

Effect of Essential Oil Supplementation on Growth Performance and Meat Quality of Japanese Quail

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Abstract

Japanese quail (*Coturnix coturnix japonica*) has emerged as a cost-effective source of meat and eggs in Malaysia, prompting increased interest in optimizing their production. This study investigates the effects of dietary supplementation with essential oils, specifically sesame (*Sesamum indicum*) and rosemary (*Rosmarinus officinalis*), on growth performance and meat quality. Fourteen-day-old quails were subjected to supplementation with either sesame or rosemary oils at varying doses (250 or 350 mg/kg) and compared against a control group in a randomized design (n = 16 quails per group). Results revealed that the 250 mg/kg rosemary oil supplementation significantly improved average weight gain, emphasizing its potential as a growth promoter. Quails fed with 250 mg/kg sesame oil exhibited the lowest lipid oxidation levels, highlighting its effectiveness in preserving meat freshness. However, essential oil-treated groups showed different effects on water-holding capacity compared to the control. This study provides valuable insights for further research into dosage optimization and the extended shelf life of quail meat, potentially revolutionizing quail farming practices in Malaysia.

Keywords: Essential oil, Feed supplementation, Oxidative stability, post-harvest quality, Quail production

Introduction

Japanese quail (*Coturnix coturnix japonica*) has become popular in Malaysia's poultry industry, offering an efficient source of both meat and eggs. These tiny birds have captured the attention of farmers and researchers due to their remarkable growth potential.

With the ability to reach market size in just five weeks and produce up to 250 eggs annually, quail farming presents an attractive and economically viable option for poultry producers (Ahmad & Zulkifli, 2016).

The growing popularity of quail production in Malaysia stems from

several key advantages. These birds are particularly appealing because of their rapid growth rates and exceptional adaptability to confined spaces. Despite their small size, quail meats are a nutritional powerhouse. The meat is characterized by its delicate flavour, low-fat content, and impressive nutritional profile. It's particularly rich in B-complex vitamins, folate, and vitamins E and K, making it an increasingly attractive option for health-conscious consumers.

However, quail meat faces a common challenge shared by common poultry products which is its tendency to spoil quickly. The meat's high perishability is primarily due to lipid oxidation and microbial activity (Boni et al., 2010). This challenge has prompted researchers to explore innovative methods to extend the meat's shelf life and maintain its quality.

Our study takes an innovative approach to address these concerns by investigating the potential of essential oils as a dietary supplement. we examined rosemary (*Rosmarinus officinalis*) and sesame (*Sesamum indicum* L.) oils for their ability to improve quail meat quality and longevity. Both oils are known for their potent antioxidant properties. Rosemary extract, for instance, has previously shown promise in improving the stability of omega-3-rich oils, while sesame oil has been used effectively in poultry diets (Iqbal & Bhanger, 2006.)

Rosemary (*Rosmarinus officinalis*) is widely recognized for its antioxidative and antimicrobial properties, which significantly enhance

poultry meat quality. Its active compounds, such as carnosic acid, carnosol, and rosmarinic acid, have been shown to reduce lipid oxidation, improve shelf life, and maintain the sensory quality of meat. Supplementing broiler diets with rosemary oil has been found to improve body weight gain and feed conversion ratios while simultaneously reducing oxidative stress in tissues (Yesilbag et al., 2022). Additionally, the antioxidant activity of rosemary oil helps maintain the colour, flavour, and texture of meat during storage, as demonstrated in several studies (Sanchez-Escalante et al., 2001; Akhtar & Khan, 2018). Rosemary oil has also been shown to enhance the activity of antioxidant enzymes, such as superoxide dismutase and glutathione peroxidase, which protect muscle cells from oxidative damage (Hashemipour et al., 2013). Furthermore, dietary supplementation of rosemary oil in poultry diets has proven to reduce microbial spoilage, thus extending the shelf life of meat products (Safwat et al., 2021). These benefits make rosemary a natural and sustainable alternative to synthetic preservatives in poultry production, contributing to better meat quality and overall consumer appeal.

Sesame oil is rich in polyphenols and lignans, which neutralize free radicals and reduce lipid peroxidation (Iqbal & Bhanger, 2006). Sesame (*Sesamum indicum*) has shown promising effects on poultry meat quality through its antioxidative properties and ability to improve physiological and biochemical markers. Supplementation with sesame oil or

seeds has been demonstrated to reduce lipid oxidation in quail meat, thereby enhancing meat freshness and shelf life. For example, sesame seed and oil mixtures were found to improve postharvest quality parameters such as weight loss, pH, and firmness of quail meat, which are critical for maintaining its marketability and consumer appeal (Azrul-Lokman, 2020). Furthermore, dietary inclusion of sesame oil or seeds improved productive and reproductive performance in quails, enhancing feed conversion ratios and overall carcass quality (Mashadani et al., 2010). Sesame meal has also been suggested as a viable alternative protein source in poultry diets, as it can maintain growth performance and carcass traits while improving economic feasibility (Abbasi et al., 2022). Additionally, sesame supplementation reduced oxidative damage and lipid peroxidation in quails exposed to heat stress, suggesting its protective role in stressful environmental conditions (Al-Mushhadani & Al-Hayali, 2020). The inclusion of sesame oil in quail diets has been linked to decreased levels of cholesterol and triglycerides in eggs and meat, contributing to healthier meat profiles (Mohamed & Wakwak, 2014). Overall, sesame supplementation can enhance poultry meat quality by reducing oxidative spoilage, improving carcass traits, and supporting physiological resilience under stress.

The primary goal of this research is to optimize quail meat production by exploring how essential oil supplementation can enhance growth performance and meat quality. By

focusing on the high antioxidant content of these oils, we aim to address the ongoing challenge of oxidative deterioration in poultry meats. Our findings could potentially revolutionize quail farming practices in Malaysia, offering farmers a simple yet effective method to improve their product's quality and shelf life.

Materials and Methods

The study conducted at the Universiti Malaysia Terengganu utilized a standard randomized design. Eighty young (n=80) mixed-sex Japanese quail aged 7 days were obtained from a local Albakri Farm in Manir, Kuala Terengganu. The quail were placed in 20 cages with four birds in each cage in a completely randomized design and were given a 7-day adaptation period. The quail was provided with commercial feed. *Ad libitum* access to water and exposure to a photoperiod of 12 hours of daylight and 12 hours of artificial lighting at night. The experiment started when the quail reached the age of 14 days, at which point they were treated with five treatment groups (n = 16 birds per group), each with four replications, including a control treatment with a basal diet. The essential oil was bought from a Yein and Yang company that extracts pure 100% essential oil of rosemary and sesame using the Hydrodistillation method.

Essential oils were first mixed with the feed oil component of the basal diet to ensure homogeneous distribution. This oil mixture was then gradually blended with small portions of the feed (1:10 ratio) before being mixed

with the complete batch of feed. The other treatments included a basal diet supplemented with 250 mg/kg of rosemary oil (T1), a basal diet supplemented with 250 mg/kg of sesame oil (T2), a basal diet supplemented with 350 mg/kg of Rosemary (T3), and a basal diet supplemented with 350 mg/kg of Sesame (T4). The quail were provided with all requirements, such as water, shelter, and suitable pens. The growth performance of the quails was determined by measuring weekly weight gain. Live quails underwent regular weighing using a calibrated digital balance to monitor their growth. Individual quail weights were recorded weekly to accurately track their growth trajectory. Upon reaching the age of 35 days, the quail was slaughtered, and the quality of the carcasses was analyzed as follows:

Animal Ethics

This study was conducted following the guidelines approved by the institution Animal Ethics Protocol, Universiti Malaysia Terengganu.

Average Weight Gain

Individual quail weights were recorded weekly using a calibrated digital analytical balance model T-scale NHB precision scale with a precision of 0.01g. Measurements were taken at consistent times at 9.00 am every day to minimize variation effects. Birds were weighed before feeding to standardize. The balance was calibrated daily using certified reference weights, and tare was verified between each measurement.

Lipid Oxidation

Lipid oxidation was quantified using the Thiobarbituric Acid Reactive Substances (TBARS) method following Pokorny's (1991) protocol. Breast meat samples ($5\text{g} \pm 0.05\text{g}$) were homogenized with 25mL trichloroacetic acid solution (7.5% w/v) at 12,000 rpm for 30 seconds. The homogenate was filtered through the Whatman No. 1 filter paper, and 5mL of filtrate was mixed with 5mL of 0.02M thiobarbituric acid solution. Samples were incubated in a water bath at 95°C for 30 minutes, cooled immediately in an ice bath, and absorbance was measured at 532nm using a UV-visible spectrophotometer model Infitek uv vis spectrophotometer, double beam, sp-luv7500, sp-luv760. Results were expressed as μmol malondialdehyde (MDA)/g meat, calculated using a standard curve (range: 0-10 $\mu\text{mol/L}$ TEP).

The Formula:

$$\text{BA} = (50 \times (\text{As}-\text{Ab}))/200$$

$$\text{BA} = 20050 \times (\text{As}-\text{Ab})$$

Variables:

- BA: The TBARS value, often expressed in mg malondialdehyde (MDA) per kg of sample.
- As: Absorbance of the sample at the specific wavelength (usually 532 nm for TBA tests).
- Ab: Absorbance of the blank sample, which serves as the control and accounts for background noise.

Water-Holding Capacity (Drip Loss)

Drip loss was determined according to Honikel and Hamm's (1994) gravimetric

method. Fresh breast muscle samples (approximately 30g) were weighed (initial weight, W1), suspended in sealed polyethylene bags while avoiding contact with the bag walls and stored at $2^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$ for 24 hours. Surface moisture was carefully removed using filter paper before final weighing (W2). The temperature was continuously monitored using calibrated data loggers. Drip loss was calculated as percentage weight loss:

$$\text{Drip Loss (\%)} = \frac{\text{Initial Weight} - \text{Final Weight}}{\text{Initial Weight}} \times 100$$

Variables:

- Initial Weight: The weight of the meat sample before storage (in grams).
- Final Weight: The weight of the meat sample after the storage period, accounting for the water loss (in grams).

Statistical Analysis

All data were analyzed using IBM SPSS Statistics software (Version 22.0, IBM Corp., Armonk, NY, USA). Before analysis, data were tested for normality using the Shapiro-Wilk test and for homogeneity of variances using Levene's test. When

these assumptions were met, a one-way analysis of variance (ANOVA) was performed to evaluate treatment effects. Treatment means were compared using Tukey's test with significance set at $p < 0.05$.

Results and Discussion

Growth performance

Quails supplemented with 250 mg/kg rosemary oil demonstrated significantly higher average weight gain compared to other treatments ($P < 0.05$). This observation aligns with previous findings where rosemary's active compounds, such as rosmarinic acid and carnosic acid, enhanced nutrient absorption and promoted growth (Hashemipour et al., 2013). Similarly, Yesilbag et al. (2011) reported improved growth performance in broilers supplemented with rosemary oil at comparable doses due to its potential role in reducing oxidative stress and improving gut health (Yesilbag et al., 2011). Additionally, supplementing rosemary oil has been shown to modulate gut microbiota, which may further explain the observed growth performance (Cross et al., 2007).

Table 1: Effect of different inclusion rates of rosemary and sesame oils on the growth performance of quails

Weeks	C	R (250 mg/kg)	SE (250 mg/kg)	R (350 mg/kg)	SE (350)	P-value
Weeks 1	86.66 ± 0.208 ^{ab}	90.6 ± 9.21 ^{ab}	90.85 ^{ab}	87.25 ± 21.895 ^{ab}	101.65 ± 42.792 ^{ab}	<0.05
Weeks 2	145 ± 10 ^{ab}	155 ± 19.149 ^{ab}	155 ± 25.166 ^{ab}	155 ± 10 ^{ab}	155 ± 36.645 ^{ab}	<0.05
Weeks 3	195 ± 19.149 ^{ab}	295 ± 10 ^a	205 ± 30 ^{ab}	210 ± 11.547 ^{ab}	190 ± 20 ^{ab}	<0.05

a, b, Means with different letters within a row differed significantly (P < 0.05). Control (C), Rosemary (R), Sesame (SE)

Interestingly, the higher dose of rosemary oil (350 mg/kg) did not yield proportionally greater benefits, possibly indicating a threshold effect where increasing concentrations might not further enhance nutrient uptake. This trend mirrors findings by Chaves et al. (2008), where moderate

Conversely, rosemary oil treatments, particularly at 250 mg/kg, showed moderate levels of lipid oxidation, which is consistent with the antioxidative properties of carnosic acid and rosmarinic acid.

Table 2: Lipid Oxidation analysis (mcmol/L) for quail meat sample with different inclusion rates of rosemary and sesame oil

C	R (250 mg/kg)	SE (250mg/kg)	R (350 mg/kg)	SE (350mg/kg)	P-value
0.38 ± 0.12 ^{ab}	0.48 ± 0.12 ^{ab}	0.25 ± 0.12 ^{ab}	0.31 ± 0.13 ^{ab}	0.29 ± 0.15 ^{ab}	<0.05

a, b, Means with different letters within a row differed significantly (P < 0.05). Control (C), Rosemary (R), Sesame (SE).

supplementation of essential oils maximized benefits without overburdening metabolic pathways.

The 250 mg/kg sesame oil treatment exhibited the lowest lipid oxidation values, though the differences were not statistically significant (P < 0.05). This result supports the findings by Wang et al. (2017), who demonstrated sesame oil's strong antioxidant efficacy in preserving meat quality due to its high lignan and tocopherol content (Wang et al., 2017). Lignans, such as sesamin and sesamol, act as potent scavengers of free radicals, thereby reducing

malondialdehyde (MDA) formation (Kamal-Eldin et al., 2011). Previous research has highlighted rosemary oil's ability to inhibit lipid peroxidation, albeit to a lesser extent compared to sesame oil (Fernández-López et al., 2005). The disparity in effectiveness between the two oils could be attributed to the compositional differences, where sesame oil's tocopherol content provides superior oxidative stability (Nakatani, 2000).

Contrary to expectations, essential oil supplementation did not improve water-holding capacity compared to the control

group. This finding variate from those of Sanchez-Escalante et al. (2001), who reported improved moisture retention in

meat from animals supplemented with rosemary oil .

Table 3. Effect of different inclusion rates of rosemary and sesame oil on the drip loss of the quail's meat.

C	R (250 mg/Kg)	SE (250 mg/Kg)	R (350 mg/Kg)	SE (250 mg/Kg)	P-value
2.4 ± 0.15^a	8.78 ± 0.15^{ab}	4.63 ± 0.2^{ab}	6.25 ± 0.26^{ab}	6.67 ± 1.03^{ab}	<0.05

^{a, b}, Means with different letters within a row differed significantly ($P < 0.05$). Control (C), Rosemary (R), Sesame (SE).

The difference may be due to differences in dosage levels, meat composition, and experimental conditions. Moreover, essential oils are known to interact with muscle proteins, potentially impacting drip loss by altering protein-water interactions (Gao et al., 2015).

The relatively high drip loss observed in rosemary oil treatments could indicate suboptimal dosage levels or variability in quail muscle composition. Similarly, the sesame oil groups showed lower readings in drip loss, aligning with studies that suggest sesame oil's antioxidative properties could indirectly influence water retention (Al-Hijazeen et al., 2016).

Conclusion

Despite the lack of statistically significant findings in lipid oxidation, the study revealed promising trends. The supplementation of sesame oil at 250 mg/kg showed potential in reducing oxidative spoilage, while rosemary oil at the same dose enhanced growth performance. These findings contribute

valuable insights into the use of natural antioxidants in poultry diets, particularly in extending shelf life and improving meat quality. Future research should explore optimal dosages, treatment durations, and environmental factors to maximize the benefits of essential oil supplementation. Additionally, investigating the interaction between essential oils and meat properties may clarify inconsistencies observed in water-holding capacity outcomes. Moreover, the researcher is recommended to dive into the long-term effects of essential oil supplementation on meat quality during extended storage, explore molecular mechanisms underlying the interaction of essential oils with muscle proteins and lipids, and conduct cost-benefit analyses to assess economic viability for small-scale farmers. examine synergistic effects of combining sesame and rosemary oils to maximize benefits.

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Conflict of interest

The authors declare that there are no conflicts of interest.

References

- Abbasi, M. A., & Achakzai, K. (2022). Effects of substitution of soybean meal with sesame meal on the performance of Japanese quails and its impact on economics. *Poult. Sci. J.*, 10(2), 45–52.
- Abd El-Hack, M. E., Alagawany, M., Farag, M. R., Tiwari, R., Karthik, K., Dhama, K., Zorriezhahra, J., & Adel, M. (2016). Beneficial impacts of thymol essential oil on health and production of animals, fish and poultry: A review. *J. Essent. Oil Res.*, 28(5), 365–382.
- Ahmad, S., & Zulkifli, I. (2016). Quail production in Malaysia: current status and prospects. *World's Poult. Sci. J.*, 72(2), 259–270.
- Akhtar, M., & Khan, Z. (2018). Effect of rosemary oil supplementation on meat quality and oxidative stability in broiler chickens. *Asian J. Poult. Sci.*, 11(1), 22–29.
- Al-Mushhadani, H. I., & Al-Hayali, A. H. (2020). Biochemical and physiological study of the effect of sesame seeds on quail males exposed to thermal stress. *Anim. Nutr. J.*, 7(1), 11–18.
- Amani, M. S., Zakaria, E. M., & Abd, E. R. (2017). The efficiency of some essential oils in control of Methicillin-Resistant *Staphylococcus aureus* (MRSA) in minced beef. *Benha Vet. Med. J.*, 32, 177–183.
- Azrul-Lokman, I. (2020). Effect of sunflower oil and sesame seed treatment mixture at different ratios on postharvest quality of quail fresh meat. *J. Food Process. Preserv.*, 44(3), e14312.
- Boni, I., Nurul, H., & Noryati, I. (2010). Comparison of meat quality characteristics between young and spent quails. *Int. Food Res. J.*, 17, 661–666.
- Botsoglou, N. A., Grigoropoulou, S. H., Botsoglou, E., Govaris, A., & Papageorgiou, G. (2004). Effects of dietary oregano essential oil and α -tocopheryl acetate supplementation on lipid oxidation in raw and cooked chicken meat during refrigerated storage. *Meat Sci.*, 68(2), 289–295.
- Campo, M. M., Nute, G. R., Hughes, S. I., Enser, M., Wood, J. D., & Richardson, R. I. (2006). Flavour perception of oxidation in beef. *Meat Sci.*, 72, 303–311.
- Cross, D. E., McDevitt, R. M., Hillman, K., & Acamovic, T. (2007). The effect of dietary essential oils on growth performance, digestibility and gut microflora in white fish. *Aquaculture*, 272(1–4), 511–519.

- Genchev, A., Mihaylova, G., Ribarski, S., Pavlov, A., & Kabakchiev, M. (2008). Meat quality and composition in Japanese quails. *Trakia J. Sci.*, 6(4), 72–82.
- Govaris, A., Botsoglou, E., Papageorgiou, G., Botsoglou, N., & Ambrosiadis, I. (2007). The effect of oregano essential oil and α -tocopherol on lipid oxidation in raw and cooked lamb meat during refrigerated storage. *Meat Sci.*, 76(4), 682–689.
- Hashemipour, H., Kermanshahi, H., Golian, A., & Veldkamp, T. (2013). Effect of thymol and carvacrol feed supplementation on performance, antioxidant enzyme activities, and fatty acid composition in broiler chickens. *Poult. Sci.*, 92(8), 2059–2069.
- Hernández, F., Madrid, J., García, V., Orengo, J., & Megías, M. D. (2004). Effect of formic acid and plant extracts on growth, nutrient digestibility, intestine mucosa morphology, and performance of broiler chickens. *J. Appl. Poult. Res.*, 13(2), 237–244.
- Iqbal, S., & Bhanger, M. I. (2006). Effect of season and production location on antioxidant activity of sesame seed constituents. *J. Food Compos. Anal.*, 19(3–4), 277–283.
- Kamal-Eldin, A., Moazzami, A., & Washi, S. (2011). Sesame seed lignans: Potent physiological modulators and possible ingredients in functional foods and nutraceuticals. *Food Nutr. Agric.*, 3, 17–29.
- Küçükyılmaz, K., Bozkurt, M., Çınar, M., Çatlı, A. U., Bintaş, E., & Çöven, F. (2014). The effects of an organic rearing system and dietary supplementation of an essential oil mixture on performance and meat yield of slow-growing broilers in two seasons. *S. Afr. J. Anim. Sci.*, 44(4), 360–370.
- Lee, K. W., Everts, H., Kappert, H. J., & Beynen, A. C. (2003). Effects of dietary essential oils on growth performance, digestive enzyme activity, and lipid metabolism in female broiler chickens. *Poult. Sci.*, 82(8), 1311–1316.
- Mahmoud, U. T., Abdel-Rahman, M. A. M., & Darwish, M. H. A. (2014). Effects of propolis, ascorbic acid, and vitamin E on thyroid and corticosterone hormones in heat-stressed broilers. *J. Adv. Vet. Res.*, 4(1), 18–27.
- Mashadani, H. I., & Daraji, H. J. (2010). Effect of feeding diets containing sesame oil or seeds on productive and reproductive performance of laying quail. *Iraqi J. Vet. Sci.*, 24(1), 57–62.
- Mohamed, A., & Wakwak, A. (2014). Effect of sesame seeds or oil supplementation to the feed on some physiological parameters in Japanese quail. *Egypt. J. Anim. Prod.*, 51(3), 45–53.

- Peng, Y., Dong, N., Wang, L., Zhang, X., & Wang, X. (2016). Effects of dietary supplementation with rosemary extract on the growth performance, lipid peroxidation, antioxidant activity, and immune response of broilers. *Poult. Sci.*, 95(7), 1629–1635.
- Safwat, A., Taher, M., Bahie El-Deen, M., & Abd El-Naeem, M. (2021). Essential oils as dietary supplements in poultry. *J. Anim. Nutr.*, 13, 45–56.
- Sanchez-Escalante, A., Djenane, D., Torrescano, G., Beltrán, J. A., & Roncales, P. (2001). Antioxidant activity of commercial oregano and rosemary essential oils. *J. Food Prot.*, 64(4), 616–621.
- Wang, H., Chen, G., Ren, D., Yang, J., & Yang, B. (2017). Antioxidant capacities of sesame hulls and their radical-scavenging constituents. *J. Food Drug Anal.*, 25(3), 536–544.
- Windisch, W., Schedle, K., Plitzner, C., & Kroismayr, A. (2008). Use of phytogenic products as feed additives for swine and poultry. *J. Anim. Sci.*, 86(14), E140–E148.
- Yesilbag, D., Eren, M., Agel, H., & Balci, F. (2011). Effects of rosemary oil on broiler performance, oxidative stress, and blood parameters. *Rev. Bras. Zootec.*, 40(9), 2038–2046.