RESEARCH ARTICLE

Effect of Supplementation of Thyme and Turmeric Essential Oils on Haemato-biochemical Parameters of Japanese Quails

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Abstract

This experiment was undertaken to assess the influence of thyme (*Thymus vulgaris*) and turmeric (*Curcuma longa*) essential oils on haemato-biochemical parameters of Japanese quails. One hundred eighty, 6-day old Japanese quail chicks were subjected to five weeks trial. Quail chicks were distributed at random into five dietary treatment groups each with three replicates of 12 quails per treatment. Quails of T_0 group fed diet without essential oils (Basal diet), T_1 group fed basal diet with 0.2 % thyme essential oil, T_2 group fed basal diet with 0.3% turmeric essential oil, T_3 group fed basal diet with combination of 0.125 % thyme essential oil and 0.075 % turmeric essential oils, T_4 group fed basal diet with combination of 0.075% thyme essential oil and 0.125 % turmeric essential oils. The results revealed that supplementation of essential oils (Group T4 had significantly ($p > 0.05$) increased red blood cell count, packed cell volume, haemoglobin, mean corpuscular volume, mean corpuscular haemoglobin, serum protein, albumin globulin and high-density lipoprotein concentrations. Supplementing Japanese quails with thyme and turmeric essential oils significantly lowered serum uric acid, creatinine, total bilirubin, glucose, total cholesterol, triglycerides, LDL, SGOT and SGPT activity. It can be concluded that nutritional supplementation of thyme and turmeric essential oils at 0.075 % and 0.125 % in combination improved haematological indices and most of the serum biochemical parameters in Japanese quails.

Keywords: Hemato-biochemical, Japanese quail, Thyme essential, Turmeric essential oil.

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Introduction

The poultry sector in India is one of the most organized and scientifically based livestock sub-sector, and it has been the fastest-growing segment of Indian Agriculture.

Antibiotic feed additives have been used as growth stimulant in animal production for decades, particularly in commercial chicken production. Concerns regarding antibiotic resistance and residues have recently prompted a raised level of caution in the use of antibiotics in the livestock and poultry industry. Essential oils (EO) are one of the most promising new alternatives for addressing the challenges that the fast-growing poultry sector faces today. Essential oils are hydrophobic liquids containing the odoriferous and volatile aromatic components of a plant.

Thyme (*Thymus vulgaris L.*) is a prominent plant of Mediterranean countries which has unique medicinal properties. The major bioactive components of thyme essential oil, thymol and carvacrol have antibacterial and antifungicidal properties. Turmeric (*Curcuma longa*) is a perennial rhizomatous herbaceous plant. Turmeric essential oil has been shown to have potent antioxidant, antimicrobial, anti-inflammatory and antinociceptive activities (Liju *et al*., 2011). The objective of the current experiment was to evaluate the impact of dietary thyme and turmeric essential oils supplementation on hematobiochemical profile of Japanese quails.

Material and Method

Experimental Birds and Diet

This feeding trial was conducted for 5 weeks on a total of 180, six- day old Japanese quail chicks at Instructional Poultry Farm, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, strictly in accordance with the Institutional Animal Ethics Committee's guidelines (IAEC). Quails were individually weighed and randomly distributed into five dietary treatment groups each with 3 replicates of 12 birds each. The five treatment groups were, control (T_0) fed with basal diet only, T_1 and T_2 groups were given the same basal diet with 0.2 % thyme and 0.3 % turmeric essential oil was mixed with feed, respectively, T_3 group supplemented with combination of 0.125% thyme essential oil and 0.075% turmeric essential oils, T_4 group supplemented with 0.075% thyme essential oil and 0.125% turmeric essential oil in

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Table 1: Effect of thyme and turmeric essential oils supplementation on haematological profile of Japanese quails (Mean ± S.E.)

Parameters	T_0	T_1	T_2	T_3	T_4
TEC* (10^6/µL)	2.81^{d} ±0.05	3.12^{c} ±0.06	3.41^{b} ±0.06	3.25^{bc} ±0.03	3.63^{a} ±0.07
TLC (10^3/ µL)	21.58 ±0.31	21.40 ±0.38	21.61 ±0.39	21.84 ±0.44	21.87 ±0.22
PCV* (%)	32.20^{d} ±0.33	34.57^{b} ±0.47	34.40^{b} ±0.23	33.41^{c} ±0.39	35.92^{a} ±0.20
Hb* (g/dL)	11.10^{c} ±0.19	11.82^{b} ±0.18	11.80^{b} ±0.27	11.28^{bc} ±0.18	12.54^{a} ±0.18
MCV* (fl)	114.91^{a} ±1.68	110.98^{a} ±3.26	101.07^{b} ±1.65	102.86^{b} ±1.68	99.17^{b} ±2.21
MCH* (pg)	39.60^{a} ±0.69	37.95^{a} ±1.40	34.64^{b} ±0.58	34.73^{b} ±0.67	34.61^{b} ±0.87
MCHC (%)	34.46 ±0.30	34.16 ±0.40	34.30 ±0.58	33.77 ±0.39	34.90 ±0.33
Heterophils*(%)	24.67^{a} ±0.67	23.00^{ab}±0.58	21.83^{bc}±0.70	21.67^{bc}±0.49	21.33^{c} ±0.42
Basophils+ Eosinophils (%)	4.67 ±0.61	4.50 ±0.43	4.83 ±0.48	4.50 ±0.43	4.33 ±0.62
Lymphocytes (%)	68.83 ±0.60	70.50 ±0.56	70.00 ±0.68	70.83 ±0.60	71.17 ±0.70
Monocytes (%)	2.50 ±0.50	2.50 ±0.34	2.83 ±0.40	2.83 ±0.40	2.67 ±0.33
H/L ratio*	0.36^{a} ±0.01	0.33^{b} ±0.01	0.31^{bc} ±0.02	0.31^{bc} ±0.02	0.30^{c} ±0.01

Within the same row, values with different superscripts vary significantly *p<0.05

combination. Throughout the trial period Japanese quails were provided *ad libitum* feed and water. Thyme and turmeric essential oils were procured from Empirical Sciences, Greater Noida (Uttar Pradesh).

Haemato-Biochemical Study

At the end of the experiment on 35th day, blood samples were collected from 6 Japanese quails per treatment. For haematological study blood was collected in EDTA vial and plain tubes were used to collect blood samples for serum biochemical analysis. Total erythrocyte count (TEC) and total leucocyte count (TLC) were measured as described by Jain (1986). Packed cell volume (PCV) was determined by haematocrit method. The cyanmethemoglobin method was used for haemoglobin (Hb) estimation. For serum biochemical indices, blood sample was drawn and allowed to stand for an hour at room temperature (18^{0}C). Serum was separated by centrifugation at 1000 g and stored (–20^{0}C) and most of serum biochemical parameters were analysed by using commercial kits (Autospan). Globulin concentration was calculated as the difference between total protein and albumin concentrations and consequently ratio of albumin to globulin was calculated. Serum LDL cholesterol was calculated using friedwald's equation.

Statistical Analysis

Data emanated from different treatments were analysed for statistical significance using completely randomized design (CRD) by following the method of Snedecor and Cochran (1989).

Results and Discussion

Haematological Parameters

Data regarding thyme and turmeric essential oils impact on haematological indices presented in Table 1 showed that there was a significant (p<0.05) improvement in TEC, PCV and Hb concentration of essential oils supplemented groups over control group with best outcome recorded in Japanese quails of T_4 group. MCV and MCH values, on the other hand, were considerably lower in supplemented groups except T_1 group. However, the addition of thyme and turmeric essential oils had no effect on TLC and MCHC levels. Thyme and turmeric essential oils had a significant (P<0.05) impact on heterophils and heterophils-lymphocytes ratio in Japanese quails, with the highest heterophils and H/L ratio seen in the control group. While levels of monocytes, lymphocytes, basophils and eosinophils were statistically similar among different groups. These findings are in accordance with Oluwafemi *et al.* (2021) who noted a significant improvement in RBC, PCV, Hb, MCV and MCH on supplementation of turmeric oil in broilers. In contrast, Mohammed *et al.* (2022) reported no significant influence on total erythrocyte count. The antioxidant ability of thyme and turmeric essential oils may have contributed to significant increase in total erythrocyte count in Japanese quails. As an antioxidant, they destroy free radical, increase antioxidant enzymes and inhibit lipid peroxidation therefore increased cell membrane stability, resulting in lower haemolysis of erythrocyte and favourable influence on haematopoiesis. Abdelnour *et al.* (2022) observed no significant effect on TLC values. Adam *et al.* (2020) found significant improvement in PCV, Hb, MCV and MCH values in broilers with thyme essential oil supplementation. Thyme and turmeric essential oils enhance villi surface area and maximise absorption of iron and copper ions with other minerals and thereby increased availability of these minerals in blood, which causes increase in haemoglobin levels in thyme and turmeric essential oils supplemented Japanese quails. In contrary, Azodo *et al.* (2021) found a significant increase in MCHC levels on addition of turmeric and negro pepper in broilers. MCH is commonly elevated in quails after starvation,

anaerobic stress, or tiredness for lengthy durations, the decrease in MCH values in the thyme and turmeric essential oil supplemented groups may be attributed to an increase in haemoglobin levels with a stable and normal RBC size. Hosseini and Meimandipour (2018) found significant decrease in H/L value but with regards to lymphocyte and heterophil percentage no significant difference was observed in broilers supplemented with thyme essential oil. All the components of leucocytes viz heterophils, lymphocytes, monocytes, basophils and eosinophils are crucial part of body defence mechanism in birds. Healing injured tissues and providing protection against infection is the basic function of leucocytes. Any increase in leucocytic count in blood is an indicative of stress, injury or an infection. In this study the normal range of leucocytes represents active body defence mechanism. Both lower heterophil count and reduced H/L ratio are physiological indicators of health status.

Serum Biochemical Parameters

Findings of the experiment with regards to the influence of thyme and turmeric essential oils supplementation on serum biochemical parameters are shown in Table 2 and 3. Table 2 indicates that serum glucose level was significantly ($p<0.05$) reduced with supplementation of thyme and turmeric essential oils. The group provided 0.075 % thyme + 0.125 % turmeric essential oils had the lowest serum glucose concentration. These results agreed with Büyükkılıç *et al.* (2020) and Parvin *et al.* (2021) who reported a significant decrease in glucose levels with thyme essential oil and turmeric supplementation, respectively. However, Samant *et al.* (2021) and Noruzi *et al.* (2022) reported no significant influence of adding thyme essential oils and turmeric on serum glucose concentration.

Thyme and turmeric essential oils effect on serum lipid profile indicated that serum total cholesterol, serum triglycerides and serum LDL cholesterol levels were significantly reduced ($p<0.05$) in groups supplemented with essential oils and lowest LDL cholesterol was recorded in T_4 group, while T_3 group had lowest serum triglyceride values. Serum HDL cholesterol levels were significantly ($p<0.05$) raised in groups treated with thyme and turmeric essential oils, with the highest HDL cholesterol seen in T_4 group. The results are consistent with Gumus *et al.* (2017) and Ayodele *et al.* (2021) who noted a significant reduction in serum cholesterol level with supplementation of thyme essential oil and turmeric in Japanese quails and broilers, respectively. A significant reduction in serum triglyceride concentration was observed by Noruzi *et al.* (2022). A significant impact on LDL cholesterol concentration was reported by Sulastri and Basri (2019). Adam *et al.* (2020) reported significantly higher serum HDL concentrations in broilers. The significant reduction in serum lipid profile may be attributed to ability of thyme and turmeric to influence liver fatty acid synthase which leads to improved lipid and lipoprotein metabolism.

Data regarding impact of thyme and turmeric essential oils on serum protein and health status related parameters presented in Table 3 revealed that serum total protein, albumin and globulin levels were considerably higher ($p<0.05$) in Japanese quails of T_4 group. As compared to control group, A/G ratio was significantly reduced in groups fed diet with thyme and turmeric essential oil. Ruben *et al.* (2017) found a marked difference in serum albumin value of broilers supplemented with thyme essential oil. In contrast, Omar *et al.* (2020) could not find significant influence in serum albumin levels due to thyme oil supplementation. The albumin value increased with the inclusion of essential oils in present experiment indicates that the synthetic activity of liver was normal. A marked impact of turmeric supplementation on serum globulin concentration in Japanese quails was observed by Elnaggar *et al.* (2021). In thyme and turmeric oil combination groups of Japanese quails, significantly ($p<0.05$) lower serum creatinine and uric acid levels were observed. Whereas total bilirubin concentrations were significantly ($p<0.05$) lower in T_2, T_3 and T_4 groups of Japanese quails. Findings of this experiment regarding uric acid and creatinine were supported by Fawaz *et al.* (2022). In contrast, Noruzi *et al.* (2022) and Moustafa *et al.* (2020) reported no significant effect in the uric acid and creatinine levels of birds in thyme essential oil and turmeric supplemented groups. The decreased serum creatinine levels in the groups supplemented with essential oils may be attributed to better protein metabolism and thus a reduction in activity of muscle wasting. Oyebanji *et al.* (2018) found a significant reduction in serum bilirubin concentration in birds supplemented with turmeric powder. In present study, decrease in serum bilirubin concentrations may be because of antioxidant properties of essential oils.

Table 2: Effect of thyme and turmeric essential oils supplementation on serum glucose and lipid profile of Japanese quails (Mean ± S.E.)

Parameters (mg/dL)	T_0	T_1	T_2	T_3	T_4
Glucose*	124.35^{a}±0.23	120.89^{b}±0.29	120.27^{bc}±0.18	121.72^{bc}±1.14	119.95^{c}±0.31
Total cholesterol*	213.44^{a}±0.63	211.93^{ab}±0.73	210.57^{b}±0.68	204.08^{c}±0.67	197.99^{d}±0.84
Triglycerides*	109.68^{a}±0.40	105.22^{bc}±0.55	105.77^{b}±0.99	102.98^{c}±1.12	103.62^{bc}±0.90
HDL *	42.05^{c}±0.36	45.35^{b}±0.38	44.53^{ab}±0.35	45.63^{ab}±0.33	45.89^{a}±0.32
LDL *	141.94^{a}±0.33	134.93^{b}±0.47	132.78^{c}±0.33	131.58^{cd}±0.50	130.53^{d}±0.60

Within the same row, values with different superscripts vary significantly (*$p<0.05$)

Table 3: Effect of thyme and turmeric essential oils supplementation on serum protein profile and health status related parameters of Japanese quails (Mean ± S.E.)

Serum parameters	T_0	T_1	T_2	T_3	T_4
Total protein* (g/dL)	4.04^{d} ±0.06	4.58^{c} ±0.07	4.80^{ab} ±0.05	4.64^{bc} ±0.06	4.95^{a} ±0.09
Albumin* (g/dL)	1.18^{c} ±0.01	1.24^{b}±0.01	1.28^{ab} ±0.02	1.27^{ab} ±0.02	1.32^{a}±0.01
Globulin* (g/dL)	2.86^{d} ±0.05	3.35^{c} ±0.06	3.52^{ab} ±0.04	3.37^{bc} ±0.04	3.62^{a} ±0.08
A/G Ratio*	0.41^{a} ±0.01	0.37^{b}±0.02	0.36^{b} ±0.01	0.38^{b} ±0.01	0.37^{b}±0.02
Uric acid* (mg/dL)	1.59^{a} ±0.03	1.51^{ab}±0.06	1.41^{abc} ±0.02	1.47^{bc} ±0.04	1.35^{c} ±0.05
Creatinine* (mg/dL)	0.67^{a} ±0.01	0.63^{ab} ±0.01	0.61^{bc} ±0.02	0.58^{cd} ±0.02	0.55^{d} ±0.02
Total bilirubin* (mg/dL)	2.25^{a} ±0.01	2.20^{ab} ±0.02	2.09^{c} ±0.01	2.19^{b} ±0.03	2.08^{c} ±0.02
SGPT (IU/L)*	15.22^{a} ±0.56	12.75^{bc} ±0.51	14.07^{ab} ±0.83	9.73^{d} ±0.29	11.51^{c} ±0.30
SGOT (IU/L)*	152.24^{a} ±2.55	144.64^{a} ±2.0	146.28^{a} ±3.63	133^{b} ±2.62	133.90^{b} ±2.89

Within the same row, values with different superscripts vary significantly (*p<0.05)

The activities of SGPT and SGOT were significantly (p <0.05) influenced, with the lowest level obtained in T_3 group of Japanese quails. These results are supported by Fawaz *et al.* (2022). However, contrary to the results of present experiment Widiastuti *et al.* (2020) observed no significant difference in SGOT activity. Liver enzymes play a vital role in determining the liver functions. The results of present experiment showed that there is no adverse effect of thyme and turmeric essential oils on liver health of Japanese quails. Reduced liver enzyme activity might be attributed to enhanced liver function as a result of curcumin and thymol in turmeric and thyme essential oils, which have antioxidant properties and protect liver cells from free radical damage.

Conclusion

It is concluded from the present study that dietary addition of thyme and turmeric essential oils at 0.075 % and 0.125% in combination improved most of the haematological indices, serum HDL cholesterol and protein profile and reduced serum glucose, total cholesterol, triglycerides, LDL cholesterol, uric acid, creatinine, total bilirubin and SGOT of Japanese quails.

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References

Abdelnour, S. A., El-Ratel, I. T., Peris, S. I., El-Raghi, A. A., & Fouda, S. F. (2022). Effects of dietary thyme essential oil on blood haematobiochemical, redox status, immunological and reproductive variables of rabbit does exposed to high environmental temperature. *Italian Journal of Animal Science*, *21*(1), 51-61.

Adam, A., Shihata, S., El-Hady, A., & Mohamed, A. (2020). Effect of thyme (*Thymus vulgaris*) on productive performance, carcass characteristics, blood hematology and lipid profile of broiler chicks of broiler chicks. *Egyptian Poultry Science Journal*, *40*(3), 715-727.

Ayodele, A. D., Tayo, G. O., Olumide, M. D., Adeyemi, O. A., & Akanbi, A. S. (2021). Haematological and serum biochemical responses of pullet chicks fed diets containing single and combined levels of turmeric and clove. *Nigerian Journal of Animal Production, 48*(3), 71-85.

Azodo, N. L., Jiwuba, P. D. C., Mbah, N. T., & Ezeoke, F. C. (2021). Effect of feeding broilers with phytogenic feed additives containing diets on blood biochemical and haematological constituents. *Journal of Agricultural Science*, *32*(2),195–203.

Büyükkılıç Beyzi, S., Konca, Y., Kaliber, M., Sarıözkan, S., Kocaoğlu Güçlü, B., Aktuğ, E., & Şentürk, M. (2020). Effects of thyme essential oil and A, C, and E vitamin combinations to diets on performance, egg quality, MDA, and 8-OHdG of laying hens under heat stress. *Journal of Applied Animal Research*, *48*(1), 126-132.

Elnaggar, S. A., Ali, R., & El-Said, E. (2021). Complementary effect of black pepper and turmeric on productive performance and physiological responses of Japanese quail. *Egyptian Poultry Science Journal*, *41*(1), 77-91.

Fawaz, M. A., Südekum, K. H., Hassan, H. A., & Abdel-Wareth, A. A. (2022). Productive, physiological and nutritional responses of laying hens fed different dietary levels of turmeric powder. *Journal of Animal Physiology and Animal Nutrition*, *10*, 1–8.

Gumus, R., Ercan, N. A. Z. L. I., & Imik, H. (2017). The effect of thyme essential oil (*Thymus vulgaris*) added to quail diets on performance, some blood parameters, and the antioxidative metabolism of the serum and liver tissues. *Brazilian Journal of Poultry Science*, *19*, 297-304.

Hosseini, S. A., & Meimandipour, A. (2018). Feeding broilers with thyme essential oil loaded in chitosan nanoparticles: an efficient strategy for successful delivery. *British Poultry Science*, *59*(6), 669-678.

Jain, N. C. (1986). *Schalms Veterinary Haematology Lea and Febiger.* Philadelphia, USA, 1221.

Liju, V. B., Jeena, K., & Kuttan, R. (2011). An evaluation of antioxidant, anti-inflammatory, and antinociceptive activities of essential oil from *Curcuma longa. Indian Journal of Pharmacology*, *43*(5), 526-529.

Mohammed, A. B., Abdulwahid, A. S., & Raouf, S. M. (2022). Effect of *Thymus vulgmus* addition to the diet of laying hens on egg production, egg quality, biochemical and antioxidant parameters. *Advances in Animal and Veterinary Sciences, 10*(2), 427-433.

Moustafa, N., Aziza, A., Orma, O., & Ibrahim, T. (2020). Effect of supplementation of broiler diets with essential oils on growth performance, antioxidant status, and general health. *Mansoura Veterinary Medical Journal*, *21*(1), 14-20.

Noruzi, S., Torki, M., & Mohammadi, H. (2022). Effects of supplementing diet with Thyme (*Thymus vulgaris* L.) essential oil and/or selenium yeast on production performance and blood variables of broiler chickens. *Veterinary Medicine and Science*, *8*, 1137–1145.

Oluwafemi, R. A., Uankhoba, I. P., & Alagbe, J. O. (2021). Effects of turmeric oil as a dietary supplement on the growth performance and carcass characteristics of broiler chickens. *International Journal on Orange Technologies*, *3*(4), 54-62.

Omar, E. M., Mohamed, W. H. A., Abdel Wahed, H. M., & Ragab, M. S. (2020). Addition of essential oils and medium chain fatty acids in the diets and their effect on productive performance of broiler chickens. *Egyptian Journal of Nutrition and Feeds*, *23*(2), 289-303.

Oyebanji, B. O., Oyewumi, O. C., & Fadopemu, O. C. (2018). Effect of turmeric rhizome (*Curcuma longa*) powder and coconut oil mixture on growth performance, haematological and biochemical parameters of Noiler birds. *International Journal of Agricultural Sciences and Veterinary Medicine*, *3*(4), 118-124.

Parvin, M.M., Beg, M.A.H., Begum, M., Islam, M.S., Rubel, M.Z.U.,& Shafiqur,M. (2021). Effects of using garlic (*Allium sativum*) and turmeric (*Curcuma longa*) powder on production performance and biochemical parameters of broiler chicken. *International Journal of Veterinary Science and Animal Husbandry, 6*(4), 53-57.

Ruben, N. T., Raphaël, K. J., Boris, N. T., Doriane, Y. M. D., Kuietche, M., Hervé, K. S., & Amir, M. (2017). Performances of broiler chickens fed on diet supplemented with thyme and oregano essential oils stabilized in a plant charcoal matrix. *Journal of World's Poultry Research*, *7*(2), 79-87.

Samant, N., Mondal, B. C., Lata, M., & Kumar, A. (2021). Effect of dietary incorporation of lemon grass (*Cymbopogon flexusosus*) oil and turmeric (*Curcuma longa*) rhizome powder on haemato-biochemical parameters in commercial broiler chickens. *Journal of Pharmaceutical Innovation*, *10*(8), 870-874.

Snedecor, G.W., & Cochran, W.G. (1994). *Statistical Methods*. Edn 8th , The Iowa State University Press, Ames, Iowa, USA.

Sulastri, M. P., & Basri, H. (2019). The effect of turmeric and ginger powder on Japanese quail (Coturnix coturnix) serum lipid profile. *Biosaintifika: Journal of Biology and Biology Education*, *11*(2), 243-248.

Widiastuti, E., Isroli, I., Yudiarti, T., Sugiharto, S., Sartono, T. A., Wahyuni, H. I., & Murwani, R. (2020). Haematological indices and carcass yield of Kampong chickens administrated with turmeric (*Curcuma domestica*). *Earth and Environmental Science*, *518*(1), 1-5.