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Effect of Dietary Supplementation of Oregano (*Oreganum vulgare*) Essential Oil on Nutrient Utilization and Haemato-biochemical Profile of Growing Japanese Quail

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ABSTRACT

The experiment was conducted during the month of June in 2022 at the Poultry Experimental Unit, Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, Anjora, Durg, Chhattisgarh, India to evaluate the effect of dietary supplementation of oregano (*Origanum vulgare*) essential oil on nutrient utilization and haemato-biochemical parameters in broiler quails. Total 240 Japanese quail chicks procured from the college hatchery were randomly assigned to four groups: T_0 (control), T_1 (75 mg kg^{-1}), T_2 (150 mg kg^{-1}), and T_3 (225 mg kg^{-1}) on a dry matter basis. Birds received a formulated concentrate mixture during the starter and finisher phases. Oregano oil significantly (p<0.01) improved intake, outgo, and digestibility of dry matter (DM), crude protein (CP), and ether extract (EE). Haemoglobin and total erythrocyte count increased significantly in T_3, while packed cell volume and total leucocyte count remained unaffected (p>0.05). Serum AST and ALT levels were significantly lower in T_3 (160 and 19.26 IU l^{-1}) compared to T_0 (213.33 and 29.93 IU l^{-1}), while total protein and globulin increased with supplementation. Albumin and A:G ratio showed no significant change. Cholesterol was significantly reduced in T_3 (182.44 mg dl^{-1}) versus control (211.20 mg dl^{-1}). Oregano essential oil up to 225 mg kg^{-1} can be safely included in quail diets to enhance nutrient utilization and physiological health.

KEYWORDS: Haemato-biochemical profile, nutrient utilization, oregano essential oil, quail

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

The poultry sector has expanded in the last few decades and has become an important part of the agricultural economy. With the drastic rise of the global human population, the demand for meat and eggs has also increased as a cheap and easily available source of Protein. The poultry birds have also dominated other meat producing animals in term of feed conversion ratio. In India, Japanese quail (*Coturnix coturnix japonica*) has emerged as a viable alternative to broiler chicken in over the past two to three decades, owing to its compact size, rapid growth, high reproductive efficiency and minimal space requirements (Sathiya et al., 2017; Mujeebulla et al., 2025). It has less feeding requirement (about 20–25 g day^{-1}) compared to chicken (120–130 g day^{-1}) and it can attain a market weight of 140–180 g between 5–8 weeks of age (Poonia et al., 2023). Quail meat is increasingly preferred for its high protein content, essential fatty acids, and mineral richness, particularly sodium, potassium, and iron (Owen and Dike, 2013). To enhance productivity, growth promoters have been widely used in poultry diets; however, rising concerns over antibiotic resistance in zoonotic pathogens have led to regulatory restrictions on antibiotic-based feed additives (Golestan, 2010). In this context, essential oils (EOs) have gained attention as natural alternatives. Classified as "Generally Recognized as Safe (GRAS)" by the FDA and FEMA, EOs are volatile aromatic compounds derived from various plant parts, including leaves, seeds, bark, and roots. They are complex mixtures of terpenoids and phenolic compounds, including thymol, carvacrol, eugenol, and cinnamaldehyde, which are known for their antimicrobial, antioxidant, antifungal, and immunomodulatory properties (Greathead, 2003; Dorman and Deans, 2000). There are around 3000 types of essential oils from more than 2000 plant species (Puvaca et al., 2022). Beside using in the cosmetics, pesticides industries and pharmaceutical industries; there are also used in animal nutrition (Puvaca et al., 2022). Between 20–60 different biologically active compounds are present in different concentrations (Lahlou, 2004). Among the essential oils, oregano (*Origanum vulgare*) essential oil is particularly promising due to its high concentrations of carvacrol and thymol (78–82%), along with minor constituents like α-terpinene and p-cymene (Adam et al., 1998; Yanishlieva et al., 1999). It is a well-known traditional medicine and cooking spice (Jin et al., 2021). It has a great potential to be alternative to antibiotics and is useful as poultry feed supplement for improving the immunity as well as growth performance (Jin et al., 2021). Its supplementation has shown beneficial effects on immune organ development and overall health too (Leyva-López et al., 2017; Chang et al., 2021). Beside antimicrobial effects, it also has antioxidant, antifungal and insecticidal properties, which make it a valuable dietary supplement for stress sensitive and highly-productive broiler chickens (Ivanov and Bozakova, 2022, Elbaz et al., 2025; Toso et al., 2025). Considering its therapeutic potential, the present study was conducted to evaluate the effect of dietary supplementation with oregano essential oil on nutrient utilization and hematobiochemical parameters in broiler quails.

2. MATERIALS AND METHODS

The study was conducted during the month of June in 2022 at the Poultry Experimental Unit, Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, Anjora, Durg, Chhattisgarh (298 m above MSL; 21.1623°N, 81.4279°E). A total of 240-day-old Japanese quail broiler chicks (Namakkal Gold strain) were procured from the college hatchery and randomly divided into four groups: T_0 (control), T_1, T_2 and T_3, with three replicates of 20 birds each.

Birds were reared on deep litter using rice husk bedding under standard housing and management conditions for five weeks. Before the experiment, the poultry house and equipment were cleaned, sanitized, and fumigated using formaldehyde and potassium permanganate. Upon arrival, chicks were weighed individually and assigned to treatment groups. No vaccinations or antibiotics were administered during the trial. To reduce transportation stress, jaggery-mixed water was provided on day one, followed by Groviplex (15 ml 100 $birds^{-1}$ day^{-1}) and Vimerol (5 ml 100 $birds^{-1}$ day^{-1}) in drinking water for three days.

Experimental diets were formulated for starter (1–3 weeks) and finisher (4–5 weeks) phases as per Anonymous (2013) standards. Feed ingredients were analyzed (Anonymous, 2005), and oregano (Origanum vulgare) essential oil was supplemented at 75 mg kg^{-1} (T_1), 150 mg kg^{-1} (T_2), and 225 mg kg^{-1} (T_3) levels. Group T_0 received the basal diet without supplementation. Clean drinking water was provided ad libitum. Measured quantities of feed were offered daily, and leftover feed was weighed weekly.

For nutrient utilization, dry matter (DM), crude protein (CP), and ether extract (EE) intake, outgo, and digestibility were recorded. Feed was offered, and the residue was measured to calculate intake. Faecal samples were collected, dried, and analyzed for proximate principles. Nutrient balance and metabolizability were computed using standard formulas.

At six weeks of age, blood samples were collected from the wing vein. For haematological analysis (Hb, PCV, TEC, TLC), samples were collected in heparinized vials and analyzed using a semi-automatic haematology analyzer (Mindray BC–2800 Vet). For biochemical parameters (total protein, albumin, globulin, cholesterol, ALT, AST), blood

was collected in non-heparinized tubes, serum separated by centrifugation (3000 rpm for 10 min), and stored at -20°C until analysis using diagnostic kits in a semi-automated analyzer.

Data were analyzed using one-way ANOVA under a Completely Randomized Design (CRD) as per Snedecor and Cochran (1994). Differences among treatment means were tested using Duncan's Multiple Range Test (DMRT).

3. RESULTS AND DISCUSSION

3.1. Nutrient utilization

The effect of dietary supplementation of oregano (*Origanum vulgare*) essential oil on nutrient utilization in broiler quails is presented in Table 1. Dry matter (DM), crude protein (CP), and ether extract (EE) intake, outgo, balance, and metabolizability were significantly influenced (p<0.01) by increasing levels of oregano oil.

Dry matter intake, balance, and metabolizability were highest in T_3, followed by T_2 and T_1, with the lowest values in the control group. Crude protein intake, balance, and metabolizability also showed a similar trend, with T_3 outperforming other groups significantly (p<0.01). Ether extract intake and balance increased with higher oregano oil levels, although outgo was statistically non-significant (p>0.05). Metabolizability of ether extract was significantly higher in T_2 and T_3 compared to T_0 and T_1, but the difference between T_2 and T_3 was non-significant.

The improvement in nutrient digestibility with increasing oregano oil levels may be attributed to enhanced enzymatic activity and better gut absorption. Oregano oil has been reported to improve total tract apparent nutrient digestibility and caecal microflora (Attia et al., 2017). These findings align with Attia et al. (2017), who observed improved digestibility in broilers supplemented with a blend of plant extracts, including oregano, fenugreek, chamomile, and fennel. Similar results were reported by Ding et al. (2020) in ducks, where oregano essential oil significantly enhanced nutrient utilization.

3.2. *Haematological parameters*

The effect of dietary supplementation of oregano (*Origanum vulgare*) essential oil on haematological parameters in broiler quails is presented in Table 2. Haemoglobin (Hb), total erythrocyte count (TEC), and total leucocyte count (TLC) were significantly affected by treatment levels, whereas packed cell volume (PCV) remained statistically non-significant (p>0.05).

Haemoglobin and TEC values were significantly higher (p<0.01) in T_3 compared to control, indicating improved erythropoiesis, possibly due to the antioxidant properties of carvacrol and cineole. TLC values were highest in the control group, with T_3 showing a significant reduction (p<0.05), potentially due to reduced inflammatory response. PCV values did not differ significantly among groups. These findings are consistent with Yesilbag et al. (2012), who reported increased Hb and haematocrit values in quails supplemented with volatile oil mixtures. Conversely, Méndez Zamora et al. (2017) found no significant changes in haematological indices with Mexican oregano oil

Table 1: Effect of dietary supplementation of oregano essential oil on nutrient utilization in broiler quails

Particulars	Group T_0	Group T_1	Group T_2	Group T_3	p value	Significance
Intake	25.74±0.005^d	25.78±0.005^c	26.20±0.008^b	26.54±0.005^a	0	**
Outgo	8.89±0.005^a	8.64±0.011^b	8.26±0.005^c	7.83±0.005^d	0	**
Balance	16.85±0.01^d	17.14±0.005^c	17.94±0.01^b	18.71±0.00^a	0	**
Metabolizability	65.46±0.02^d	66.48±0.03^c	68.48±0.03^b	70.49±0.01^a	0	**
Crude protein (%)						
Intake	5.13±0.005^d	5.49±0.005^c	5.57±0.005^b	5.63±0.005^a	0	**
Outgo	1.29±0.005^a	1.28±0.005^a	1.29±0.005^a	1.24±0.005^b	0.001	**
Balance	3.84±0.005^d	4.19±0.005^c	4.28±0.005^b	4.39±0.005^a	0	**
Metabolizability	74.85±0.028^d	76.32±0.024^c	76.84±0.024^b	77.97±0.022^a	0	**
Ether extract (%)						
Intake	0.70±0.005^d	0.78±0.005^c	0.81±0.005^b	0.85±0.005^a	0	**
Outgo	0.18±0.005	0.18±0.011	0.15±0.005	0.16±0.005	0.064	NS
Balance	0.52±0.01^c	0.60±0.01^b	0.65±0.006^a	0.69±0.00^a	0	**
Metabolizability	74.26±1.03^b	76.89±1.65^b	80.98±0.20^a	81.18±0.55^a	0.003	**

Superscripts a, b, c, d indicate significant differences within rows (p<0.05, p<0.01); NS: Non-significant

Table 2: Effect of dietary supplementation of oregano essential oil on haematological parameters in broiler quails

Particular	Group			
	T_0	T_1	T_2	T_3
Haemoglobin** (g dl^{-1})	13.00± 0.10^{d}	13.50± 0.20^{c}	14.09± 0.20^{b}	14.55± 0.05^{a}
PCV (%)	31.16± 1.04	32.50± 0.28	32.66± 1.52	34.36± 0.73
TEC** (million mm^{-3})	2.42± 0.08^{c}	2.69± 0.05^{b}	3.11± 0.06^{a}	3.18± 0.08^{a}
TLC* (×10^3 mm^{-3})	23.16± 0.17^{a}	22.88± 0.05^{ab}	22.76± 0.12^{ab}	22.55± 0.07^{b}

Superscripts a, b, c, d indicate significant differences within rows (p<0.05, p<0.01)

supplementation. A study conducted in the poultry birds in Bangladesh also reported that feeding oregano (5 g kg^{-1}) resulted in increase of Hemoglobin, TEC and PCV (Khatun et al., 2025).

3.3. Biochemical parameters

The effect of oregano essential oil supplementation on serum biochemical parameters is presented in Table 3. AST and ALT levels decreased significantly (p<0.01) with increasing supplementation, indicating improved liver function. Total protein and globulin levels increased significantly (p<0.05), while albumin and A:G ratio remained unaffected. Cholesterol levels declined significantly (p<0.01) in treated groups.

Table 3: Effect of dietary supplementation of oregano essential oil on biochemical parameters in broiler quails

Particulars	Groups			
	T_0	T_1	T_2	T_3
AST** (IU l^{-1})	213.33± 3.17^{a}	185.66± 3.38^{b}	174.66± 3.84^{b}	160± 4.04^{c}
ALT** (IU l^{-1})	29.93± 0.82^{a}	26.8± 0.81^{a}	22.66± 0.92^{b}	19.26± 0.86^{c}
Total protein* (g dl^{-1})	3.82± 0.11^{b}	3.90± 0.09^{b}	3.95± 0.03^{b}	4.3± 0.17^{a}
Albumin (g dl^{-1})	2.53± 0.06	2.45± 0.06	2.50± 0.07	2.45± 0.08
Globulin* (g dl^{-1})	1.29± 0.13^{b}	1.45± 0.09^{b}	1.44± 0.10^{b}	1.84± 0.09^{a}
A/G ratio	2.01± 0.26	1.70± 0.15	1.75± 0.18	1.33± 0.04
Cholesterol* (mg dl^{-1})	211.20± 1.4^{a}	190.60± 2.53^{b}	188.13± 0.98^{b}	182.44± 3.34^{c}

Superscripts a, b, c indicate significant differences within rows (p<0.05, p<0.01)

The reduction in AST and ALT values in T_3 suggests hepatoprotective effects of thymol, consistent with findings by Giannenas et al. (2014). Similar trends were reported by Khaksar et al. (2012) who observed improved protein profiles and reduced cholesterol in birds supplemented with oregano and thyme essential oils. Farouk et al. (2020) also reported enhanced serum protein and globulin levels at higher oregano oil inclusion rates.

4. CONCLUSION

Dietary supplementation of oregano (*Origanum vulgare*) essential oil exerted beneficial effects on nutrient utilization, haematological, and biochemical parameters in broiler quails. Birds supplemented with 225 mg kg^{-1} oregano oil (T_3) showed improved haemoglobin concentration, total erythrocyte count, and total leucocyte count. Serum AST, ALT, and cholesterol levels were significantly reduced, while total protein and globulin concentrations increased proportionately. Based on these findings, oregano essential oil at 225 mg kg^{-1} diet may be recommended for improving physiological health and metabolic efficiency in broiler quails.

5. REFERENCE

Adam, K., Sivropoulou, A., Kokkini, S., Lanaras, T., and Arsenakis, M., 1998. Antifungal activities of *Origanum vulgare* subsp. *Hirtum hirtum*, *Mentha spicata*, *Lavandula angustifolia* and *Salvia fruticosa* essential oils against human pathogenic fungi. Journal of Agricultural and Food Chemistry 46, 1739–1745. http://dx.doi.org/10.1021/jf9708296.

Anonymous, 2005. AOAC,. 2005. Official Methods of Analysis. 18th edn. Association of Official Analytical Chemists, Virginia, USDA, Washington, D.C. Accessed on 01.10.2025.

Anonymous, 2013. ICAR, 2013. Nutrient requirements of cattle and buffalo. Indian Council of Agricultural Research, New Delhi, India. Accessed on 01.10.2025.

Attia, G., El-Eraky, W., Hassanein, E., El-Gamal, M., Farahat, M., Hernandez-Santan, A., 2017. Effect of dietary inclusion of a plant extract blend on broiler growth performance, nutrient digestibility, caecal microflora and intestinal histomorphology. International Journal of Poultry Science 16(9), 344–353.

Chang, L.Y., Di, K.Q., Xu, J., Chen, Y.F., Xi, J.Z., Wang, D.H., Hao, E.Y., Xu, L.J., Zhou, R.Y., 2021. Effect of natural garlic essential oil on chickens with artificially infected *Eimeria tenella*. Veterinary Parasitology 300, 109614. https://doi.org/10.1016/j.vetpar.2021.109614.

Ding, X., Wu, X., Zhang, K., Bai, S., Wang, J., Peng, H.,

Zeng, Q., 2020. Dietary supplement of essential oil from oregano affects growth performance, nutrient utilization, intestinal morphology and antioxidant ability in Pekin ducks. Journal of Animal Physiology and Animal Nutrition 104(4), 1067–1074.

Dorman, H.D., Deans, S.G., 2000. Antimicrobial agents from plants: antibacterial activity of plant volatile oils. Journal of Applied Microbiology 88, 308–316. https://doi.org/10.1046/j.1365-2672.2000.00969.x.

Elbaz, A.M., Ashmawy, E.S., Mourad, D.M., Amin, S.A., Khalfallah, E.K.M., Mohamed, Z.S., 2025. Effect of oregano essential oils and probiotics supplementation on growth performance, immunity, antioxidant status, intestinal microbiota, and gene expression in broilers experimentally infected with Eimeria. Livestock Science 291, 105622.

Farouk, S.M., Yusuf, M.S., El Nabtiti, A.A.S., Abdelrazek, H.M.A., 2020. Effect of oregano essential oil supplementation on performance, biochemical, haematological parameters, and intestinal histomorphometry of Japanese quail (*Coturnix coturnix japonica*). Veterinary Research 11, 219. https://doi.org/10.30466/vrf.2019.97574.2325.

Giannenas, I., Papaneophytou, C.P., Tsalie, E., Pappas, I., Triantafillou, E., Tontis, D., Kontopidis, G.A., 2014. Dietary supplementation of benzoic acid and essential oil compounds affects buffering capacity of the feeds, performance of turkey poults and their antioxidant status, pH in the digestive tract, intestinal microbiota, and morphology. Asian-Australasian Journal of Animal Sciences 27, 225–236. https://doi.org/10.5713/ajas.2013.13376.

Golestan, I., 2010. Phytogenics as a new class of feed additive in the poultry industry. Journal of Animal and Veterinary Advances 9, 2295–2304. https://doi.org/10.3923/javaa.2010.2295.2304.

Greathead, H., 2003. Plants and plant extracts for improving animal productivity. Proceedings of the Nutrition Society 62, 279–290. https://doi.org/10.1079/pns2002197.

Ivanov, V., Bozakova, N., 2022. Possibilities of using oregano (*Origanum vulgare* L.) as a dietary supplement in broiler chicken and hens production. Journal of Hygienic Engineering & Design 38, 266–271.

Jin, X., Huang, G., Luo, Z., Hu, Y., Liu, D., 2021. Oregano (*Origanum vulgare* L.) essential oil feed supplement protected broilers chickens against Clostridium perfringens induced necrotic enteritis. Agriculture 12(1), 18.

Khaksar, V., Van Krimpen, M., Hashemipour, H., Pilevar, M., 2012. Effects of thyme essential oil on performance, some blood parameters, and ileal microflora of Japanese quail. The Journal of Poultry Science 49, 106–110. https://doi.org/10.2141/jpsa.011089.

Khatun, A., Lahiry, A., Nishat, N.J., Begum, M., Roy, B.C., Das, S.C., 2025. Effects of feeding thyme, rosemary, and oregano powder supplementation on broiler chickens: Performance, meat quality, hematology and serum biochemistry. Advances in Animal and Veterinary Sciences 13(4), 752–763.

Lahlou, M., 2004. Methods to study the phytochemistry and bioactivity of essential oils. Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives 18(6), 435–448.

Méndez Zamora, G., Duran Melendez, L.A., Hume, M.E., Silva Vázquez, R., 2017. Performance, blood parameters, and carcass yield of broiler chickens supplemented with Mexican oregano oil. Revista Brasileira de Zootecnia 46, 515–520. https://doi.org/10.1590/s1806-92902017000600006.

Mujeebulla, S.M., Susmita, T., Tirupathi Reddy, E., Raja Kishore, K., 2025. Effect of supplementation of onion peel powder as a herbal feed additive on carcass traits, sensory evaluation and cost economics of Japanese quails. International Journal of Bio-resource and Stress Management 16(3), 01–07. https://doi.org/10.23910/1.2025.5762.

Nayely, L.L., Gutiérrez-Grijalva, E.P., Vazquez-OlivoVázquez-Olivo, G., Heredia, J.B., 2017. Essential oils of oregano: biological activity beyond their antimicrobial properties. Molecules 22, 989. https://doi.org/10.3390/molecules22060989.

Owen, O.J., Dike, U.A., 2013. Japanese quail (*Coturnix coturnix japonica*) husbandry: a means of increasing animal protein base in developing countries. Journal of Environmental Issues and Agriculture in Developing Countries 5, 1–4. https://icidr.org.ng/index.php/jeiadc/article/view/223.

Poonia, N.K., Choudhary, G., Kumar, V., 2023. Effect of dietary supplementation of giloy (*Tinospora cordifolia*) herb and ascorbic acid along with different bedding materials on cost economics of Japanese quail rearing. International Journal of Bio-resource and Stress Management 14(12), 1654–1662. https://doi.org/10.23910/1.2023.4933.

Puvaca, N., Tufarelli, V., Giannenas, I., 2022. Essential oils in broiler chicken production, immunity and meat quality: Review of *Thymus vulgaris*, *Origanum vulgare*, and *Rosmarinus officinalis*. Agriculture 12(6), 874.

Sathiya, R., Pazhanisamy, C., Banumathy, V., 2017. Economics of quail farming, India. Research Journal of Animal Husbandry and Dairy Science 8(1), 74–78. DOI: 10.15740/HAS/RJAHDS/8.1/74-78.

Snedecor, G.W., Cochran, W.J., 1994. Statistical methods. 8th edn. Iowa State University Press, Ames, Iowa, USA. Accessed on 01.10.2025.

Toso, F., Buldain, D., Retta, D., Di Leo Lira, P., Marchetti, M.L., Mestorino, N., 2025. Antimicrobial activity of *Origanum vulgare* L. and *Salvia rosmarinus* Spenn (syn *Rosmarinus officinalis* L.) essential oil combinations against Escherichia coli and Salmonella typhimurium isolated from poultry. Processes 13(9), 2856.

Yanishlieva, N.V., Marinova, E.M., Gordon, M.H., and Raneva, V.G., 1999. Antioxidant activity and mechanism of action of thymol and carvacrol in two lipid systems. Food Chemistry. 64, 59–66. https://doi.org/10.1016/S0308-8146(98)00086-7.

Yesilbag, D., Gezen, S.S., Biricik, H.A.K., Bulbul, T., 2012. Effect of a rosemary and oregano volatile oil mixture on performance, lipid oxidation of meat, and haematological parameters in Pharaoh quails. British Poultry Science 53, 89–97. https://doi.org/10.1080/00071668.2012.654763.