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Research Article

Dietary Dill Oil Enhanced Growth Performance, Antioxidative Capacity and Economical Efficiency of Japanese Quails

Saad Z. Eldamrawy; Hager S. Morad; Talaat K. El-Rayes*

Department of Animal Production, Faculty of Agriculture, Tanta University 31527, Tanta, Egypt.
* Correspondence: talat.elrayes@gmail.com ; hager.saied.hamed@gmail.com

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Abstract:

This study aimed to assess the impacts of dill oil on growth performance, oxidative status, and economic efficiency of Japanese quails. A total of 300 one-week-old unsexed Japanese quails were randomly distributed into 4 equal groups (75 birds into 5 replicates/group). The 1st group (control) was fed a diet without any dill oil, while dill oil was added at levels of 250, 500, and 750 m per ton of feed, respectively at the 2nd, 3ed and 4th groups. At the age of 3 and 5 wks, the best values of productive performance represented in body weight, weight gain, feed consumption and feed conversion ratio were achieved in groups fed diet supplemented with 500 and 750 m dill oil/ton of diet. A significant (P⩽0.01) improvement was achieved in antioxidant status; especially in the levels of both SOD and GSH enzymes while, decreasing the amount of MDA in blood plasma. Japanese quail fed diet supplemented with 750 g/ton had the highest relative economic efficiency followed by those fed diet supplemented with 500 g/ton by 23.51and 21.43% respectively, compared to the control group. It could be recommended that, supplemented diet with dill oil up to 750g/ton improved the productive performance traits, antioxidative capacity and economic efficiency of Japanese quails.

1. Introduction

Quail farming has long been a vital agricultural industry in Egypt. Its enhancement is one of the primary goals of both the corporate and public sectors. Quail was prolific, grew quickly, had a small body size, and produced a lot of meat. The quail production industry has shown substantial progress in recent years. This tremendous advancement was accompanied by a large rise in output rates, whether for meat or eggs. Unfortunately, this development has unfavorable consequences, including a decrease in immune-response and antioxidant status. As a result, several synthetic feed additives, such as pharmaceuticals and antibiotics (antimicrobial agents), were utilized as growth promoters in their diets to enhance productivity, adjust gut microbiota, manage diseases, and enhance immune response (Bedford, 2000; Whitehead, 2002). Different approaches have been implemented to increase the return on quail investment for the sustainability of the quail sector and its primary role in providing high-quality animal protein, and dietary modulation represents a noticeable way in altering animal performance (Akbari et al., 2016, 2018; El-Senousey et al., 2019). In terms of nutrition, delivering a well-balanced diet that meets all nutritional requirements is the foundation of a successful production (Uniyal et al., 2017; Sebola et al., 2018). In addition, the use of green (Eco-friendly) feed additives may be mitigating the effects of various nutritional abnormalities.

In the poultry business, the usage of phytobiotic compounds in their diets became a widespread practice in order to support high performance by chickens. Phytochemicals that are useful can be categorized into a number of groups, including phenolics and polyphones (including simple phenols, phenolic acids, quinones, flavones, tannins, and coumarins), terpenoids, essential oils, alkaloids, lectins, and polypeptides. The good impact on feed intake, digestive secretions, immunological stimulation, antibacterial and coccidiostat, antiviral, or anti-inflammatory activity of botanical supplements in poultry may be the source of these benefits (Reda et al., 2021).

The active ingredients in these medicinal plants' leaves, stems, seeds, roots, and barks are extremely helpful in treating a variety of illnesses and enhancing digestion, both of which might enhance the performance of those who consume them (Ashayerizadeh et al., 2009). Some essential oils such as thymol and cinnamaldehyde have generally been recognized as safe, which is endorsed by the Flavor and Extract Manufacturers' Association and Food and Drug Administration of the USA (Lee et al., 2003). In addition to their antimicrobial activity (Dorman and Deans, 2000), phytobiotic compounds exhibit antioxidants activities (Botsoglou et al., 2002) and can stimulate animal digestive systems (Ramakrishna et al., 2003) by increasing digestive enzymes secretion and improving the utilization of digestive products through enhanced liver functions

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(Hernandez et al., 2004).

So, the goal of the current study was to evaluate the effect of dill oil (DO) as a feed supplement affected quail productivity, antioxidants status, and economical efficiency.

2. Materials and Methods

2.1. Experimental Design

2.1.1. Birds and management

Three hundred one-week-old unsexed Japanese quail chicks were randomly divided into 4 experimental groups with five duplicates of fifteen birds. The first group served as control and fed a basal diet without any dill oil (DO), while dill oil was added at levels of 250, 500, and 750g per ton of feed in the second, third and fourth, groups, respectively. Throughout the five-week of study, all experimental groups were raised in conventional cages (100*50*40 cm) and reared under similar managerial and hygienic conditions.

2.1.2. Experimental diet

The basal diet was a commercial corn-soybean meal diet formulated to meet or exceed the nutritional requirement of growing Japanese quail as recommended by the National Research Council (NRC, 1994) as shown in Table (1)

Table (1): The composition and calculated analysis of basal diet.

Ingredients	g/kg
Yellow corn (8.5%)	518.0
Soybean meal (44%)	367.0
Corn gluten meal (62%)	52.10
Premix[1]	3.00
Soybean oil	29.00
Dicalcium phosphate	16.50
Limestone	7.00
Salt	3.00
Dl-Methionine	1.10
L. Lysine	1.30
Choline chloride	2.00
Total	1000
Calculated analysis [2]	
Crude protein (%)	23.78
ME, MJ/Kg	12.59
Digestible Lys	1.30
Digestible Meth + Cysteine	0.92
Digestible Thr	0.78
Calcium	0.80
Available phosphorus	0.45

[1] Each 3kg of premix contained: Vit. A 12000IU, Vit. D 2200IU, Vit. E 10mg, Vit. K_3 2000mg, Vit. B_1 1000mg, Vit. B_2 3000mg, Vit. B_6 1300mg, Vit. B_{12} 10mg, Pantothenic acid 10mg, Niacin 30mg, Folic acid 1000mg, Biotin 50mg, Choline chloride 300mg, Manganese 60mg, Zinc 50mg, Copper 10mg, Iron 30mg, Iodine 1000mg, Selenium 100mg, Cobalt 100mg and $CaCo_3$ to 3g.

[2] Calculated according to NRC (1994).

2.2. Measurements

2.2.1. Performance traits

Live body weight (LBW), weight gain (WG), feed consumption (FC) and feed conversion ratio (FCR) were evaluated at 1, 3, and 5 wk of age. Economic efficiency was evaluated at the end of the experimental period, as fellow:

$$WG = LBW_2 - LBW_1$$

$$FCR = \frac{\text{Feed consumed (g) during a certain period}}{\text{Body weight gain (g) during the same period}}$$

2.2.2. Antioxidants indices:

At the end of the trial, blood samples were collected from 5-week-old quails into heparinized tubes and centrifuged for 15 min at 3000 rpm to obtain plasma. Plasma samples were examined for levels of superoxide dismutase (SOD), malondialdehyde (MDA), and glutathione (GSH) using a microplate spectrophotometer with a commercial detection kit (Bio-diagnostic, Egypt), following the manufacturer's instructions.

2.3. Statistical analysis

Data were statistically analyzed by one-way ANOVA, using the general linear model procedure (SAS, 1996). Tests of significance for differences among treatments were done according to Duncan (1955). The statistical model was used for the analysis of variance to estimate the effect of dill oil supplementation levels on Japanese quail performance and physiological status as follows:

$Y_{ij} = U + T_i + e_{ij}$

Where:

Y_{ij} = The observations

U = Overall mean

T_i = Effect treatments (i = 1, 2, 3and 4)

e_{ij} = Residual effects (Random error).

3. Results

3.1. Productive performance traits

Data of Japanese quail chick's body weight, weight gain, feed consumption and feed conversion ratio as influenced by dill oil supplementation level (0, 250, 500 and 750 g/ton feed) are illustrated in Table (2).

Dill oil (DO) supplementation significantly impacted body weight (BW, g), weight gain (WG, g), feed consumption (FC, g/), and feed conversion ratio (FCR, g/g) at 3 wk of the experimental period. These effects were also observed at the end of the feeding trial. Among all groups, chicks fed diets supplemented with dill oil at levels of 500 and 750 g/ton showed the highest BW and WG, and the best FCR values at 3 and 5 wks of the experimental period. Groups fed diets supplemented with dill oil at levels of 250 and 500 g/ton recorded the highest FC values, while chicks fed diets supplemented with 750 g/ ton dill oil showed the lowest FC value. Dill oil supplementation at different levels promotes body weight, weight gain and feed conversion ratio specially, at the level of 500 and 750 g/ton feed.

Table (2): Productive performance of Japanese quail affected by dill oil supplementation levels.

Items	Dill oil levels (g/ton feed)				SEM	Significant
	0	250	500	750		
Body weight (g)						
1 week (Initial body weight)	24.12	23.87	24.23	23.92	±0.27	NS
3 weeks	160.82^{b}	163.91^{b}	172.49^{a}	170.37^{a}	±2.14	*
5 weeks	230.33^{b}	236.84^{b}	274.72^{a}	267.02^{a}	±3.58	*
Body weight gain (g)						
1-3 week	136.7	140.04	148.26	146.45	±1.76	NS
3-5 weeks	69.51^{b}	72.93^{b}	102.23^{a}	96.65^{a}	±2.99	*
1-5 weeks	206.21^{b}	212.97^{b}	250.49^{a}	243.10^{a}	±3.27	*
Feed consumption (g)						
1-3 week	224.34^{b}	258.3^{a}	260.41^{a}	218.64^{b}	±1.23	*
3-5 weeks	254.08^{b}	258.14^{b}	263.67^{a}	240.00^{c}	±1.19	*
1-5 weeks	478.42^{b}	516.44^{a}	524.08^{a}	458.64^{c}	±1.04	**
Feed conversion ratio (g/g)						
1-3 week	1.64^{bc}	1.84^{a}	1.76^{b}	1.49^{c}	±0.98	*
3-5 weeks	3.66^{a}	3.54^{a}	2.58^{b}	2.48^{b}	±0.86	**
1-5 weeks	2.32^{a}	2.42^{a}	2.09^{b}	1.89^{b}	±1.16	**

-Means of each raw followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

-NS indicate not significant -* indicate significance at P<0.05
-** indicate significance at P<0.01

3.2. Antioxidants Status

Data illustrated in Table (3) shows the effect of DO supplementation levels on antioxidants status of Japanese quail. Results indicated a significant (P≤ 0.01) improvement in the antioxidant status; this is evident through a significant increase in the levels of both SOD and GSH enzymes and decreasing the amount of MDA in blood plasma. Whereas the activity of SOD was significantly (P≤ 0.01) increased with increasing level from 250 up to750g/ton of feed. Japanese quail fed diet supplemented with DO at the level of 750g/ton of feed possessed the highest activity of SOD followed by those received 500g/ton and then those treated by 250g/ton of feed by 382.14, 275 and 221.4% respectively, as compared to the control.

The same direction was observed for the activity of GSH enzyme, Japanese quail fed diet supplemented with DO at the level of 750g/ton of feed possessed the highest activity of GSH followed by those received 500g/ton and then those treated by 250g/ton of feed by 160, 105and 68.3% respectively, as compared to the control. On the other hand, the concentration of MDA was significantly (P≤ 0.01) decreased by increasing DO supplementation level from 250 up to750g/ton of feed. Japanese quail fed diet supplemented with DO at the level of 750g/ton of feed possessed the lowest content of MDA followed by those received 500g/ton and then those treated by 250g/ton of feed by 58.65, 49.17 and 42.41% respectively, as compared to the control.

Table (3): Antioxidant status of Japanese quail as affected by dill oil supplementation levels.

Items	Dill oil levels (g/ton feed)				SEM	Significant
	0	250	500	750		
SOD (u/ml)	5.60^{c}	18.00^{b}	21.00^{b}	27.00^{a}	±1.29	**
GSH (u/ml)	20.00^{c}	33.66^{b}	41.00^{b}	52.00^{a}	±2.14	**
MDA (n.mol/l)	13.30^{a}	7.66^{b}	6.76^{bc}	5.50^{c}	±0.41	**

Means of each row followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test
-** indicate significance at P<0.01

SOD= Super oxide dismutase
GSH= Glutathione
MDA= Malondialdehyde

3.3. Economic Efficiency

Table (4) showed economic efficiency of Japanese quail fed tested diets for 35 days. Results showed that, Japanese quail fed diet supplemented with 750 g/ton had the highest relative economic efficiency followed by those fed diet supplemented with 500 g/ton by 23.51and 21.43% respectively, compared to control.

The current result of economic efficiency may be due to the effect of dill oil in reducing the amount of feed intake and increasing the average body weight. At the same time, the price of kilogram of dill oil is relatively cheap compared to the other feed additives, which does not exceed the amount of 140 L.E.

Table (4): Economic efficiency of Japanese quail as affected by dill oil supplementation levels.

Items	Dill oil levels (g/ton feed)			
	0	250	500	750
Total feed intake (g))	478.42	516.44	524.08	458.64
Price/kg diet (L.E.)	7.00	7.03	7.07	7.10
Total feed cost (L.E.)	3.35	3.63	3.71	3.26
Selling price* (L.E.)	25.00	25.00	30.00	30.00
Net revenue (L.E.)**	21.65	21.37	26.29	26.74
Relative E.E.* **	100.00	98.71	121.43	123.51

* Selling price = 25.0 L.E. per pair of light birds (first and second groups) or 30.0 L.E. per pair of heavy birds (third and fourth groups).

- The price of 1 kg dill seed oil = 140 L.E

** Net revenue = Selling price of meat yield-feed cost.

*** Assuming that the relative economic efficiency of control diet equal to 100

4. Discussion

The positive effect of DO on body weight and weight gain may be due the higher content of various nutrients and functional ingredients such; unsaturated fatty acids, vitamins, minerals, steroids, alkaloids, saponins, tannins, terpenoids and flavonoids (Ozliman et al., 2021; Babri et al., 2012) which stimulates the growth rate. In addition, the active principles of essential oils function as a digestibility enhancer, balancing the gut microbial ecosystem and stimulating the secretion of endogenous digestive enzymes, and thus improving growth performance in poultry (Lovkova et al., 2001; Williams and Losa, 2001; Cross et al., 2007). There are many studies suggest that dietary essential oil can improve digestion and increase the performance of poultry. They have been shown to stimulate bile salt secretion and digestive enzyme activities of intestinal mucosa and pancreas (Hernandez et al. 2004). Also, numerous studies showed that, the improvement of body weight and weight gain are due to active materials found in dill essential oil causing greater efficiency in utilization of feed, resulting in enhanced growth (Radulescu et al. 2010 and Hippenstie et al. 2011).

Adding essential oil (EO) of herbs and spices to Japanese quail diets will increase the feed's palatability due to its flavorful qualities, which will increase feed consumption (Williams and Losa, 2001). Additionally, due to the presence of several compounds with intrinsic effects on physiological and metabolic processes, there is evidence that EO may have digestion-stimulating qualities and enhances the efficiency of feed conversion (Basset, 2000; Hernandez et al., 2004; García et al., 2007).

Some authors studied the effect of essential oils such dill oil or dill extract as feed additive on feed intake and feed conversion of poultry and they revealed that essential oil improved FC and FCR (Isabel and Santos, 2009; Cao et al., 2010; Al-Mashhadani et al., 2011; Mukhtar, 2011; Mahmoodi et al., 2014).

The current results are compatible with that observed by (Chalghoumi et al., 2013; Mahmoodi et al., 2014; Mehr et al., 2014 and Khattak et al., 2014) who found that, body weight and weight gain of broilers received different level and sources of essential oils were improved when supplemented at different levels varied from 100 to 500 g/ton of feed. Additionally, (Hamodi et al., 2021) concluded that body weight and weight gain of broilers were significantly improved for group fed diet supplemented with 0.4 and 0.6% dill powder, as compared to the control.

The results of antioxidants status may attribute to phospholipids and poly unsaturated fatty acids PUFA in dill oil that inhibits accumulation of lipid peroxidation product and improved antioxidants indices (Rezvukin et al., 1995; Xu et al., 2009). Dill plant possesses antioxidant properties because it includes phenolic acids and aromatic components. The phenolic components that produce most of the antioxidant activity play important roles in absorbing and neutralizing free radicals, quenching singlet, and triplet oxygen, or dissolving peroxides (Sharafi et al., 2010; Choi et al., 2017). Our results are compatible with those observed by Mohammadi, (2020) who showed that, broiler fed diet containing 1% dill powder had the highest activities of superoxide dismutase (SOD), catalase (CAT), and total antioxidant capacity (TAC) than broiler fed basal diet. On the other hand, the concentration of malondialdehyde (MDA) was significantly decreased by using 1% aerial parts of dill powder compared to the control. While there was not significant effect on glutathione peroxidase (GSH-Px) between broiler fed basal diet containing 1% dill powder and broiler fed basal diet (P>0.05). Additionally, Saadat Shad et al. (2016) reported that; thymol essential oil at (250 mg/kg diet) and carvacrol essential oil at (300 and 500 mg/kg diet) enhanced glutathione peroxidase activity of heat stressed broilers compared to the control group.

Our results of economic efficiency are compatible with the observation of Mukhtar (2011) and Eldamrawy et al. (2021) who found that the supplementation of clove oil to broiler diets improved net revenue and economic efficiency.

5. Conclusions

In conclusion, it could be recommended that, supplemented diet with dill oil up to the level of 750g /ton of feed caused to improve productive performance traits physiological response and economic efficiency of Japanese quails.

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