5 th	6 th
B ₁	5.40	29.74 ^a	57.78 ^a	97.55 ^a	127.75 ^a	156.73	180.67
B ₂	5.45	31.35 ^b	61.10 ^c	102.10 ^b	134.65 ^b	161.12	184.11
B ₃	5.41	30.89 ^{ab}	59.58 ^b	101.57 ^b	134.67 ^b	160.58	184.54
SEM	0.104	0.405	0.381	0.533	0.638	1.416	1.601

Table 5: Effect of dietary supplements and bedding materials interaction on body weight (g) at different weeks

Interaction Effect	Day old	1 st week	2 nd week	3 rd week	4 th week	5 th week	6 th week
T ₁₀	5.52	29.10	56.75	93.40	121.67	149.17	169.40
T ₁₁	5.39	29.40	56.97	94.67	123.60	150.17	173.64
T ₁₂	5.52	30.10	56.77	99.17	134.46	166.20	194.50
T ₁₃	5.19	30.38	58.64	98.99	131.28	161.38	185.13
T ₂₀	5.50	30.25	57.35	98.02	127.95	149.75	169.85
T ₂₁	5.61	31.83	61.37	99.97	132.01	156.91	178.85
T ₂₂	5.25	31.85	63.55	107.99	143.09	174.82	199.18
T ₂₃	5.43	31.49	62.13	102.45	135.54	163.01	188.56
T ₃₀	5.20	28.91	56.02	95.22	124.88	147.78	168.28
T ₃₁	5.52	30.54	58.51	101.68	131.67	155.97	178.27
T ₃₂	5.39	32.09	61.46	104.56	142.56	170.36	199.23
T ₃₃	5.52	32.04	62.35	104.85	139.59	168.22	192.39
SEM	0.208	0.810	0.763	1.066	1.276	2.833	3.203

Table 6: Mean sum of squares for body weight at different weeks

Source of variation	DF	Age in weeks						
		MEAN SQUARES						
		0	I	II	III	IV	V	VI
Supplement	3	0.021	4.868*	27.164**	105.061**	271.949**	562.312**	949.433**
Bedding	2	0.004	5.503*	22.098**	49.508**	127.260**	45.914	36.061
Interaction (TxB)	6	0.059	0.763	2.985	5.886	6.359	15.160	7.568
Error	11	0.087	1.314	1.165	2.274	3.256	16.057	20.519

*= significant (P≤0.05), **= highly significant(P≤0.01)

Weekly average body weight gain

Effect of dietary supplementation: Means of weekly body weight gain (g/bird) of Japanese quail among various treatment groups recorded at weekly intervals are presented in table 7. Mean sum of squares obtained by

analysis of variance for weekly average body weight gain is presented in table 10.

The overall results of experiment indicate that feeding Japanese quail with Tulsi, either alone or in combination with Moringa as a feed addition has

improved body weight gain. Regarding supplementation of Moringa alone in the diet, no effect on mean weight gain was observed but numerically higher value was found than control group.

The results observed were similar to the findings of Gupta and Charan (2007), Pandian *et al.* (2013), Srivastava *et al.* (2013) and Kumar *et al.* (2019) who concluded that supplementation of holy basil leaf in broilers diet significantly improved body weight gain. Kouatcho *et al.* (2019) also reported higher body weight gain by supplementing 1% level of Moringa.

Effect of bedding material: Weekly body weight gain (g/bird) means of Japanese quail based on the effect of bedding materials in different groups are given in table 8. The mean sum of squares obtained with analysis of variance is given in table 10.

The results obtained in present trial fall in line with the findings of Hafeez *et al.* (2009), Davis *et al.* (2010), Navneet *et al.* (2011), Farghly *et al.* (2012) and Mohammed *et al.* (2017) as no effect of different litter material was observed on weekly body weight gain. Hafeez *et al.* (2009) and Onu *et al.* (2011) concluded that sawdust, sand and wheat straw, any of these bedding materials may be used.

Interaction effect of dietary supplementation and bedding materials: The mean body weight gain of Japanese quail since the interaction between dietary supplements and different bedding materials of various groups at different weeks of age has been depicted in Table 9.

The statistical analysis revealed a non-significant effect of interaction between the incorporation of dietary supplements and different bedding materials throughout

Table 7: Effect of dietary supplements on body weight gain (g) at different weeks

Supplement Effect	Age in weeks						Cumulative
	1 st	2 nd	3 rd	4 th	5 th	6 th	
T ₀	24.01 ^a	27.28 ^a	38.83 ^a	29.29 ^a	24.06 ^a	20.27 ^a	163.77 ^a
T ₁	25.08 ^{ab}	28.35 ^{ab}	39.82 ^{ab}	30.32 ^a	25.25 ^{ab}	22.56 ^b	171.41 ^b
T ₂	25.96 ^b	29.91 ^b	43.97 ^c	34.80 ^b	30.42 ^c	27.17 ^c	192.25 ^d
T ₃	25.92 ^b	29.72 ^b	41.05 ^b	33.38 ^b	28.73 ^{bc}	24.49 ^b	183.31 ^c
SEM	0.485	0.500	0.549	0.651	1.169	0.657	1.827

Table 8: Effect of bedding materials on body weight gain (g) at different weeks

Bedding Effect	Age in weeks						Cumulative
	1 st	2 nd	3 rd	4 th	5 th	6 th	
B ₁	24.34	28.03 ^a	39.77 ^a	30.20 ^a	28.97	23.93	175.26
B ₂	25.90	29.74 ^b	41.00 ^{ab}	32.54 ^b	26.47	22.98	178.66
B ₃	25.48	28.68 ^{ab}	41.99 ^b	33.10 ^b	25.90	23.96	179.13
SEM	0.420	0.433	0.476	0.564	1.012	0.569	1.582

Table 9: Effect of dietary supplements and bedding materials interaction on body weight gain (g) at different weeks

Interaction Effect	1 st week	2 nd week	3 rd week	4 th week	5 th week	6 th week	Cumulative
T ₁₀	23.57	27.65	36.65 ^a	28.27	27.50	20.23	163.88
T ₁₁	24.01	27.56	37.70 ^{ab}	28.93	26.57	23.47	168.25
T ₁₂	24.58	28.66	44.40 ^d	31.30	31.73	28.30	188.98
T ₁₃	25.19	28.25	40.35 ^{bc}	32.30	30.10	23.75	179.94
T ₂₀	24.75	27.10	40.67 ^{bc}	29.93	21.80	20.10	164.35
T ₂₁	26.22	29.53	38.60 ^{ab}	32.05	24.90	21.93	173.24
T ₂₂	26.60	31.70	44.44 ^d	35.10	31.73	24.36	193.93
T ₂₃	26.06	30.63	40.32 ^{bc}	33.10	27.47	25.55	183.13
T ₃₀	23.71	27.10	39.20 ^{ab}	29.66	22.90	20.50	163.08
T ₃₁	25.01	27.96	43.17 ^{cd}	30.00	24.30	22.30	172.75
T ₃₂	26.70	29.37	43.10 ^{cd}	38.00	27.80	28.87	193.84
T ₃₃	26.52	30.30	42.50 ^{cd}	34.75	28.63	24.17	186.87
SEM	0.841	0.867	0.952	1.128	2.025	1.138	3.165

the experiment. However, T₂₂ group reported the highest cumulative body weight gain (193.93 g/bird) at the end of the trial as compared to rest of the groups.

Weekly average feed consumption

Effect of dietary supplementation: The data of weekly mean feed consumption (g/bird) of Japanese quail

because of dietary supplementation among various treatment groups have been depicted in table 11. The mean sum of squares obtained with analysis of variance has been given in table 14.

The result of the present study agreed with the findings of various scientists Gupta and Charan (2007),

Table 10: Mean sum of squares for body weight gain (g) at different weeks

Source of variation	DF	Age in weeks						
		MEAN SQUARES						
		I	II	III	IV	V	VI	I-VI
Supplement	3	5.039*	9.188**	29.815**	39.764**	52.597**	51.382**	953.631**
Bedding	2	5.269	5.958*	9.873*	18.979**	21.327	2.468	35.696
Interaction (S×B)	6	0.591	1.597	6.626*	4.444	4.503	4.236	6.788
Remainder	12	1.415	1.505	1.814	2.548	8.208	2.592	20.638

Table 11: Effect of dietary supplements on feed consumption (g) in different weeks

Supplement Effect	Age in weeks						Cumulative
	1 st	2 nd	3 rd	4 th	5 th	6 th	
T ₀	46.25 ^b	65.92 ^b	117.97 ^b	102.90 ^b	91.64	87.52	512.22 ^c
T ₁	38.77 ^a	55.77 ^a	111.72 ^a	93.83 ^a	91.45	85.66	477.22 ^b
T ₂	37.29 ^a	53.24 ^a	108.16 ^a	93.14 ^a	77.79	85.90	455.54 ^a
T ₃	39.41 ^a	51.97 ^a	105.80 ^a	92.43 ^a	85.00	80.92	455.55 ^a
SEM	0.927	1.382	1.863	2.038	3.691	2.330	5.488

Table 12: Effect of bedding material on feed consumption (g) in different weeks

Bedding Effect	Age in weeks						Cumulative
	1 st	2 nd	3 rd	4 th	5 th	6 th	
B ₁	38.51 ^a	52.80 ^a	110.90	97.80	82.35 ^a	84.46	466.85 ^a
B ₂	41.52 ^b	57.33 ^b	112.43	95.51	79.00 ^a	82.31	468.12 ^a
B ₃	41.27 ^b	60.05 ^c	109.40	93.41	98.06 ^b	88.21	490.42 ^b
SEM	0.803	1.197	1.614	1.765	3.691	2.018	1.227

Table 13: Effect of dietary supplements and bedding materials Interaction on Feed Consumption (g) in different weeks

Interaction Effect	1 st week	2 nd week	3 rd week	4 th week	5 th week	6 th week	Cumulative
T ₁₀	43.24	62.55	117.50 ^{ef}	102.57	81.64	86.73 ^{ab}	494.25
T ₁₁	37.25	53.34	113.98 ^{de}	96.13	93.48	80.63 ^a	474.83
T ₁₂	36.18	46.76	106.65 ^{ab}	101.85	75.95	94.91 ^b	462.31
T ₁₃	37.36	48.56	105.50 ^{ab}	90.65	78.35	75.59 ^a	436.02
T ₂₀	47.43	62.92	124.34 ^f	104.96	84.70	87.24 ^{ab}	511.60
T ₂₁	41.35	58.62	105.20 ^{ab}	96.80	79.03	77.57 ^a	458.57
T ₂₂	37.27	52.63	116.32 ^{de}	87.29	71.36	76.71 ^a	441.59
T ₂₃	40.02	55.15	103.88 ^a	92.99	80.92	87.75 ^{ab}	460.73
T ₃₀	48.09	72.30	112.08 ^{bcd}	101.15	108.60	88.59 ^{ab}	530.83
T ₃₁	37.72	55.35	115.99 ^{cd}	88.56	101.85	98.77 ^b	498.26
T ₃₂	38.42	60.34	101.52 ^a	90.28	86.05	86.08 ^{ab}	462.71
T ₃₃	40.85	52.22	108.02 ^{bc}	93.64	95.73	79.43 ^a	469.89
SEM	1.606	2.394	3.228	3.531	6.394	4.036	9.507

Gadzirayi et al. (2012), Khatun et al. (2013), Pandiyan et al. (2013), Srivastava et al. (2013), Okafor (2014), Singh et al. (2014), Bhosale et al. (2015), Minj et al. (2018), Kouatcho et al. (2019) and Kumar et al. (2019). They investigated on inclusion of *Moringa oleifera* and *Ocimum sanctum* leaves and observed similar results.

Effect of bedding material: Weekly mean feed consumption of Japanese quail according to bedding materials have been presented in table 13. The mean sum of squares obtained with analysis of variance has been given in Table 15. In the present experiment, the feed intake of groups reared on different bedding materials were found highly significant and these results were varying from the one reported by Mohammed et al. (2017) who concluded non-significant effect of bedding materials on quail performance including feed consumption. Hafeez et al. (2009) however also found out non-significant effect of bedding materials on broiler performance.

Interaction effect of dietary supplementation and bedding materials: the mean values of feed consumption in Japanese quail based on interaction between dietary supplementation and different bedding materials of different treatment groups at different weeks of age have been depicted in table 13.

The statistical analysis of the data shown in Table 14 revealed a significant effect of interaction between

the incorporation of dietary supplements and different bedding materials on feed consumption during 3rd week of age however highly significant effect was seen during 6th week of age. The overall effect was found non-significant. Group T₃₀ reported the highest feed consumption (530.83 g/bird) from 1st to 42nd days of experimental trial when compared to rest of the groups.

Weekly average feed conversion ratio

Effect of dietary supplementation: Weekly mean feed conversion ratio (FCR) of Japanese quail based on dietary supplementation in different treatment groups are illustrated in table 15. The mean sum of squares obtained with analysis of variance is given in table 18.

The result of the present study agreed with the findings of various scientists: Gupta and Charan (2007), Khatun et al. (2013), Pandiyan et al. (2013), Srivastava et al. (2013), Okafor (2014), Singh et al. (2014), Bhosale et al. (2015), Minj et al. (2018), Kouatcho et al. (2019) and Kumar et al. (2019). They investigated on inclusion of *Moringa oleifera* and *Ocimum sanctum* leaves so observed similar results.

Effect of bedding material: Weekly mean feed consumption ratio of Japanese quail according to the bedding materials in different groups are presented in table 16.

Table 14: Mean sum of squares for Feed Consumption (g) in different weeks

Source of variation	DF	Age in weeks						
		MEAN SQUARES						
		I	II	III	IV	V	VI	I-VI
Supplement	3	95.139**	240.393**	168.422**	144.998**	258.226	48.470	4295.324**
Bedding	2	22.317*	107.216**	18.341	38.626	828.008**	71.380	1406.015**
Interaction (SxB)	6	3.569	27.546	81.535*	44.609	54.442	145.398**	321.914
Remainder	12	5.163	11.468	20.840	24.936	81.781	32.591	180.767

Table 15: Effect of dietary supplements on Feed Conversion Ratio (FCR) at different weeks

Supplement Effect	Age in weeks						Cumulative
	1 st	2 nd	3 rd	4 th	5 th	6 th	
T ₀	1.92 ^b	2.41 ^c	3.04 ^c	3.51 ^c	3.86 ^b	4.32 ^c	3.12 ^c
T ₁	1.54 ^a	1.96 ^b	2.81 ^b	3.09 ^b	3.65 ^b	3.81 ^b	2.78 ^b
T ₂	1.43 ^a	1.78 ^a	2.45 ^a	2.71 ^a	2.61 ^a	3.16 ^a	2.37 ^a
T ₃	1.52 ^a	1.74 ^a	2.57 ^a	2.77 ^a	2.97 ^a	3.30 ^a	2.48 ^a
SEM	0.053	0.045	0.052	0.052	0.192	0.114	0.042

Table 16: Effect of bedding materials on feed conversion ratio (FCR) at different weeks

Bedding Effect	Age in weeks						Cumulative
	1 st	2 nd	3 rd	4 th	5 th	6 th	
B ₁	1.59	1.89 ^a	2.81 ^b	3.25 ^b	2.87 ^a	3.57	2.67
B ₂	1.60	1.94 ^a	2.74 ^{ab}	2.95 ^a	3.07 ^a	3.62	2.63
B ₃	1.63	2.10 ^b	2.61 ^a	2.85 ^a	3.87 ^b	3.76	2.76
SEM	0.046	0.039	0.045	0.045	0.166	0.099	0.036

Similar findings were reported by Hafeez *et al.* (2009), Davis *et al.* (2010), Navneet *et al.* (2011), Farghly *et al.* (2012), Mohammed *et al.* (2017) as non-significant effect of different litter material was observed on weekly body weight gain.

Interaction effect of dietary supplementation and bedding materials: The mean values of feed conversion ratio for Japanese quail based on interaction between dietary supplements and different bedding materials across different treatment groups at different weeks of age is depicted in Table 17.

The statistical analysis of data showed in table 18 revealed significant ($P \leq 0.05$) effect of interaction between incorporation of dietary supplementation and different bedding materials on feed conversion ratio. The effect was found highly significant ($P \leq 0.01$) during fourth week of age. The effect was found non-significant during 1st, 3rd, 5th, and 6th weeks of age. However, group T₂₂ reported best cumulative feed conversion ratio (2.28) at the end of the experimental trial.

CONCLUSION

Thus, the current study found that Tulsi supplementation alone improves Japanese quail performance overall in terms of production, followed by the group supplemented with a combination of Tulsi and Moringa. When compared to sand, Japanese quail raised

on wheat straw and sawdust performed better in this experiment, and there was no apparent association between the bedding material and food supplements. Accordingly, the study concludes that Tulsi supplementation improves Japanese quail performance overall, including growth performance. A stronger benefit was seen when Tulsi and Moringa herbs were combined, as opposed to when Moringa was added alone.

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Table 17: Effect of dietary supplement and bedding material interaction on feed conversion ratio (FCR) at different weeks

Interaction Effect	1 st week	2 nd week	3 rd week	4 th week	5 th week	6 th week	Cumulative
T ₁₀	1.84	2.26 ^{de}	3.21	3.63 ^g	2.96	4.28	3.01
T ₁₁	1.56	1.94 ^{bc}	3.02	3.32 ^f	3.54	3.45	2.82
T ₁₂	1.47	1.64 ^a	2.40	3.26 ^{ef}	2.38	3.35	2.44
T ₁₃	1.48	1.72 ^{ab}	2.61	2.81 ^{cd}	2.61	3.18	2.42
T ₂₀	1.91	2.32 ^e	3.05	3.51 ^{fg}	3.88	4.34	3.11
T ₂₁	1.57	1.98 ^{bc}	2.72	3.02 ^{de}	3.17	3.53	2.64
T ₂₂	1.40	1.66 ^a	2.61	2.49 ^{ab}	2.29	3.16	2.28
T ₂₃	1.53	1.8 ^{abc}	2.57	2.81 ^{cd}	2.94	3.43	2.51
T ₃₀	2.03	2.67 ^f	2.86	3.41 ^{fg}	4.73	4.33	3.25
T ₃₁	1.50	1.97 ^{bc}	2.68	2.95 ^{cd}	4.23	4.44	2.88
T ₃₂	1.43	2.05 ^{cd}	2.35	2.37 ^a	3.16	2.98	2.39
T ₃₃	1.54	1.73 ^{ab}	2.54	2.70 ^{bc}	3.36	3.28	2.51
SEM	0.092	0.079	0.090	0.091	0.333	0.198	0.072

Table 18: Mean sum of squares for FCR at different weeks

Source of variation	DF	Age in weeks						
		MEAN SQUARES						
		I	II	III	IV	V	VI	I-VI
Supplement	3	0.285**	0.567**	0.405**	0.820**	2.028**	1.662**	0.688**
Bedding	2	0.003	0.101**	0.085*	0.344**	2.230**	0.080	0.031
Interaction (Tx B)	6	0.007	0.036*	0.029	0.078**	0.218	0.207	0.016
Remainder	12	0.017	0.012	0.016	0.016	0.222	0.078	0.010

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