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Influence of thyme and turmeric essential oils supplementation on growth performance, nutrient utilization and economics of Japanese quails

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ABSTRACT

This experiment aimed to study the effect of dietary thyme and turmeric essential oils supplementation on growth performance, nutrient utilization and economics of Japanese quails. For this purpose, a total of 180 six-day-old Japanese quail chicks were randomly assigned into five different treatment groups, each with three replicates (12 birds per replicate). The experiment was conducted for 35 days. Different treatment groups of Japanese quails were designated as T_0 (Basal diet without essential oils), T_1 (Basal diet with 0.2% thyme essential oil), T_2 (Basal diet with 0.3% turmeric essential oil, T_3 (Basal diet with 0.125% thyme + 0.075% turmeric essential oils), and T_4 (Basal diet with 0.075% thyme + 0.125 % turmeric essential oils). At the end of experiment, it was found that dietary supplementation of thyme and turmeric essential oils reduced feed consumption, improved body weight gain, feed conversion ratio and protein efficiency ratio, with Japanese quails of T_4 group showing best performance during overall experimental period. The feed cost per kg weight gain was minimum in treatment T_4 over other treatment groups. Addition of thyme and turmeric essential oils in diet significantly enhanced nutrient utilization in Japanese quails. In conclusion, supplementing thyme and turmeric essential oils in combination at 0.075% and 0.125% of feed improved growth performance, utilization of nutrients and reduced feed cost per kg weight gain in Japanese quails.

Keywords: Growth performance, Japanese quails, Nutrient utilization, Thyme essential oil, Turmeric essential oil

Essential oils are being utilised as potential replacements for antibiotics in animal feed, since they are organic, non-toxic and leave no residue (Bassole and Juliani 2012). Trials conducted in vivo and in vitro have shown that essential oils have a variety of biological properties, particularly antibacterial, anti-inflammatory, antiviral, antiparasitic properties (Liu *et al*. 2019) as well as antioxidant capacity (Pirgozliev *et al*. 2019). Poultry studies have shown that adding essential oils to chicken diets can significantly reduce growth loss and the negative impacts of pathogenic *Escherichia coli* (Liu *et al*. 2018) and *Eimeria* species (Upadhaya *et al*. 2019) as well as increase growth performance (Srivastava *et al*. 2022) and control microbial community (Alali *et al*. 2013).

The majority of essential oils are herbal extracts that contain combinations of phytochemical substances like thymol, carvacrol, and eugenol (Oladokun *et al.* 2022). Combinations of various essential oils are gaining popularity as a way to investigate a synergistic effect. *Thymus vulgaris* is one of the most widely used Lamiaceae plant for medical, cosmetic and gastrointestinal functions worldwide. Thyme essential oil has several beneficial properties, including antibacterial, antioxidant and antiseptic effects owing to its thymol and carvacrol component (Alagawany *et al*. 2021). Previous scientific studies have already proven to be effective at enhancing growth rate (Placha *et al*. 2019).

Popular medical herb turmeric (*Curcuma longa L*.) has a variety of therapeutic properties. Turmerone, dehydro turmerone, aromatic ketones, as well as other volatile substances like mono- and sesquiterpene hydrocarbons or oxygenates, are known to be present in the essential oil extracted from turmeric rhizomes (Gonçalves *et al*. 2019). Owing to its bioactive compounds it has antioxidant, antiprotozoal, antivenom, antibacterial, anti-inflammatory, anti-proliferative, antiangiogenic, anticancer and antiaging properties (Amalraj *et al*. 2017).

Essential oils have been used in poultry feed but scanty information is present in the literature about the essential oil usage in Japanese quails especially thyme essential oil, turmeric essential oil and combination of thyme and turmeric essential oil. Therefore, the objective of this study was to study the effects of dietary thyme (*Thymus vulgaris*) and turmeric (*Curcuma longa*) essential oils supplementation on growth performance, nutrient utilization and economics of Japanese quails.

MATERIALS AND METHODS

Experimental design and management: This experiment

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Table 1. Ingredient composition of basal ration used for experimental Japanese quails (Dry matter basis)

Ingredient (%)	Starter feed	Finisher feed
Maize	50.05	54.95
Soya flake	29.80	24.35
GNC-solvent extracted	12.05	11.25
Rice polish	4.80	5.80
Vegetable oil	1.325	1.715
Di calcium phosphate	1.00	1.00
DL- methionine	0.40	0.38
Lysine	0.20	0.18
Mineral mixture	0.20	0.20
Vitamin premix	0.025	0.025
Common salt	0.15	0.15
Total	100	100

Table 2. Chemical composition of basal ration used for experimental Japanese quails (Dry matter basis)

Chemical composition (%) (Calculated)	Starter feed	Finisher feed
Moisture	9.28	9.11
Organic matter	90.72	90.89
Crude protein	24.60	22.40
Crude fibre	3.96	4.16
Ether extract	4.11	4.25
Total ash	6.51	7.03
Acid insoluble ash	1.40	1.43
NFE (Nitrogen Free Extract)	60.82	62.16
Calcium	1.08	1.03
Total phosphorus	0.79	0.73

was carried out with permission of Institutional Animal Ethical Committee of GBPUA&T, Pantnagar, Uttarakhand. The experiment was conducted at Instructional Poultry Farm (I.P.F.), Pantnagar for six weeks duration. A total of 180, six-day-old Japanese quail chicks (*Coturnix coturnix japonica*) were randomly allocated to five treatment groups (T_0, T_1, T_2, T_3 and T_4) each treatment with 36 quails. Each treatment group had three replicates each with 12 quails. Basal diets (starter and finisher) were prepared as per the specifications of ICAR (2013). Five dietary treatment groups of Japanese quails were T_0 group fed basal diet without essential oils, T_1 group fed basal diet supplemented with 0.2% thyme essential oil, T_2 group fed basal diet supplemented with 0.3% turmeric essential oil, T_3 group fed basal diet supplemented with 0.125% thyme + 0.075% turmeric essential oils and T_4 group fed basal diet supplemented with 0.075% thyme + 0.125% turmeric essential oils (Tables 1, 2).

Thyme and turmeric essential oil (100% natural) were purchased from Empirical Sciences, Greater Noida (Uttar Pradesh). Thyme essential oil contains 50.84% thymol and turmeric essential oil contains 22-25% turmerones. During experimental period, thyme and turmeric essential oils at different concentration and combination were supplemented to Japanese quails through feed. Throughout the trial, quails were reared in battery cage system where *ad lib.* feed and drinking water was provided. Japanese quails of all treatment groups were reared under similar environmental conditions.

Growth performance indices: Data regarding body weight was individually measured and feed intake was recorded per replicate at weekly interval for five weeks. Based on these data feed consumption, body weight gain, FCR and protein efficiency ratio were calculated.

Nutrient utilization: A metabolic trial was conducted between 35th and 42nd day of study to assess nutrient utilization. Four Japanese quails from each replicate were utilized for this purpose. Feed offered and left over was recorded to estimate nutrient intake. Excreta was collected, ground, and assessed for proximate principles in accordance with AOAC (2003) procedure.

Economics of Japanese quail production: The cost of treatment diets utilised in the feeding trial was determined considering feed cost as well as cost of essential oils. Based on this feed cost per kg weight gain was calculated.

Statistical analysis: The experiment was performed using completely randomized design and one way ANOVA was applied to analyse the data. The critical difference was determined to know the significant difference among the treatment means (Snedecor and Cochron 1994).

RESULTS AND DISCUSSION

Growth performance: The impact of dietary thyme and turmeric essential oils supplementation on feed consumption (FI), body weight gain (BWG), feed conversion ratio (FCR), Protein efficiency ratio (PER) and feed cost/kg weight gain of Japanese quails on 35th day of the trial are given in Table 3.

Thyme and turmeric essential oils supplemented groups of Japanese quails showed significantly ($p < 0.05$) reduced feed consumption with maximum feed intake recorded in Japanese quails of T_0 group while minimum and significantly lower feed intake was noted in T_4 group supplemented with combination of 0.075% thyme and 0.125% turmeric essential oils as compared to other groups of Japanese quails except T_3 group of Japanese quails. The average feed consumption up to five weeks study period showed significant differences among the treatments. These results are supported by Shamma *et al.* (2019) and Sariözkan *et al.* (2020) who noted a significant reduction in amount of feed consumed by broilers supplemented with thyme essential oil. Similarly, Daramola (2020) and Thomas *et al.* (2020) reported significant reduction in feed consumption in broilers and gramapriya chicks fed diet with 0.5% and 0.75% turmeric addition, respectively. In contradiction to the results of this study, Moustafa *et al.* (2020) found insignificant impact on feed consumption in broilers supplemented with thyme essential oil. Recently Oluwafemi *et al.* (2021) found no significant influence on feed intake in turmeric oil supplemented groups of broilers.

The data regarding overall body weight gain showed that thyme and turmeric essential oils supplementation significantly ($P<0.05$) increased body weight gain in

Table 3. Effect of thyme and turmeric essential oils supplementation on growth performance of Japanese quails (Mean ± S.E.)

Parameter	Period	T_0	T_1	T_2	T_3	T_4	SEM	P value
Feed consumption	Starter	168.17^{a}±0.10	167.05^{a}±0.35	165.69^{ab}±0.93	164.24^{bc}±0.68	162.38^{c}±1.44	0.63	<0.05
	Finisher	465.97^{a}±1.28	460.25^{b}±1.13	454.44^{c} ±2.25	442.81^{d}±1.11	442.53^{d}±1.12	2.56	<0.05
	Overall	634.14^{a}±1.38	627.30^{b}±1.18	620.13^{c}±2.78	607.05^{d}±1.43	604.91^{d}±0.91	3.09	<0.05
Body weight gain	Starter	80.61^{c}±0.60	83.45^{b}±0.79	84.40^{ab}±0.36	85.40^{ab}±0.61	86.42^{a}±1.13	0.60	<0.05
	Finisher	107.97^{c}±0.41	110.81^{c}±0.12	115.56^{b}±0.25	117.06^{ab}±1.40	119.81^{a}±1.55	1.20	<0.05
	Overall	188.58^{d}±0.43	194.26^{c}±0.69	199.96^{b}±0.27	202.46^{b}±0.92	206.22^{a}±1.83	1.70	<0.05
FCR	Starter	2.09^{a} ±0.01	2.00^{b} ±0.02	1.96^{bc} ±0.02	1.92^{cd} ±0.02	1.89^{d} ±0.01	0.02	<0.05
	Finisher	4.32^{a} ±0.02	4.15^{b} ±0.01	3.93^{c}±0.02	3.78^{d} ±0.04	3.69^{e} ±0.04	0.06	<0.05
	Overall	3.36^{a} ±0.01	3.23^{b} ±0.02	3.10^{c}±0.01	3.00^{d} ±0.02	2.93^{e} ±0.02	0.04	<0.05
Protein efficiency ratio	Starter	1.95^{d} ±0.01	2.03^{c} ±0.02	2.07^{bc}±0.02	2.11^{ab}±0.02	2.16^{a} ±0.01	0.02	<0.05
	Finisher	1.03^{d}±0.01	1.08^{c}±0.01	1.14^{b}±0.01	1.18^{a}±0.01	1.21^{a}±0.02	0.02	<0.05
	Overall	1.29^{e}±0.01	1.34^{d}±0.01	1.40^{c}±0.01	1.45^{b}±0.01	1.48^{a}±0.02	0.02	<0.05

Within the same row, values with different superscripts vary significantly (P<0.05).

Japanese quails with 0.075% thyme and 0.125% turmeric essential oils in combination showed highest body weight gain compared to other treatment groups. Japanese quails of T_0 (control) group showed minimum body weight gain compared to other treatment groups. However, no significant differences in body weight gain were recorded between T_2 and T_3 groups of Japanese quails during five weeks feeding trial. These findings are in line with the experiments that showed a significant increase (P<0.05) in body weight gain over control in broilers supplemented with thyme essential oil (Moustafa *et al.* 2020, Amouei *et al.* 2021). Similarly, Choudhury *et al.* (2018) and Shohe *et al.* (2019) observed significantly higher gain in body weight in turmeric powder supplemented broilers. Kennedy *et al.* (2020) and Oluwafemi *et al.* (2021) also reported a significantly higher gain in body weight in Japanese quails and broilers provided with 0.5% turmeric and turmeric essential oil, respectively. However, Oyebanji *et al.* (2018) and Shamma *et al.* (2019) did not find any significant impact of turmeric rhizome powder and thyme essential oil supplementation in broilers.

Addition of thyme and turmeric essential oils at different levels and combinations showed significantly improved FCR and protein efficiency ratio over control group during starter, finisher and overall experimental period. Japanese quails provided 0.075% thyme and 0.125% turmeric essential oils showed best results regarding FCR and protein efficiency ratio followed by quails supplemented with 0.125% thyme and 0.075% turmeric essential oils. Earlier studies reported significant reduction in FCR of thyme essential oil supplemented broilers (Moustafa *et al.* 2020, Amouei *et al.* 2021). Similarly, Kennedy *et al*. (2020) found that turmeric rhizome powder supplementation showed a significant improvement in FCR of Japanese quails. While, NM *et al.* (2018) reported a significant decrease in feed conversion ratio in broilers supplemented 1% turmeric extract. Bharti *et al.* (2018) and Oluwafemi *et al.* (2021) also recorded a significant reduction in feed conversion ratio in turmeric oil supplemented broilers. Finding regarding protein efficiency ratio was supported by Choudhury *et al.* (2018) and Hassan *et al*. (2018). On the other side, Placha *et al.* (2019) and Sariözkan *et al.* (2020) on thyme essential oil supplementation in broilers, did not observe any significant impact on FCR. Similarly, Ayodele *et al.* (2021) found that addition of turmeric powder did not influence feed conversion ratio in ISA brown pullets. The significance of essential oils in expanding intestinal villi surface area, improvement of overall nutrient absorption and utilisation as well as a decrease in several G.I. diseases are attributed for enhanced growth performance in essential oils supplemented groups of Japanese quails. Also, antioxidant, hepatoprotective, antibacterial and anti-inflammatory activities of thyme and turmeric essential oils may contribute to the improved growth performance (Amalraj *et al*. 2017, Placha *et al*. 2019).

Nutrient utilization: The impact of dietary thyme and turmeric essential oils supplementation on nutrient utilization in Japanese quails is given in Table 4.

The highest nutrient utilization in terms of dry matter, crude protein, ether extract and organic matter was noted in Japanese quails supplemented with 0.075% thyme and 0.125% turmeric essential oils. Whereas lowest one was noted in T_0 group of Japanese quails fed basal diet without

Table 4. Effect of thyme and turmeric essential oils supplementation on Nutrient utilization (%) of Japanese quails (Mean±S.E.)

Parameter	T_0	T_1	T_2	T_3	T_4	SEM	P value
Dry matter	66.78^{d}±0.57	68.70^{c}±0.53	69.71^{bc}±0.38	70.52^{ab}±0.42	71.72^{a} ±0.15	0.48	<0.05
Crude protein	69.98^{d}±0.43	71.37^{cd}±0.42	72.20^{bc}±0.83	73.50^{ab}±0.25	74.15^{a}±0.35	0.44	<0.05
Ether extract	70.25^{d} ±0.56	72.33^{c}±0.77	72.83^{bc}±0.50	74.70^{ab}±0.54	75.46^{a}±0.59	0.54	<0.05
Organic matter	68.70^{c}±0.86	69.53^{bc}±0.38	71.04^{ab}±0.95	71.16^{ab}±0.15	72.08^{a}±0.74	1.40	<0.05

Within the same row, values with different superscripts vary significantly (P<0.05).

Table 5. Effect of thyme and turmeric essential oils supplementation on economics of Japanese quails (Mean±S.E.) for overall period (I – V week)

Parameter	T_0	T_1	T_2	T_3	T_4	SEM	P value
Average body weight gain (g)	188.58^{d}±0.43	194.26^{c}±0.69	199.96^{b}±0.27	202.46^{b}±0.92	206.22^{a}±1.83	1.70	<0.05
Average feed intake (g)	634.14^{a}±1.38	627.30^{b}±1.18	620.13^{c}±2.78	607.05^{d}±1.43	604.91^{d}±0.91	3.09	<0.05
Feed cost (₹)	19.96^{d}±0.04	23.00^{a}±0.04	21.60^{b}±0.10	21.58^{b}±0.05	21.06^{c}±0.03	0.31	<0.05
Feed cost (₹)/ kg weight gain	105.82^{c}±0.11	118.41^{a}±0.59	108.01^{b}±0.39	106.59^{bc}±0.54	102.13^{d}±0.77	1..93	<0.05

Within the same row, values with different superscripts vary significantly (P<0.05).

any essential oil. A significant improvement in crude protein utilization in broiler chickens supplemented with thyme essential oil was reported by Abbasi *et al.* (2020). Fawaz *et al.* (2023) found a significant improvement in protein and fat utilization in laying hens supplemented with turmeric powder. Similarly, Asmara *et al.* (2018) noted a significant increase in utilization of dry matter and crude protein in Sentul chickens supplemented with turmeric powder. However, Samant *et al.* (2021) found no significant influence of turmeric supplementation on nutrient utilization in broiler chickens. Bioactive compounds such as carvacrol, curcumin, curcuminoid and AR turmerone present in thyme and turmeric essential oil can improve gut function by improving digestive secretions like bile, pancreatic juice, mucus and increase enzymatic activity. This could lead to increased nutrient utilization.

Economics of Japanese quail production: During the entire trial period, feed cost per kg weight gain was significantly higher (P<0.05) in T_1 group as compared to other treatment groups, while Japanese quails in T_4 group had minimum and significantly (P<0.05) lower feed cost per kg weight gain. The addition of 0.075% thyme with 0.125% turmeric essential oil reduced the feed cost per kg weight gain in Japanese quails. These findings are consistent with those of Parvin *et al.* (2021), who found that 0.5% turmeric supplementation lowered broiler production costs while increasing net profit. Similarly, Shohe *et al.* (2019) found an improvement in net profit in production of broilers by supplementing turmeric @ 7.5 g/kg. However, Büyükkılıç *et al.* (2020) found that thyme essential oil provided no benefit in terms of economic evaluation, and it even reduced net profit over control group. Presumably, reduced feed consumption and higher gain in body weight of Japanese quails of T_4 treatment group makes the supplementation of 0.075% thyme and 0.125% turmeric essential oils in combination more economical compared to other groups.

It can be concluded that, dietary supplementation of 0.075% thyme and 0.125% turmeric essential oils in combination reduced feed intake, FCR and enhanced mean body weight gain, protein efficiency ratio and nutrient utilization in Japanese quails. Also, it lowered the feed cost per kg body weight gain of Japanese quails compared to all others groups.

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