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Effect of supplementation of Tulsi (*Ocimum sanctum*) and Ginger (*Zingiber officinale*) powder as feed additives on growth performance of Japanese quail (*Coturnix japonica*)

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Abstract
An experiment was carried out in 210, chicks of Japanese quails from day-old to eight weeks of age to study the "effect of supplementation of Tulsi (*Ocimum sanctum*) and ginger (*Zingiber officinale*) powder as feed additives on growth performance of Japanese quails **(***Coturnix japonica*)*"*. The birds were randomly divided into seven different dietary treatment groups with 3 replicates (10 birds in each replication). The treatment groups consisted of control group (T_1) fed only basal diet, T_2 supplemented with 0.5% Tulsi powder, T_3 supplemented with 0.5% ginger powder, T_4 supplemented with 0.25% Tulsi powder + 0.25% ginger powder, T_5 supplemented with 1% Tulsi powder, T_6 supplemented with 1% ginger powder and T_7 supplemented with 0.5% Tulsi powder + 0.5% ginger powder in the basal diet. The growth performance (weekly body weight and body weight gain) and feed efficiency (feed conversion ratio and feed intake) was measured weekly. Feed intake recorded daily basis. The results revealed a significant difference ($p< 0.05$) in body weight, body weight gain, feed intake and FCR among the treatments supplemented with Tulsi and ginger powder and control group. The weekly body weight and body weight gain were significantly highest in T_7 and lowest in control group. Whereas, feed intake and feed conversion ratio were significantly lowest in T_7 and highest in T_1 group. During the period of experiment, it may be concluded that 0.5% Tulsi + 0.5% ginger powder supplementation enhance the feed efficiency and feed conversion ratio of Japanese quails.

Keywords: Japanese quail, Tulsi, ginger, feed intake, feed conversion ratio

1. Introduction
Quail commonly referred to as "Batter", are a member of the pheasant family. It is small species of bird that was domesticated first time in Japan and introduced to India in 1974 from California. There are primarily two species of quail present in India: The Japanese quail (*Coturnix coturnix japonica*) and the black breasted quail (*Coturnix coromandelica*). When compared to chicken, quail grow quickly, have a close generation gap, and need less space. A quail requires less vaccination and medication than chickens because they are more resistant to disease. At six to seven weeks old, broiler quails reach sexual maturity and begin to lay eggs. Consequently, can sale at the age of five weeks. For the purpose of eggs and meat, quails are reared. It is the one of best sources of non-vegetarian food and a useful converter of agricultural waste or cereals to animal protein. The consumption of quail egg and meat has also increased considerably. Japanese quail meat and eggs are renowned for being rich in vitamins, essential amino acids, unsaturated fatty acids and phospholipids, which are very important for human physical and mental development. Japanese quail eggs and meat can be induced in the diet of children, pregnant ladies and geriatric and convalescent patients.
Herbal feed additive being natural, non-toxic and easy availability make them first choice as alternate to chemical growth promoters in poultry production. They have many positive effects on birds including appetite stimulation, enhance digestibility and possess bactericidal, antiviral, anti-oxidant properties when supplemented in diets for birds.

Throughout the India, Tulsi is considered the most sacred herb and Ayurveda has well described the use of Tulsi as an aromatic herb, belongs to the Labiateae family. In Sanskrit, the name "Tulsi" means "incomparable" and the entire plant is used as a remedy source (Bansod *et al.*, 2008) [2]. For antimicrobial, immunemodulatory, anti-stress, anti-inflammatory, antipyretic, anti-asthmatic, hypoglycemic, hypotensive and analgesic activities, this plant has been studied pharmacologically (Chiang *et al.*, 2005) [3]. The main constituents responsible for these properties are eugenol, ascorbic acid, ß- carotene, ß-sitosterol, palmitic acid and tannins (Gupta *et al.* 2006, Choudhary *et al.*, 2010) [9, 4]. Herbal feed additives could serve as safer alternatives as growth promoter due to their suitability and preference, lower cost of production, reduced risks of toxicity and minimum health hazards. Ginger belongs to the Zingiberaceae family, used as a delicacy, condiment or spice and used as a medicinal plant for disease prevention or growth (Chrubasik *et al.*, 2005) [5]. Gingerol, gingerdiol and gingerdione are main compounds that have the potential to activate or quicken digestive system enzymes, stimulate microbial activity and have antioxidant activity (Dieumou *et al.*, 2009) [7]. Ginger (*Zingiber officinale*) has been found to be an alternate antibiotic growth promoter (Demir *et al.*, 2003) [6]. It also reported to improve growth, reduced the mortality rate and increase the feed efficiency in poultry birds. Ginger is one of the natural plants which can be used as phyto-biotic to improve quail's performance. The present investigation was planning to study the effect of supplementation of Tulsi and ginger powder as feed additives on growth performance of Japanese quails.

Materials and Methods

The experiment carried out at poultry farm, Department of Animal Production, Rajasthan College of Agriculture, MPUAT, Udaipur, for a period of 8 weeks. The study was to find out the optimum inclusion level of Tulsi and ginger powder in bird diet and observe the effect of Tulsi and ginger on growth parameters in Japanese quails.

Procurement of feed: The experimental diets were formulated as per NRC (1994) [12] and showed in table 1. The chemical analysis of the experimental feed was carried out as per AOAC (2016) [1]. Birds were provided free access to feed and water during the entire experimental period.

Table 1: Chemical composition of experimental feeds (%)

	T_1	T_2	T_3	T_4	T_5	T_6	T_7
Dry matter	94.86	94.46	94.02	94.28	94.70	94.14	94.18
Crude Protein	24.17	24.06	24.06	24.06	23.96	23.95	23.96
Crude Fiber	4.01	4.07	4.01	4.04	4.14	4.00	4.07
Ether Extract	2.95	2.97	2.94	2.96	2.99	2.94	2.96
Nitrogen Free Extract	59.75	59.34	59.04	59.23	59.58	59.29	59.19
Ash	3.98	4.01	3.97	3.99	4.03	3.96	4.00

Experimental birds: The study was conducted on 210 day-old chicks which were taken from the hatchery unit of Poultry farm, Department of Animal Production, Rajasthan College of Agriculture, Udaipur, Rajasthan. The birds were randomly divided into 7 treatments of 3 replicates (10 birds in each).

Housing management: The experimental birds were reared in cages. All the cages were similar in all facilities. Before the procurement of day-old chicks, the cages and equipment were properly cleaned and washed using suitable disinfectant. All possible measures were strictly followed to maintain uniform management condition during experimental work.

Body weight: The body weight of chicks was recorded individually at weekly intervals and from this data the average weekly bodyweight gain per birds was calculated for various treatment groups. Weekly body weight gain was calculated by subtracting the body weight of previous week from that of current week.

Weekly body weight gain (g) = Current week weight of bird (g) – previous week of bird (g)

Feed intake and FCR: Daily feed intake was calculated by offering the measured quantity of feed at the morning of day and subtracting the left over residue at next day. The FCR was calculated by dividing the weekly feed intake by weekly body weight gain. The weekly feed conversion ratio was determined by using the formula given here.

$$FCR = \frac{\text{Weekly feed consumption (g)}}{\text{Weekly body weight gain (g)}}$$

Statistical analysis: The data recorded for evaluation of different treatments will be statistically analysed using standard procedure as suggested by Snedecor and Cochran (1994) [14].

Result and Discussion

Body weight and body weight gain: At the 8th week of age (Table 1), body weight was 255.74±1.16, 265.73±1.01, 262.92±1.05, 284.86±1.07, 265.29±0.08, 264.75±1.10 and 304.89±1.05 g in T_1, T_2, T_3, T_4, T_5, T_6 and T_7 groups, respectively. The body weight of 8rd week was significantly highest in T_7 group as compared to other groups. The difference among T_2, T_3, T_5 and T_6 was found non-significant. The mean cumulative body weight gain (Table 2) was 247.06±2.88, 257.76±1.57, 254.88±2.16, 276.79±1.58, 257.7±2.05, 256.64±2.55 and 296.99±2.17 g in T_1, T_2, T_3, T_4, T_5, T_6 and T_7 groups, respectively. The data revealed that the cumulative body weight gain was significantly highest in T_7 group and lowest in T_1 group as compared to rest of treatment groups. The difference among T_2, T_3, T_5 and T_6 was found statistically non-significant.

Table 2: Effect of supplementation of Tulsi and ginger powder on weekly body weight (g)

Week	T_1	T_2	T_3	T_4	T_5	T_6	T_7	SEm±	CD at 5%
DOC	8.68 ±0.34	7.97 ±0.24	8.04 ±0.13	8.07 ±0.23	7.59 ±0.22	8.11 ±0.21	7.90 ±0.14	0.22	NS
1st	30.21^{b} ±0.49	32.73^{ab} ±1.08	29.63^{b} ±1.21	34.95^{a} ±1.05	30.75^{b} ±0.86	30.89^{b} ±1.04	34.81^{a} ±0.96	0.98	3.00
2nd	65.41^{d} ±0.50	71.73^{c} ±1.04	68.33^{d} ±0.91	77.56^{b} ±1.02	71.26^{c} ±1.11	72.67^{c} ±0.87	85.92^{a} ±1.00	0.94	2.88
3rd	99.42^{e} ±0.45	106.48^{c} ±1.04	103.14^{d} ±1.12	113.56^{b} ±1.02	105.80^{cd} ±0.97	106.51^{c} ±1.10	124.32^{a} ±1.09	0.99	3.04
4th	134.13^{e} ±0.49	142.88^{c} ±0.98	139.36^{d} ±0.98	151.45^{b} ±0.82	141.00^{cd} ±1.02	140.95^{cd} ±1.01	164.82^{a} ±1.06	0.93	2.84
5th	166.45^{e} ±0.51	174.88^{c} ±1.08	171.56^{d} ±1.06	184.95^{b} ±1.05	173.26^{cd} ±1.05	172.52^{cd} ±0.85	200.03^{a} ±1.04	0.97	2.97
6th	195.67^{d} ±0.48	204.66^{c} ±0.90	201.77^{c} ±1.04	218.95^{b} ±1.08	203.13^{c} ±1.08	202.91^{c} ±1.05	235.23^{a} ±1.11	0.99	3.02
7th	226.09^{d} ±1.01	235.39^{c} ±0.86	232.90^{c} ±1.01	252.78^{b} ±1.10	234.58^{c} ±0.97	233.93^{c} ±1.11	269.53^{a} ±0.73	0.98	3.00
8th	255.74^{d} ±1.16	265.73^{c} ±1.01	262.92^{c} ±1.05	284.86^{b} ±1.07	265.29^{c} ±0.08	264.75^{c} ±1.10	304.89^{a} ±1.05	1.00	3.05

Means with the same superscript in a particular row do not differ significantly ($P < 0.05$) from each other

Table 2: Effect of supplementation of Tulsi and ginger powder on weekly body weight gain (g)

Week	T_1	T_2	T_3	T_4	T_5	T_6	T_7	SEm±	CD at 5%
1st	21.53^{c} ±0.71	24.76^{ab} ±0.60	21.59^{c} ±0.70	26.88^{a} ±0.85	23.16^{bc} ±0.70	22.78^{bc} ±0.70	26.91^{a} ±0.68	0.71	2.17
2nd	35.2^{d} ±0.63	39.00^{c} ±0.73	38.70^{c} ±0.82	42.61^{b} ±0.81	40.51^{bc} ±0.82	41.78^{b} ±0.65	51.11^{a} ±0.81	0.76	2.32
3rd	34.01^{c} ±0.49	34.75^{c} ±0.32	34.81^{c} ±0.48	36.00^{b} ±0.40	34.54^{c} ±0.32	33.84^{c} ±0.24	38.40^{a} ±0.31	0.38	1.15
4th	34.71^{c} ±0.73	36.4^{bc} ±0.65	36.22^{bc} ±0.71	37.89^{b} ±0.31	35.20^{c} ±0.62	34.44^{c} ±0.78	40.50^{a} ±0.69	0.66	2.01
5th	32.32^{b} ±0.69	32.00^{b} ±0.63	32.20^{b} ±0.70	33.50^{ab} ±0.69	32.26^{b} ±0.70	31.57^{b} ±0.76	35.21^{a} ±0.74	2.14	0.70
6th	29.22^{b} ±0.82	29.78^{b} ±0.69	30.21^{b} ±0.69	34.00^{a} ±0.64	29.87^{b} ±0.69	30.39^{b} ±0.69	35.20^{a} ±0.69	0.70	2.15
7th	30.42^{b} ±0.69	30.73^{b} ±0.71	31.13^{b} ±0.61	33.83^{a} ±0.66	31.45^{b} ±0.55	31.02^{b} ±0.67	34.30^{a} ±0.56	0.64	1.95
8th	29.65^{b} ±0.72	30.34^{b} ±0.63	30.02^{b} ±0.68	32.08^{b} ±0.66	30.71^{b} ±0.99	30.82^{b} ±0.67	35.36^{a} ±0.61	0.72	2.20
Cumulative Body Weight Gain	247.06^{d} ±2.88	257.76^{c} ±1.57	254.88^{c} ±2.16	276.79^{b} ±1.58	257.7^{c} ±2.05	256.64^{c} ±2.55	296.99^{a} ±2.17	2.18	6.68

Means with the same superscript in a particular row do not differ significantly (p< 0.05) from each other

The results of present experiment are in close agreement with the finding of Luqman *et al.* (2021) [10] who fed basal diet with supplementation of 0%, Neem @ 0.5%, Tulsi @ 0.5% and Neem @ 0.25% + Tulsi @ 0.5% level. Results showed that neem and Tulsi alone and their combinations as supplementation significantly increased the body weight and body weight gain as compared to control group in Japanese quail. Similarly, Shende *et al.* (2021) [16] reported similar results on feeding diets consists of 0, 0.5% Tulsi, 0.5% ginger, 0.25% Tulsi + 0.25% ginger, 1% Tulsi, 1% ginger and 0.5% + 0.5% ginger level and reported that highest body weight and weight gain of broiler significantly with increased levels of supplementation of Tulsi and ginger in alone and combination as compared to control group. Also, results found by Naeen *et al.* (2021) [11] and Tanwar *et al.* (2021) [16] were in accordance with our finding.

Feed intake: The cumulative feed intake (Table 3) up to 8th week of age was 777.63±2.11, 747.91±1.14, 747.49±1.19, 738.87±1.36, 744.45±1.50, 743.72±1.37 and 723.44±1.46 g in T_1, T_2, T_3, T_4, T_5, T_6 and T_7 groups, respectively. The cumulative feed intake was significantly lowest in T_7 group and highest in T_1 group as compared to other treatment groups. The difference among T_2, T_3, T_5 and T_6 was found statistically non-significant.

Shende *et al.* (2021) [16] evaluated the effect of dietary supplementation of Tulsi (*Ocimum sanctum*) leaf and ginger (*Zingiber officinale*) powder as feed additives on broiler performance and reported that feed intake was significantly decreased with level of supplementation of Tulsi and ginger in alone and in combination as compared to control group. which confirms the results of present investigation. Similarly, Luqman *et al.* (2021) [10] conducted studies to evaluate neem and Tulsi supplementation on growth performance parameters of Japanese quail. They found that the feed intake decreased with the level of supplementation of the Tulsi leaves in the basal diet. However, Naeen *et al.* (2021) [11] supplemented Japanese quail with 0, 0.5, 1 and 1.5% Tulsi powder and reported a higher feed intake on Tulsi supplementation than the control group. Tanwar *et al.* (2021) [16] reported non-significant effect on feed intake in among different groups due to supplementation of feed additives (aloe vera and Tulsi).

Feed conversion ratio: The cumulative FCR (Table 4) was 3.15±0.05, 2.90±0.05, 2.93±0.04, 2.67±0.04, 2.89±0.04, 2.90±0.05 and 2.44±0.04 in T_1, T_2, T_3, T_4, T_5, T_6 and T_7 groups, respectively. The cumulative FCR was significantly lowest in T_7 group as compared to rest of treatment groups. The difference among T_2, T_3, T_5 and T_6 was found statistically non-significant for cumulative feed conversion ratio.

The results of the present study are in close agreement with the results of Shende *et al.* (2021) [16] who reported the FCR of broiler improved with supplementation of Tulsi and ginger in alone and in combination as compared to control group. Naeen *et al.* (2021) [11] also observed that the increasing levels of Tulsi in diet improved FCR in Japanese quails. Rahman *et al.* (2015) [13] conducted the study to evaluate the effects of neem leaf and ginger extracts as a growth promoter in broilers and concluded that feeding of neem leaf and ginger extract improved FCR and feed efficiency in broilers. However, Eltazi (2014) [8] studied the response of broiler chicks to containing mixture of garlic and ginger powder as a natural feed additive and reported that the mixture of garlic and ginger powder improved FCR in poultry birds. Luqman *et al.* (2021) [10] evaluated the growth performance parameters in Japanese quail supplemented with neem and Tulsi powder reported that the mixture of neem and Tulsi powder improved FCR in Japanese quail birds. These reports are in agreement with the findings of present study.

Table 3: Effect of supplementation of Tulsi and ginger powder on feed intake (g/bird/week)

Week	T_1	T_2	T_3	T_4	T_5	T_6	T_7	SEm±	CD at 5%
1st	40.09^{a} ±0.76	37.07^{b} ±0.63	32.98^{cd} ±0.87	33.74^{c} ±0.83	34.13^{c} ±0.68	32.45^{cd} ±0.85	30.67^{d} ±0.70	0.76	2.34
2nd	76.30^{a} ±0.78	70.45^{c} ±0.96	71.34^{bc} ±0.91	69.89^{cd} ±0.38	70.00^{c} ±0.70	73.50^{b} ±0.93	67.32^{d} ±0.68	0.78	2.41
3rd	80.97^{a} ±0.84	76.89^{bc} ±0.81	77.62^{b} ±0.91	74.67^{cd} ±0.82	77.32^{bc} ±0.79	76.83^{bc} ±0.68	73.45^{d} ±0.81	0.81	2.48
4th	95.17^{a} ±0.70	91.23^{b} ±0.84	92.24^{b} ±0.94	90.35^{b} ±0.82	92.01^{b} ±0.92	90.11^{b} ±0.91	89.65^{b} ±0.89	0.86	2.65
5th	106.12^{a} ±0.94	101.15^{b} ±0.84	100.65^{bc} ±0.76	100.78^{b} ±0.92	101.23^{b} ±0.90	100.03^{bc} ±0.75	97.78^{c} ±0.85	0.86	2.62
6th	114.41^{a} ±0.84	111.89^{ab} ±0.89	112.67^{ab} ±0.99	110.65^{b} ±0.89	110.11^{b} ±0.81	112.67^{ab} ±0.82	109.79^{b} ±0.95	0.89	2.72
7th	125.67^{a} ±0.40	122.45^{b} ±0.42	123.67^{b} ±0.46	122.89^{b} ±0.40	123.11^{b} ±0.45	120.45^{c} ±0.41	120.11^{c} ±0.31	0.41	1.25
8th	138.90^{a} ±0.07	136.78^{c} ±0.09	136.32^{c} ±0.10	135.90^{c} ±0.09	136.54^{c} ±0.32	137.68^{b} ±0.38	134.67^{d} ±0.56	0.29	0.89
Cumulative Feed Intake	777.63^{a} ±2.11	747.91^{b} ±1.14	747.49^{b} ±1.19	738.87^{c} ±1.36	744.45^{b} ±1.50	743.72^{b} ±1.37	723.44^{d} ±1.46	1.48	4.52

Means with the same superscript in a particular row do not differ significantly (p< 0.05) from each other

Table 4: Effect of supplementation of Tulsi and ginger powder on weekly feed conversion rati

Week	T_1	T_2	T_3	T_4	T_5	T_6	T_7	SEm±	CD at 5%
1st	1.86^{a} ±0.03	1.50^{b} ±0.05	1.53^{b} ±0.04	1.26^{c} ±0.03	1.47^{b} ±0.03	1.42^{b} ±0.04	1.14^{c} ±0.03	0.04	0.11
2nd	2.17^{a} ±0.04	1.81^{bc} ±0.03	1.84^{b} ±0.04	1.64^{d} ±0.02	1.73^{cd} ±0.03	1.76^{bc} ±0.02	1.32^{e} ±0.01	0.03	0.09
3rd	2.38^{a} ±0.01	2.21^{c} ±0.01	2.23^{bc} ±0.02	2.07^{d} ±0.01	2.24^{bc} ±0.01	2.27^{b} ±0.01	1.91^{e} ±0.01	0.01	0.04
4th	2.74^{a} ±0.01	2.51^{c} ±0.01	2.55^{c} ±0.01	2.38^{d} ±0.01	2.61^{b} ±0.01	2.62^{b} ±0.01	2.21^{e} ±0.01	0.01	0.04
5th	3.28^{a} ±0.01	3.16^{b} ±0.01	3.14^{b} ±0.02	3.01^{c} ±0.01	3.14^{b} ±0.01	3.17^{b} ±0.01	2.78^{d} ±0.01	0.01	0.04
6th	3.92^{a} ±0.01	3.76^{b} ±0.02	3.73^{bc} ±0.01	3.25^{d} ±0.02	3.69^{c} ±0.01	3.71^{bc} ±0.01	3.12^{e} ±0.01	0.01	0.04
7th	4.13^{a} ±0.01	3.98^{b} ±0.01	3.97^{b} ±0.01	3.63^{d} ±0.01	3.91^{c} ±0.01	3.88^{c} ±0.01	3.50^{e} ±0.01	0.01	0.03
8th	4.68^{a} ±0.04	4.51^{bc} ±0.01	4.54^{b} ±0.02	4.24^{d} ±0.01	4.45^{c} ±0.02	4.47^{bc} ±0.02	3.81^{e} ±0.02	0.02	0.07
Cumulative FCR	3.15^{a} ±0.05	2.90^{b} ±0.05	2.93^{b} ±0.04	2.67^{c} ±0.04	2.89^{b} ±0.04	2.90^{b} ±0.05	2.44^{d} ±0.05	0.05	0.15

Means with the same superscript in a particular row do not differ significantly ($p< 0.05$) from each other

Conclusion

From the results, it could be concluded that feeding of 0.5% Tulsi + 0.5% ginger powder supplementation is beneficial in improving growth performance of Japanese quails.

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