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Growth performance, carcass traits and meat physical characteristics of growing Japanese quail fed ginger powder and frankincense oil as feed additives

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ABSTRACT This work aimed to investigate the effects of dietary frankincense oil and ginger on the growth efficiency of growing Japanese quail, including live body weight, body weight gain, feed intake, feed conversion ratio, carcass traits, and physical characteristics of the meat. In total, 150 unsexed Japanese quail chicks that were 7 d old were utilized in the experiment. The chicks were randomly divided into 5 groups. Each group was divided into 3 replicates with ten birds in a completely randomized design. Group 1 received a basal diet without supplements and was used as a control group. Groups 2 and 3 received basal diets with 250 and 500 mg of ginger per kg of diet, respectively. Groups 4 and 5 received basal diets with 200 and 400 mg of frankincense oil per kg of diet, respectively. Results showed that BW of chicks received 500 mg of ginger and the 2 levels of frankincense oil at 5 wk of age, and 250 mg of ginger and 400 mg of frankincense oil at 6 wk significantly increased. BWG was significantly increased by using 500 mg of ginger and 2 levels of frankincense oil at 1 to 3 wk, 250 mg of ginger and 400 mg of frankincense oil at 3 to 6 wk, and 1 to 6 wk of age, in comparison with the control group. Treatments insignificantly influenced feed intake (**FI**), and feed conversion ratio (**FCR**) was improved considerably by using 250 mg of ginger and 400 mg of frankincense at 3 to 6 wk and 1 to 6 wk of age, respectively. Gizzard% was notably reduced with 200 mg of frankincense oil. The pH value of meat was significantly increased by having 2 levels of ginger. Still, water holding capacity and tenderness significantly decreased owing to 500 mg of ginger and 400 mg of frankincense oil. We can conclude that adding ginger and frankincense oil to Japanese quail diets may be beneficial.

Key words: frankincense oil, ginger, growth performance, quail

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INTRODUCTION

Supplementary nutrients are essential for improving the animal's immunity, general health, and capacity to consume its food. Vargas-Sánchez et al. (2019) demonstrated a relationship between carcass traits, meat quality, and additive type and amount. Adding edible fungi, plants, seeds, spices, phytochemicals, and medicinal herbs enhanced the quality of the Japanese quail's meat and carcass. Additionally, Abd El-Hack et al. (2022;2023a) indicated that natural products derived from plants and peppermint essential oils have demonstrated promise in the fight against aflatoxin contamination and *A. flavus* infestations. Furthermore, Abd El-Hack et al. (2023b) discovered that adding organic acids, essential oils, or probiotics and prebiotics to the diets of Japanese quail improved the health of the intestines, the characteristics of the villus, and the control of pathogens, all of which improved growth performance.

The plant *Zingiber officinale*, commonly referred to as ginger, is used for food, medicine, and spices.

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Gingerdione and gingerol are the 2 most beneficial compounds found in ginger. These substances influence microbial activity and encourage the enzymatic activity of enzymes for digestion while being included in broiler diets (Kothari et al., 2019). Antibacterial, anti-tumorigenic, anti-inflammatory, anti-apoptotic, anti-hyperglycemic, anti-lipidemic, antioxidant, immune-modulating, and antiemetic qualities are found in the active ingredient of ginger (Morakinyo et al., 2011). Ahmed et al. (2019) discovered that ginger and cinnamon oil could successfully substitute antibiotics (colistine) in the diets of developing Japanese quail. According to Abd El-Hack et al. (2024), treating quails with cinnamon and ginger enhanced their gastrointestinal and hepatic histology, reduced inflammation, and improved blood biochemical indicators in the birds. Dosoky et al. (2023) found that when organic supplements such as frankincense oil or ginger powder were added, Japanese quail laying hen efficiency, reproductive efficiency, and blood serum characteristics were higher than in control birds.

Boswellia serrata is the source of frankincense, a tropical tree extract that boosts immunity, offers antioxidants, and fights gram-positive bacteria (Suther et al., 2022). The antimicrobial properties of frankincense, namely monoterpene, diterpene, and ciscoterpene, are responsible for its effectiveness against bacteria and are utilized for treating bacterial illnesses such as *Salmonella* and *E. coli* (Camarda et al., 2007). Although little is known about frankincense oil, Frank et al. (2009) propose it as a possible substitute for treating bladder cancer in Japanese quails. According to Amer et al. (2023), adding up to 600 mg kg−1 of frankincense oil to broiler diets enhances immune system function, growth performance, and nutrient levels in the breast muscle. This suggests that frankincense oil may tackle problems such as resistant bacteria in global livestock farming by acting as an immune-stimulating agent and growth promoter.

This research aimed to evaluate the impacts of natural feed additives, such as frankincense oil or ginger, as phytogenic supplements and naturalistic antioxidants on the growth, carcass features, and physical attributes of the meat of Japanese quail.

MATERIALS AND METHODS

Ethical Approval

The Poultry Research Laboratory, Alexandria University, Faculty of Agriculture (Saba Basha). This investigation was conducted in Alexandria, Egypt. Every step of the process follows the guidelines set forth by a regional committee for evaluating the care of animals.

Animal Experiments

In this experiment, 150 seven-day-old unsexed Japanese quail chicks were utilized. The chicks were randomly separated into 5 groups, and in a completely randomized design, each group was assigned to 3 replicates (10 birds each). Table 1 displays the chemical analyses and composition of the testing basal diets prepared following the NRC (1994). Weekly mixes of fresh feed were made, and they were never kept longer than a week. Water and feed were ad libitum available for the entire 6-week trial. Group 1 received a basal diet without supplements and was utilized as a control group. Groups 2 and 3 received basal diets with 250 mg and 500 mg of ginger per kg of diet, respectively. Groups 4 and 5 received 200 mg and 400 mg of frankincense oil per kg, respectively.

Table 1. Composition and calculated analysis of the experimental basal diet.

Ingredients	%
Yellow corn	53.30
Soybean meal (44 %)	33.00
Concentrate (50 %)[1]	10.00
Di-calcium phosphate	0.20
Limestone	1.70
Sunflower oil	0.80
Vit. and min. mix.[2]	0.50
Salt (NaCl)	0.50
Total	100
Calculated analyses[3]:	
Crude protein %	24.05
ME (Kcal/ kg diet)	2907.10
Ether extract %	2.44
Crude fiber %	3.63
Methionine %	0.76
Methionine + cystine, %	0.88
Lysine, %	1.42
Calcium, %	1.11
Available phosphorus, %	0.39

[1]Concentrate: ME (KCal/kg) 2870, Crude protein 50%, Crude fiber 1.51%, Crude fat 1.54%, Calcium 4.29%, Phosphorus 2.39%, NaCl 0.8%, Methionine 4.6%, Methionine & Cystine 5.38%, Lysine 3.90%.

[2]Each kg of vitamin and minerals mixture contained: Vit. A, 4,000,000 IU; Vit. D_3, 500,000 IU; Vit, E, 16.7 g., Vit. K, 0.67 g., Vit. B1, 0.67 g., Vit. B2, 2 g., Vit. B 6, .67 g., Vit. B12, 0.004 g., Nicotinic acid, 16.7 g., Pantothenic acid, 6.67 g., Biotin, 0.07 g., Folic acid, 1.67 g., Choline chloride, 400 g., Zn, 23.3 g., Mn, 10 g., Fe, 25 g., Cu,1.67 g., I, 0.25 g., Se, 0.033 g. and, Mg, 133.4 g.

[3]According to NRC (1994).

Measured Traits

Growth Performance For every replicate, live body weight (**LBW**) and feed intake (**FI**) were tracked over 6 wk of age. Each replicate's body weight gain (**BWG**) and feed conversion ratio (**FCR**) were determined during the trial.

Carcass Traits At random, 6 birds were selected from every pen after the trial, and their lives were ended by slaughter. After being slaughtered, the birds were placed in a water tank and burned for 30 s at 55 to 60°C. After that, the intestinal tract and vent were removed. The liver and gizzard were eliminated and weighed individually. Then, utilizing body weight as a percentage, they were calculated.

Physical Characteristics The pH reading for meat was ascertained using a pH meter and the technique described by Mäki-Petäys et al. (1991). El-Seesy's (2000) method was utilized to determine tenderness and water-holding capacity. The procedure involved placing 0.3 g of minced meat under Whatman No. 41 ashless

Table 2. Effect of ginger and frankincense oil on live body weight (g) of Japanese quail from 1 to 6 wk of age.

Treatments	Body weight (g)					
	1 wk	2 wk	3 wk	4 wk	5 wk	6 wk
Control	31.19 ± 0.64	79.27 ± 1.73	133.13 ± 2.90	177.27 ± 3.75	195.02 ± 3.88[d]	234.49 ± 5.52[b]
250 mg ginger/kg diet	30.98 ± 0.49	80.13 ± 1.14	138.48 ± 1.90	186.42 ± 2.53	202.96 ± 3.08[cd]	255.97 ± 5.59[a]
500 mg ginger/kg diet	30.98 ± 0.49	76.13 ± 1.35	140.36 ± 2.16	183.19 ± 2.81	213.74 ± 4.85[bc]	248.40 ± 5.21[ab]
200 mg frankincense oil/kg diet	30.96 ± 0.49	75.45 ± 1.29	140.60 ± 2.32	182.02 ± 2.67	220.43 ± 4.26[ab]	249.18 ± 7.23[ab]
400 mg frankincense oil/kg diet	30.97 ± 0.49	77.20 ± 1.62	142.29 ± 2.30	176.18 ± 3.41	227.74 ± 4.86[a]	264.66 ± 6.61[a]
P value	0.998	0.108	0.063	0.11	0.001	0.012

[a-d]Different superscripts within a column indicate significant differences ($p < 0.05$).

filter paper and pressing with a 1 kg weight for 10 min. On the filter paper, 2 zones were developed, and a planimeter was used to measure their surface areas. Tenderness in cm^2 was indicated by the internal zone caused by the meat pressing. The area of the inner zone was subtracted from the area of the outer zone to determine the water-holding capacity.

Hunt et al. (1991) described a method for determining the color brightness of meat extract. A total of 10 g of meat were shaken with 22.5 mL of distilled water in a darkened space for 10 min. The filtrate's color intensity (absorbance) was determined using a spectrophotometer at 542 nm.

Statistical Analysis

To determine substantial variations among the means, the collected data was statistically examined utilizing the one-way ANOVA processes of SPSS® (Version 16) along with Duncan's Multiple Range Test (Duncan, 1955). The model that was employed was:

$$Y_{ij} = \mu + T_i + e_{ij}.$$

Where: Y_{ij} = An observation treatment.

μ = Overall mean.
T_i = the i-treatment effect (I =1— 5).
e_{ij} = The random error.

RESULTS

Growth Performance

Tables 2 and 3 show the impact of frankincense oil and ginger on the body weight (**BW**) and body weight gain (**BWG**) of Japanese quail. Compared to other groups, BW substantially rose when 500 mg of ginger and each level of frankincense oil were included at 5 wk of age. It also rose substantially when 250 mg of ginger and 400 mg of frankincense were added at 42 d of age. However, no substantial variations were seen at other test periods. In contrast to the other groups and control group, BWG was significantly elevated when using a high level of ginger and 2 levels of frankincense oil at 1 to 3 wk of age, and it also increased substantially when utilizing the lowest amount of ginger and the highest level of frankincense at 3 to 6 wk and 1 to 6 wk.

Data from Tables 4 and 5 show how ginger and frankincense oil affected the FI and FCR of developing Japanese quail. In comparison with the control group, FI was insignificantly influenced by adding ginger or frankincense oil at any level during all experimental periods. During the 1 to 3 wk of age, significant ($P < 0.05$) variations were seen in FI between chicks received 250 mg ginger and 200 mg frankincense oil. Compared to control chicks, insignificant improvements were detected in FCR of chicks received ginger and frankincense oil at any level during 1 to 3 wk of age. Meanwhile, FCR significantly ($P < 0.05$) improved in chicks received 250 mg ginger or 400 mg frankincense oil during 3 to 6 wk of age, and significantly ($P < 0.01$) improved in chicks received the 2 levels of ginger or 400 mg frankincense oil during 1 to 6 wk of age.

Carcass Traits

Data in Table 6 show that adding all feed additives had no significant impact on the percentages of carcass and liver. Still, the percentage of gizzard was significantly lower in the groups that received 200 mg of

Table 3. Effect of ginger and frankincense oil on body weight gain (g/ bird/ period) of Japanese quail from 1 to 6 wk of age.

Treatments	Body weight gain (g/bird/period)		
	1−3 wk	3−6 wk	1−6 wk
Control	101.94 ± 2.64[b]	101.36 ± 5.40[c]	203.30 ± 3.86[b]
250 mg ginger/kg diet	107.50 ± 1.70[ab]	117.49 ± 3.26[ab]	224.99 ± 3.73[a]
500 mg ginger/kg diet	109.38 ± 1.86[a]	108.04 ± 4.10[bc]	217.42 ± 6.44[ab]
200 mg frankincense oil/kg diet	109.64 ± 2.13[a]	108.58 ± 2.81[bc]	218.21 ± 4.53[ab]
400 mg frankincense oil/kg diet	111.32 ± 1.99[a]	122.37 ± 4.04[a]	233.69 ± 5.25[a]
P value	0.020	0.028	0.013

[a-c]Different superscripts within a column indicate significant differences ($p < 0.05$).

Table 4. Effect of ginger and frankincense oil on feed intake (g/bird/week) of Japanese quail from 1to 6 wk of age.

Treatments	Feed intake (g/bird/ period)		
	1−3 wk	3−6 wk	1−6 wk
Control	202.50 ± 0.91[ab]	375.92 ± 3.39	578.42 ± 3.82
250 mg ginger/kg diet	197.46 ± 3.01[b]	380.30 ± 2.51	577.76 ± 3.90
500 mg ginger/kg diet	197.99 ± 1.38[ab]	376.75 ± 0.62	574.74 ± 1.08
200 mg frankincense oil/kg diet	205.61 ± 0.40[a]	379.05 ± 0.93	584.66 ± 0.71
400 mg frankincense oil/kg diet	203.19 ± 1.68[ab]	372.19 ± 4.19	575.38 ± 2.87
P value	0.031	0.321	0.179

[a- b]Different superscripts within a column indicate significant differences ($p < 0.05$).

Table 5. Effect of ginger and frankincense oil on feed conversion ratio (g feed/g weight gain) of Japanese quail from 1to 6 wk of age.

Treatments	Feed conversion ratio (g feed/g weight gain)		
	1−3 wk	3−6 wk	1−6 wk
Control	1.99 ± 0.05	3.71 ± 0.23[a]	2.85 ± 0.07[a]
250 mg ginger/kg diet	1.84 ± 0.04	3.24 ± 0.08[b]	2.57 ± 0.04[bc]
500 mg ginger/kg diet	1.81 ± 0.05	3.49 ± 0.13[ab]	2.64 ± 0.08[bc]
200 mg frankincense oil/kg diet	1.88 ± 0.06	3.49 ± 0.09[ab]	2.68 ± 0.05[ab]
400 mg frankincense oil/kg diet	1.83 ± 0.03	3.04 ± 0.07[b]	2.46 ± 0.04[c]
P value	0.120	0.036	0.010

[a-b]Different superscripts within a column indicate significant differences ($p < 0.05$).

frankincense oil than in the other groups and the control group.

Physical Characteristics of Meat

The effects of frankincense oil and ginger on the pH value, color, tenderness, and water-holding capacity of Japanese quail meat are compiled in Table 7. Utilizing ginger at 2 levels raised the pH value significantly when contrasted with the control and frankincense oil groups. In contrast, utilizing the highest levels of ginger and frankincense oil resulted in a substantial reduction in water-holding capacity as opposed to the low-level and control groups. Additionally, utilizing frankincense at a high level considerably reduced tenderness compared to the control group and the group receiving other additives. However, there were no significant variations in the meat's color.

DISCUSSION

Results of the present study confirmed that adding 500 mg of ginger and each level of frankincense oil substantially improved the BW and BWG of Japanese quail at 5 and 6 wk of age, respectively (Tables 2 and 3). Other test periods did not show any notable differences, though. These findings aligned with those of Rahimian et al. (2018), who discovered that the birds fed ginger had considerably greater body weights than the control group. Ahmed et al. (2019) also found that chicks fed 0.25 mL of ginger at 3 wk of age had significantly greater LBW and DBWG than chicks fed either 0.5 or a control diet. According to Herawati (2010), broiler chickens' body weight increased when their diets included 2% red ginger. After the fourth week of supplementation, the body weight of the ginger and garlic nutrients group was substantially greater than that of the control group (Saeed et al., 2017; Swain et al., 2017). These results are consistent with those of Karangiya et al. (2016), who found that the BWG in broiler chickens enriched with a combination of garlic and ginger was substantially greater. Also, Dosoky et al. (2023), feeding Japanese quail laying hens with 500 mg/kg of ginger powder or 200 mg/kg of frankincense oil as nutritional supplements enhanced the hens' reproduction and productivity compared to control birds.

On the other hand, Herve et al. (2018) found that the amounts of ginger essential oil utilized had no significant

Table 6. Effect of ginger and frankincense oil on carcass weight (%), liver weight (%) and gizzard weight (%) of Japanese quail at 6 wk of age.

Treatments	Carcass characteristics (%)		
	Carcass	Liver	Gizzard
Control	61.09 ± 0.17	2.23 ± 0.18	2.13 ± 0.14[a]
250 mg ginger/kg diet	63.10 ± 1.53	2.41 ± 0.49	2.15 ± 0.16[a]
500 mg ginger/kg diet	62.06 ± 1.79	2.20 ± 0.19	1.99 ± 0.05[a]
200 mg frankincense oil/kg diet	61.84 ± 3.02	1.76 ± 0.22	1.53 ± 0.17[b]
400 mg frankincense oil/kg diet	64.60 ± 1.84	2.40 ± 0.33	1.88 ± 0.09[ab]
P value	0.301	0.576	0.024

[a-d]Different superscripts within a column indicate significant differences ($p < 0.05$).

Table 7. Effect of ginger and frankincense oil on physical characteristics of meat of Japanese quail at 6 wk of age.

Treatments	Physical characteristics of meat			
	pH value	Color	Tenderness	Water holding capacity (cm^2)
Control	6.53 ± 0.06^{cd}	0.24 ± 0.02	8.57 ± 0.70^{a}	3.63 ± 0.36^{a}
250 mg ginger/kg diet	7.00 ± 0.09^{a}	0.18 ± 0.01	8.32 ± 0.87^{a}	3.66 ± 0.60^{a}
500 mg ginger/kg diet	6.83 ± 0.06^{ab}	0.21 ± 0.03	7.24 ± 0.26^{ab}	2.42 ± 0.19^{bc}
200 mg frankincense oil/kg diet	6.74 ± 0.10^{bc}	0.16 ± 0.01	7.38 ± 0.05^{ab}	3.36 ± 0.19^{ab}
400 mg frankincense oil/kg diet	6.37 ± 0.07^{d}	0.18 ± 0.02	6.24 ± 0.13^{b}	2.13 ± 0.11^{c}
P value	0.001	0.15	0.058	0.026

[a-d]Different superscripts within a column indicate significant differences ($p < 0.05$).

impact on body weight or weight gain. These results are supported by Fakhim et al. (2013), who observed no difference in BWG between the chickens fed ginger oil and the control. Compared to the control group, Khan et al. (2022) found that groups with 1.0 and 1.5% gum Arabic (**GA**) levels had substantially greater BWGs. Furthermore, Amer et al. (2023) reported on the impact of frankincense oil levels on broiler production variables as an additive. At the beginning phase, the BW and BWG were substantially higher in the groups that received 200 mg of frankincense oil. These findings aligned with Tabidi and Ekram's (2015) findings that broiler BWG increased with GA supplementation.

According to our findings, frankincense oil and ginger greatly improved the FI and FCR of the growing Japanese quail. Except for the 1−3-week age range, no appreciable changes were seen in FI when additional ingredients were used.These findings partially supported Rahimian et al. (2018), who found that utilizing protexin and ginger substantially raised FI. However, the protexin and herbals group experienced a substantial reduction in FCR. However, Ahmed et al. (2019) demonstrated that nutritional supplementation did not affect the FI of Japanese quails throughout the study periods (1−3, 3−5, and 1−5 wk of age). Moreover, FCR was not significantly influenced by dietary strategies within the 1 to 3-wk age range but during the 3 to 5 and 1 to 5-wk age ranges. According to Muhammad et al. (2017), ginger can be included in the diets of Japanese quails up to a 2% level without harming their performance. Ginger root extract, up to 1.5% of dietary supplements, did not negatively impact growth performance; instead, it strengthened the immune system, inhibited *E. coli*, and encouraged the growth of beneficial bacteria (Dosu et al., 2023).

Hernandez et al. (2004) observed that adding botanical extracts or essential oils to broiler diets did not improve the birds' FCR, which contradicts previous findings. Furthermore, Habibi et al. (2014) discovered no appreciable variations in broiler FI because of supplementing with ginger powder or essential oils.

According to Khan et al. (2022), the group with 1.5% GA had a significantly higher FI and improved FCR than the group with 1.0% GA. The improvement in FI and palatability was because soluble fermented and fractionated foods comprise more than 85% of GA (Al-Fadil et al., 2013). The group enriched with 200 mg/kg of frankincense oil showed the most notable findings from FCR, followed by the group added with 400 mg/kg (Amer et al., 2023). Furthermore, Ismail et al. (2019) demonstrated that FCR increased in rabbits fed diets supplemented with 0.25, 0.50, 0.750, and 1.00 g/kg *Boswellia serrata* (**BS**). However, Tabatabaei et al. (2012) found that broiler diets supplemented with 0.5% BS had a lower FCR than control throughout the growing period. The improved gut villi configuration, stomach microbiota, and general health of broilers contributed to the improved feed productivity and efficiency of broilers supplemented with BS (Al-Yasiry et al., 2017). This finding implies that enhancing growth performance and activating appetite and FI can benefit medicinal plants or medicinal compounds in quail nutrition.

According to our findings, feed additives had no significant effect on the percentages of carcass and liver; however, the percentage of gizzard was considerably lower in the groups that received 200 mg of frankincense. Our findings concur with those of Hernandez et al. (2004), who found no significant differences in the carcass characteristics of broiler chicks given a diet enriched with essential oil extracts from rosemary, oregano, cinnamon, pepper, and thyme. There are no appreciable differences in the weights of the liver, lungs, empty crop, gizzard, and heart when quails are supplemented with ginger diets (Muhammad et al., 2017). According to Symeon et al. (2014), broilers fed nutrition with cinnamon oil showed negligible variations in their liver%, heart%, and gizzard%. Furthermore, Ahmed et al. (2019) discovered no statistically significant difference in the percentage of giblets, heart, liver, carcass, dressing, or gizzard among the examined groups. Furthermore, Attia et al. (2017) found no appreciable variations in the dressing percentages among the control and the various ginger groups.

Amer et al. (2023) discovered that the ratios of dressing and internal tissues in broilers were unaffected by adding 200, 400, or 600 mg/kg frankincense oil to their diets. Furthermore, after 10 d, Al-Baadani et al. (2022) found no significant impact on the weight distribution of the inside organs in chickens that got GA. However, Mohamed et al. (2021) found that adding varying amounts of BS to broiler diets resulted in a quadratic increase in the relative weights of the gizzard and giblet while maintaining enhanced weights of the liver, heart, spleen, bursa, and thymus gland. Furthermore, compared to chickens fed diets without supplements, good

carcass quality was observed in those fed diets enriched with 2.0 to 2.5% BS (Al-Yasiry et al., 2017).

Our findings demonstrate the impact of frankincense oil and ginger on the ability to hold water, color, tenderness, and pH value of Japanese quail meat. Although frankincense decreased tenderness and water-holding capacity, ginger raised the pH value. There were no differences in color found. According to Yalcin et al. (2018) color constitutes one of the most important meat quality variables influencing consumers' choice of meat and shelf life. Moreover, pH is a major factor influencing the qualities of meat (such as protein dissolution, water-holding capacity, retention of moisture, drip loss, and cooking loss), according to Ranken (2000). Our findings followed those of Attia et al. (2017), who discovered that adding 0.5% ginger to the meat raised its pH value when contrasted with the control but had little impact on most of the chemical and physical characteristics of the meat, except for lipids and meat color. Plant proteolytic enzymes can be found in ginger. Ginger extract demonstrated proteolytic action, enhancing collagen-soluble and stimulating proteolysis in ginger extract-treated spent hen muscle, as Naveena and Mendiratta (2001) observed. However, when contrasted with the control group, Agu et al. (2017) demonstrated a significant tenderness increase in the groups that fed ginger to broiler chicken. Local ducks fed torch ginger flower and betel leaf extract showed no changes in their meat pH or water-holding capacity (Handarini et al., 2021).

According to research by Young et al. (2003), adding oregano oil to a broiler chicken's diet increased the yellow color in the chicken's breast and thigh meat but did not impact the pH level. Furthermore, Puvača et al. (2022) found no significant variations in broiler breasts' pH and meat color between the dietary essential oil group and the control. Our findings concurred with An et al. (2015), who discovered that broiler meat color was not significantly affected by nutritional quercetin or methoxylated quercetin extracted from onions

CONCLUSIONS

Based on the results of the present study, it could be concluded that the use of frankincense oil (400 mg/diet) or ginger powder (500 mg/kg diet) as feed supplements could enhance the growth performance efficiency and physical characteristics of growing quail's meat.

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DISCLOSURES

The authors declare no conflicts of interest.

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