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EFFECT OF DIFFERENT LEVELS OF BASIL AND PEPPERMINT AN ESSENTIAL OILS ON PRODUCTIVE AND PHYSIOLOGICAL PERFORMANCE OF TWO QUAIL LINES DURING EGG PRODUCTION PERIOD

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ABSTRACT
The aim of this study was to investigate the effect of basil (*Ocimum basillicum* L.) and peppermint *(Mentha piperita*) as an essential oils supplementation to the diet on some productive and physiological performance of two lines (Brown and Golden**)** of laying quails (*Coturnix coturnix japonica*). Totally 240 quail birds of 8 weeks of age were used (120 brown line and 120 golden line), were randomly assigned to five treatment diets for both lines. The first treatments were fed a basal diet (BD) and served as a control group. The second and third treatments involved feeding the basal diet supplemented with Basil essential oil (BEO) at levels of (300 and 600 mg/kg). The fourth and fifth treatments involved feeding the BD supplemented with peppermint essential oil (PEO) at two levels of (300 and 600 mg/kg).The results revealed decreasing in feed intake for dietary treatments supplemented with adding 600 mg/kg of BEO compared to control group. Feed intake of (300 mg/kg) from PEO supplementation was increased than all other treatments. Addition BEO and PEO showed improving in feed conversion ratio than the control group. Dietary supplementation with 300 PEO caused increase in egg weight compared to other experimental treatments. Supplementation the diet with (300 and 600 mg/kg) of the BEO or PEO showed increase in egg mass and egg production in comparison with the control group. Yolk percentage of 600 BEO and 300 PEO supplementation treatments was better than other experimental treatments. Dietary supplementation with 300 BEO, 600 BEO and 600 PEO increased shell percent than other treatments. The inclusion of (300, 600 mg/kg) BEO and (600mg/kg) PEO resulted in an increase in total protein, albumin and A/G ratio compared to the control group. There was increase for the brown line in body weights at 8 and 16 weeks of age, feed intake, egg production, egg weights and mass, total protein, albumen, globulin and A/G ratio compared to the golden line during the laying period. The golden line was of higher hemoglobin and PCV% values than the brown line. Generally, it was concluded from this study that supplementation the diet of brown and golden quail with (300 and 600 mg/kg) of basil and peppermint essential oils improved feed conversion ratio and egg production performance.
Keywords: Quail, Basil-Peppermint an essential oils, Performance, Hemato-biochemical indices, egg production.

INTRODUCTION
With the increasing fears of the excessive use of antibiotics in the poultry sector and the negative effects of their residues in chicken products from meats and eggs have limited their use in nutrition

because of consumers interest in healthy foods rich in their bioactive ingredients. In this context, researchers have been motivated to study several safe natural alternatives in place of antibiotics to be used in the diet of poultry (Krishan and Narang, 2014). In this regard, a new generation of feed additives includes medicinal herbs and plant essential oils that have growth-stimulating, antimicrobial properties and also exhibit positive effects on the immunity of birds (Cabuk *et al*., 2014; Zhang et al., 2014; Zhai et al., 2018; Habibi *et al*., 2019) and have no side effect on health. Previous studies applied the use of plant oils in poultry feeding and explained its positive effects on growth, feed efficiency, the health and increase of some useful microorganisms by the maintenance of balanced levels of beneficial microbial populations within the gastrointestinal system (Jang *et al*., 2007; Habibi *et al*., 2019) . The antimicrobial mechanisms of essential oils include different activities, such as membrane disruption by terpenoids and phenolics, metal chelation by phenols and flavonoids, and effect on genetic material by coumarin and alkaloids that are thought to inhibit the growth of microorganisms (Cowan, 1999). Essential plant oils are aromatic components of herbs which have received increasing attention in studies because of their ability as an anti-inflammatory, anti-carcinogenic (Ardalan *et al*., 2013), and also of positive effects on animal health, productivity, appetite stimulation, enhancement of enzyme activity and secretion related to diet digestion and absorption such as trypsin, amylase and jejunal chime (Platel., 2004; Jang et al., 2007; Windisch et al., 2008; Ghazaghi et al., 2014). In layer chickens, many reports examined the possible beneficial effects of plant oils on egg production performance, improving egg quality and also supporting health status as a single compound or as mixed preparations. In recent years, studies have indicated that peppermint *(Mentha spp.*) and basil *(Ocimum basillicum*) plants have different biological effects for health purposes due to their active components, such as their antioxidant, and pathological antimicrobial role. In this context, peppermint oil contains the menthol and thymol compounds (Sokovic *et al*., 2009; Aziz *et al*., 2011; Yalcin *et al*., 2012; Kamatou et al., 2013; Shalayel et al., 2017) as well as flavonoids and carotenoids that raise the efficiency of the immune system of poultry. Basil oil is also known for its active ingredients such as eugenol and methyl eugenol (Pripdeevech *et al*. 2010) as well as Oxygenated monoterpenes with anti-bacterial and anti-fungal effect (Opalchenova and Obershlocova., 2003; Pripdeevech et al., 2010). In quail, Cetingul et al., (2008) emphasized controlling the efficiency of production in birds fed peppermint extracts supplementation at 10, 20, 30, 40, and 50 g/kg and it has been found less feed intake by birds which supplemented at 20 g/kg level compared to other treatments and insignificant differences between treatments regarding feed conversion , egg production and egg weight.

On the other hand, according to Cabuk et al. (2014) it was noticed that supplementation the basal diet of laying quail with essential oil mixture derived from herbs (oregano, laurel leaf, sage leaf, myrtle leaf, fennel seeds and citrus peel) caused an increase in egg production and improved feed conversion ratio in comparison with the control group. In layer chickens, it has been found that adding 25, 50, 75 and 100 ml of peppermint oil/kg of feed resulted in positive effects on blood hematological and physiological parameters regarding red blood cells count, hemoglobin concentration, hetrophil/lymphocyte ratio and cholesterol concentration of hens at the beginning period of egg production (Ali and Ali, 2019).

Concerning the importance of the basil plant in poultry nutrition, previous studies indicated improvement of growth, feed intake and health status of broiler chicks as a result of the active ingredients ability of the basil plant oils to increase utilization of nutrients (Osman, 2010; Abbas, 2011; Faris et al., 2012). In this respect and in a study conducted on the growing quail, Hadi and Jassim (2013) showed that adding 1.5 g/kg of basil leaves powder to the diet resulted in better body weights, less serum cholesterol and increase levels of serum total proteins and globulins from 1^{st} week up to 6^{th} week of age compared to the control group.

The present study was conducted to evaluate the effects of dietary supplementation of basil and peppermint oils on productive performance, egg quality characteristics, and blood biochemical parameters of laying quail during the egg production period.

MATERIALS AND METHODS

The present study was conducted at poultry farm, Department of Animal production, Faculty of Agriculture, University of Basrah, Iraq during the period from 12/12/2019 to 6/2/2020.

Laying quail, diets and experimental design

A total of 240 hens including 120 brown and 120 golden of laying Japanese quail (*Coturnix coturnix japonica*) at 8 weeks age were used in this experiment. The birds were randomly assigned to five diet treatments with two replicates (cages) and each replicate consisted of 24 birds in a 5 ^{x} 2 factorial arrangement. The birds of each replicate were supplied with nipple drinkers and slatted iron floor cages in closed hall under an environmentally controlled ventilation and lighting (16 L: 8D). The basal diets were formulated to satisfy the recommended requirements of Japanese quail (NRC, 1994). All birds were provided with feed and water for *ad libitum* consumption. The composition and chemical analysis of diets are presented in Table 1.

The birds were allocated into five experimental treatments, the first one was received a basal diet with no supplement and served as control group, while the second and third treatments were fed the basal diet supplemented with 300 and 600 mg/kg basil *(Ocimum basillicum* L.) oil, respectively. The fourth and fifth treatments were fed the same control diet with a supplement of 300 and 600 mg/kg peppermint *(Mentha piperita*) oil, respectively.

Productive parameters

Body weights were recorded at the beginning (initial body weight) and at the end (final body weight) of the study. Feed intake was calculated as the difference between the amount of feed offered through the experimental period and the feed residue during the experimental period (8-16 week). Feed conversion ratio (FCR, g of feed/of egg mass) was calculated for the experimental period (8-16 week). Hen-day egg production was recorded and eggs weight was recorded daily. Egg mass was calculated by multiplying egg weight by egg production rate.

Egg quality traits

Egg quality traits were measured at 16 week of age using 12 eggs from each line in the treatment group. Exterior and interior egg quality parameters (weights of yolk, albumen, shell, percentages of yolk, albumen, shell) were determined according to Romanoff and Romanoff (1949).

Blood constituents

At the end of the experiment (16 weeks), four Birds from each treatment and line (two birds per replicate) were randomly chosen and slaughtered for blood collection. Red blood cells (RBC) and total white blood cells (WBC) were measured according to the method of Natt and Herrick (1952). Packed cell volumes (PCV) was measured according to Archer (1965). Hemoglobin (Hb) was calculated by relying on PCV values using the equation described by Campbell (1995). For serum biochemical indices, a blood sample was drawn and allowed to stand for an hour at room temperature (18^{0}C). Serum was separated naturally, it was centrifuged and stored at (-20^{0}C) until further analysis. Total protein and albumin concentrations were analyzed by a colorimetric method using commercial kits (Spinreact, Spain). Globulin (Gb) concentration was calculated as the difference between total protein and albumin concentrations. Serum glucose and cholesterol concentrations were determined according to the methods of Tietz (1999) using commercial kits (Biolabo AS, France).

Statistical Analysis

The obtained data were subjected to a factorial analysis design to test the main effects of treats, lines and their interaction using the SPSS Software (2012) statistics application of the 2-way ANOVA procedure. Assisting of the differences among means was by using the least significant difference (L.S.D.) test at $P<0.05$ (SPSS, 2012).

Table (1): The ingredients and composition of the experimental diet (percentage on a dry matter basis)

Ingredient and composition	**%**
Yellow corn	33.0
Wheat	32.0
Soybean meal (44%)	23.0
[1]protein concentrates (44%)	5.0
Vegetable oil	1.5
Dicalicum phosphate	0.5
Limestone	4.6
[2]Mineral premix	0.2
Sodium chloride	0.2
Total	100
Kcal ME/Kg diet	2900
Crude protein (%)	19.61
Crude fat (%)	2.52

Crude fiber (%)	3.39
Calcium (%)	2.30
Phosphorus available (%)	0.35
Lysine (%)	0.96
Methionine + Cysteine (%)	0.71
Calorie: protein ratio	147.88

[1]Protein concentrate used from Al-Hayat Company, Jordanian Origin, to provide the following per kg of diet: 44% protein, 2800 kcal.kg^{-1}ME, 12% fat, 25% ash, 5% calcium, 2.9% phosphorus, 2.55% methionine + Cysteine, 2.8% lysine. [2]Content/kg: Manganese 80 g; iron 80 g; zinc 50 g; copper 10 g; cobalt 2 g; Iodine 1 g; excipient q.s - 1,000 g. [3]Was calculated according to the chemical composition of feedstuff contained in NRC (1994).

RESULTS AND DISCUSSION

Productive performance

The results of the effect of adding different levels of basil and peppermint oils and their effects on productive performance are summarized in table 2. Initial body weight at 8th weeks and final body weight at 16 weeks of age did not differ significantly among all the experimental treatments ($p>0.05$). However, it is a slight numerical increase, but not significant, was observed in initial and final body weights when the birds were fed with basil oil and peppermint oil compared to the control group. A previous study conducted on quail which in line with our result has demonstrated that supplementation the diet with 10, 20, 30, 40, and 50 g of peppermint did not affect the body weights of the birds (males and females) at 105 and 175 days of age (Cetingul et al., 2008). On the other hand, Hadi and Jassim, (2013) reported that quail birds treated by adding 1.5 g of basil leaves powder in diet were better significantly ($p<0.05$) than the control group in body weights at 2, 3, 4, 5 and 6 weeks of age.

In general, previous studies demonstrated positive effects of basil plant on the growth in broiler chickens as a result of its containing from a wide range of effective natural compounds such as phenolic, thymol and carvacrol that stimulate appetite and improve the growth process by increasing the utilization of indigestible nutrients and enhance production performance. (Thakare, 2004; Faris et al., 2012). A recent study conducted on quail revealed a significant ($p<0.05$) higher final body weight at 42 days of age of the birds fed diet supplemented with basil essential oil and peppermint essential oil comparing to the control group (Abbas et al., 2021), confirming the essential role of the secondary compounds contained in the oils of these plants as antioxidants and their ability to promote birds' health and growth.

The results also revealed a significant ($p <0.05$) superiority in initial and final body weights of the brown line birds than those of the golden line (Table 2). This result may be due to the different genetic variation of body weight of the two lines during the early stage of life up to the age of egg production, as the brown line is known for its high genetic ability to grow and meat production than other quail lines (Petek et al., 2004). On the other hand, the dietary supplementation of basil and peppermint oils may have a positive role in increasing the genetic variance of initial and final body weights of the two lines, and as a result, the birds of the two lines showed different responses to the dietary supplementation. A study by Aljumaily (2011) confirmed these results as indicated higher body weights of the brown quail birds during the growth rate up to 5 weeks of age than those of the white quail line. Abbas et al., (2021) also observed higher body weights at 42 days of age for the brown quail line compared to the golden line which dietary supplemented with different levels of basil and peppermint oils. On the other hand, Hassan and Abd-Alsattar (2016) found significant superiority of the black line of quail in body weights during the first 5 weeks of age compared to white and brown lines, while there was no significant difference between black and brown varieties in body weights at 6 and 7 weeks of age. On the contrary, in a comparative evaluation of three lines of quail (Al-Kafaji et al., 2018) the results of this study indicated high body weight for the brown line than black and white lines. Previous studies on quail stated that body weights were significantly influenced by different types of plumage color mutants, explaining a potential plumage color-body weight interaction during egg production period (Rahman et al., 2010; Minvielle et al., 2005).

Generally, the study on quail reported that an important part of the phenotypic variance of the body weight trait is due to the genetic factor, so most genetic improvement programs focused on it as a criterion when selecting or outbreeding as the best way to improve this trait (Hassan and Fadhil, 2019).

The results in table 2 appeared a significant ($p<0.05$) increase in feed intake for the treatment of 300 mg of peppermint oil supplementation in comparison with other treatments and the control group. On the other hand, feed intake did not differ significantly ($p>0.05$) respecting the treatments (300 mg of basil oil and 600 mg of peppermint oil) compared to the control group. It is noticed that, despite the discrepancy in feed intake among different treatments, the level of adding 300 mg of peppermint oil to the diet may have a higher effect on increasing the appetite of the birds of this treatment and therefore, this result was positively reflected on the weights of eggs produced by layer birds of this treatment compared to other treatments. A previous study conducted on Hy-line brown hens during late laying period demonstrated that adding peppermint leaves to the diet has the ability to increase feed intake by increasing the levels of supplementation (Abdel-Wareth and Lohakare, 2014). In addition, it has been reported that peppermint plant has many medicinal properties as an appetite stimulant due to its active compounds (Dorman et al., 2003; Aziz et al.,2011; Yalcin et al.,2012).

Data of feed conversion ratio (table 2) showed a significant ($p<0.05$) better FCR for all dietary supplementation treatments compared to that of the control group. The improvement that occurred in feed conversion ratio regarding all supplementation levels of basil and peppermint oils could be attributed to their positive role in improving egg production performance (Table 3). These results obtained in this research is in agreement with the finding of Hadi and Jassim,(2013) who justified the reason of the improvement in FCR when treating the birds of growing quail with 1.5 g from dried basil leaves as a result of the ability of flavonoids which contained in this plant to inhibit the process of aflatoxins formation as well as increase the efficiency of food digestion and absorption.

Riyazi et al. (2015) reported that addition basil leaves and seeds to the diet had beneficial effects on feed conversion ratio. On the other hand, the active components (cineole, citral, linalool and menthol) in the peppermint plant have shown to possess antimicrobial, antifungal and antioxidant activities and also improve digestion and absorption of dietary nutrients (Grigoleit and Grigoleil, 2005; Bupesh et al., 2007; Radwan et al., 2008). Furthermore, it has been found that plant oils have an effective role in reducing levels of pathological flora, improving gut ecology and enhancing immunity (Ghazalah and Ali, 2008).

With respect to the effect of lines, the results exhibited higher feed intake significantly ($p<0.05$) for the birds of the brown quail in comparison with the golden line, while, there was no significant ($p>0.05$) superiority for any one of the two lines of quail in feed conversion ratio. A previous study (Jatoi et al., 2015) found significant differences in feed intake for four lines of quail (k, m, s and z) during 6 weeks of the experiment. Also, the results of Inci et al. (2015) appeared an increase in feed intake and low feed conversion ratio of the wild type of quail than the other three types (dark brown, white and golden). On the other hand, Hassan and Abd-Alsattar (2016) found a decrease in feed intake of the growing brown line of quail during 6 weeks of age in comparison with the black and white lines. A study by Abbas et al. (2021) revealed a significant increase in feed intake for brown quail line compared to golden line, whereas, golden line birds showed a better feed conversion ratio in comparison with brown line during the period of (1-6) weeks of age.

Table 2: Effect of different nutritional experimental treatments on productive performance of quails at overall period 8-16 weeks old

Parameters	**Line**	**Experimental diets**					**Mean**	**SEM**	***P-value****
		Control	**BEO (mg/kg)**		**PEO (mg/kg)**				
		0.0	**300**	**600**	**300**	**600**			
initial body weight (g)	**B**	198.06	197.07	197.09	204.55	205.99	200.55^{A}	1.9745	T=0.358
	G	184.37	192.34	191.80	192.42	192.34	190.65^{B}	1.6520	L=0.004
	Mean	**191.21**	**194.70**	**194.44**	**198.49**	**199.16**	**195.60**	**1.6910**	T×L=0.677
final body weight (g)	B	212.51	205.52	227.04	220.00	221.94	217.40^{A}	3.5644	T= 0.688
	G	192.03	201.79	188.67	201.37	188.79	194.53 B	2.5072	L= 0.00
	Mean	**202.27**	**203.65**	**207.85**	**210.69**	**205.36**	**205.97**	**3.3742**	T×L=0.127
Feed intake(g)	B	1044.88	986.96	920.42	1053.12	1060.66	1013.21 A	30.5278	T= 0.435

	G	907.12	851.96	870.52	988.94	888.92	901.49 B	26.5225	L= 0.029
	Mean	**976.00^{b}**	**919.46^{bc}**	**895.47^{c}**	**1021.03^{a}**	**974.79^{b}**	**957.35**	**23.4844**	T×L 0.882
Feed conversion ratio (g/g)	B	1.98	1.66	1.57	1.77	1.71	1.74	0.0471	T= 0.000
	G	1.91	1.63	1.60	1.78	1.60	1.70	0.0443	L=0.245
	Mean	**1.94^{a}**	**1.64^{c}**	**1.59^{c}**	**1.77^{b}**	**1.65^{c}**	**1.72**	**0.0316**	T×L=0.424

^{abc}Means in the same row with no common superscript are different at $p < 0.05$; ^{AB}Means in the same column with no common superscript are different at $p < 0.05$. SEM: Standard error of the mean, P value*; T= Treat effect; L= Line effect; T×L = Interaction effect; BEO: basil essential oil; PEO: peppermint essential oil; B: Brown; G: Golden

Egg production performance

The effect of dietary supplementation on the performance of laying quail is presented in table (3). There was an increase (p<0.05) in egg weight of the birds that were fed a diet supplemented with 300 mg of peppermint essential oil compared to other dietary treatments and the control group. Whereas, egg weights laid by the hens of the dietary treatments (adding 600 mg of basil essential oil or adding 600 mg of peppermint oil to the diet) did not differ significantly (p>0.05) compared to the control group. On the other hand, the results showed less (p<0.05) egg weight for the treatment of adding 300 mg basil essential oil than other dietary treatments and the control group. The results also denoted that supplementation the diet with (300 and 600) mg from basil essential oil or peppermint essential oil resulted in a significant (p<0.05) increase concerning egg mass and egg production as compared with the control group during the experimental period (table 3). Generally, the greatest egg mass and hen-day egg production of the dietary supplementation treatments compared to the control group could be related to the effect of these oils in maintaining the health status of birds and their productive performance. The results of Cabuk et al. (2006) confirmed our result, when indicated improvement in feed efficiency, egg mass and egg production as a result of feeding plant oils as natural dietary additives. Furthermore, in a study conducted on Hy-line brown hens, Abdel-Wareth and Lohakare (2014) pointed out to the beneficial action of the essential oils presented in dried peppermint leaves in the oviposition process because of their active components and imperative on the conversion of digested feed into eggs. On the other hand, Faris et al. (2012) reported that basil plant has a big role in inhibiting harmful microorganisms in the gut and enhancing the absorption process in the intestine which led to positive effects on productive performance. Our results did not agree with the finding of a previous study that showed insignificant differences in egg weight and egg production of laying quail supplemented with different levels of peppermint (Cetingul et al., 2008). On the other hand, it has been found that the dietary inclusion of 2% and 3% of crushed peppermint levels of local white Mezzo-breed chickens during egg production period did not affect egg weight, egg mass and hen-day egg production significantly, while, supplementation the diet with crushed peppermint leaves led to keeping egg weight rate during summer period (Abood et al., 2016).

With respect to the lines, the results revealed a significant ($p<0.05$) higher egg weights, egg mass and egg production for the birds of the brown line than those of the golden line. The reason of the brown line superiority in egg production performance may be related to the significant superiority of its layer females in body weights during the egg production period, as egg production is one of the major performance parameters that influenced by additive genetic variance and several factors such as body weight of layer birds, nutrition, the system of management and the environment (Daikwo et al., 2014). Previous studies on quails confirmed the observation that the differences in genotypes of different quail lines have a clear effect on the most essential performance traits such as egg production, egg weight and egg mass (Soliman et al.,2000; Rajkumar et al., 2009; Rahman et al.,2010) as well as the effect of the conditions of nutrition (Guclu et al., 2008).

Table 3: Performance of laying quail hens fed different dietary experimental treatments at overall period 8-16 weeks old

Parameters	Line	Experimental diets					Mean	SEM	*P-value**
		Control	BEO (mg/kg)		PEO (mg/kg)				
		0.0	**300**	**600**	**300**	**600**			
Egg Weight (g)	**B**	11.32	10.79	10.78	11.60	11.18	11.13^{A}	0.1284	T= 0.003
	G	10.61	10.15	11.27	11.31	10.64	10.79^{B}	0.1505	L=0.11
	Mean	**10.96^{b}**	**10.47^{c}**	**11.02^{b}**	**11.45^{a}**	**10.91^{b}**	**11.96**	**0.1037**	T×L=0.032
Egg Mass (g)	B	528.08	593.88	586.04	592.76	618.80	583.91^{A}	10.684	T =0.000
	G	472.92	522.76	541.52	554.40	555.24	529.36^{B}	11.1124	L=0.000
	Mean	**500.50^{c}**	**558.32^{b}**	**563.78^{ab}**	**573.58^{ab}**	**587.02^{a}**	**556.64**	**9.7692**	T×L=0.669
Egg Production (HD)	B	83.33	98.26	95.17	91.37	98.79	93.38^{A}	2.0768	T = 0.001
	G	79.59	91.94	85.79	87.53	93.16	87.60^{B}	1.7766	L= 0.003
	Mean	**81.46^{c}**	**95.11^{a}**	**90.48^{b}**	**89.45^{b}**	**95.98^{a}**	**90.49**	**1.4862**	T×L=0.762

^{abc}Means in the same row with no common superscript are different at $p < 0.05$; ^{AB}Means in the same column with no common superscript are different at $p < 0.05$. SEM: Standard error of the mean,

P value*; T= Treat effect; L= Line effect; T×L= Interaction effect; BEO: basil essential oil; PEO: peppermint essential oil; B: Brown; G: Golden.

Egg quality traits

Table (4) represents the effect of dietary treatments on egg quality traits during the experiment. It appears that the differences in the yolk weight, albumen weight, albumen percentage and shell percentage were not significant (p>0.05) compared to the control group when basil essential oil and peppermint essential oil were included in the diet. However, the yolk percentage of the two diet supplementation treatments (600 BEO and 300 PEO) was better significantly (p<0.05) than other treatments as well as the control group. It is also found from the results that adding 300, 600 mg of basil essential oil and adding 600 of peppermint essential oil to the diet showed better (p<0.05) shell percentage compared to the treatment of adding 300 mg of peppermint essential oil. In relation to these results, a slight significant improvement was observed in yolk percentage in the dietary treatments (600 basil oil and 300 peppermint oil), it seems that, adding basil and peppermint oils to the diet had no effect on egg quality negatively. Our finding agreed with Cabuk et al. (2014) who did not notice a significant effect on egg quality traits of laying quail that was dietary treated by using a mixture of six plant oils. Besides, Abdel-Wareth et al. (2014) reported that different levels of dried peppermint leave additives (5, 10, 15, 20 g/kg) in the feed of Hy-line brown hens did not affect yolk and albumen percentages, but there was an impact on shell percentage at 76 weeks of age, in addition, the study also suggested that it is possible peppermint components may enhance the safety and stability of egg components. On the other hand, Jahanian et al. (2017) showed that antioxidant potency of the medical plants' components has the ability to protect yolk membrane against oxidation and damage and also increase the standing- up quality of the yolk.

In our experiment, regarding the lines, the results pointed out that under different basil essential oil and peppermint essential oil treatments, there were no significant (p>0.05) differences between brown and golden laying birds for all traits of internal egg components (table 4). A previous study (Hrncar et al., 2014) found that quail of meat type produces eggs of higher weights than the layer type quail, explaining that due to the effect of genotype on egg weight, internal components of the eggs also vary between the types as a result of genetic correlation between egg weight and egg internal components (Adeogun and Amole, 2004).

Table 4: Egg components and egg quality traits of laying quail hens fed different dietary experimental treatments at 16 weeks of age.

Parameters	Line	Experimental diets					Mean	SEM	*P-value**
		Control	BEO (mg/kg)		PEO (mg/kg)				
		0.0	300	600	300	600			
Yolk Weight (g)	B	3.74	3.46	3.73	3.78	3.60	3.66^A	0.0627	T=0.000
	G	3.32	3.31	3.67	4.24	3.19	3.55^A	0.0867	L=0.236

	Mean	**3.53^{ab}**	**3.38^{b}**	**3.70^{a}**	**4.01^{a}**	**3.39^{b}**	**3.61**	**0.0535**	T ×L=033
Albumin Weight (g)	B	5.67	5.54	5.19	6.11	5.80	5.66^{A}	0.0954	T=0.287
	G	5.55	5.13	5.80	5.21	5.63	5.46^{A}	0.0833	L=0.100
	Mean	**5.61^{ab}**	**5.34^{b}**	**5.50^{ab}**	**5.66^{ab}**	**5.72^{a}**	**5.56**	**0.0637**	T×L=0.003
Yolk Percentage (%)	B	32.94	31.96	34.37	32.66	32.01	32.79^{A}	0.4299	T=0.016
	G	31.37	32.52	32.64	36.69	30.00	32.64^{A}	0.6144	L=0.837
	Mean	**32.15^{b}**	**32.24^{b}**	**33.51^{a}**	**34.68^{a}**	**31.01^{b}**	**32.72**	**0.3734**	T×L=0.040
Albumin Percentage (%)	B	49.76	51.32	48.37	52.65	51.85	50.79^{A}	0.5954	T=0.237
	G	52.42	50.78	51.42	46.29	52.86	50.75^{A}	0.6792	L=0.965
	Mean	**51.09^{ab}**	**51.05^{ab}**	**49.89^{ab}**	**49.47^{b}**	**52.35^{a}**	**50.77**	**0.4497**	T×L=0.005
Shell Weight (g)	B	1.95	1.79	1.86	1.69	1.78	1.81^{A}	0.0385	T=0.312
	G	1.72	1.69	1.79	1.65	1.81	1.74^{A}	0.0379	L=0.142
	Mean	**1.84**	**1.74**	**1.83**	**1.67**	**1.80**	**1.77**	**0.0272**	T×L=0.671
Shell Percentage (%)	B	17.29	16.69	17.23	14.65	16.12	16.40^{A}	0.3768	T=0.045
	G	16.19	16.67	15.81	14.72	17.12	16.10^{A}	0.3355	L=0.549
	Mean	**16.74^{a}**	**16.68^{a}**	**16.52^{a}**	**14.68^{b}**	**16.62^{a}**	**16.25**	**0.2516**	T×L=540

^{abc}Means in the same row with no common superscript are different at $p < 0.05$; ^{AB}Means in the same column with no common superscript are different at $p < 0.05$. SEM: Standard error of the mean,

P value*; T= Treat effect; L= Line effect; T×L= Interaction effect; BEO: basil essential oil; PEO: peppermint essential oil; B: Brown; G: Golden.

Blood hematological and biochemical parameters

All hematological indices are presented in table (5). The results showed no significant differences in all hematological indices (Hb, RBC, WBC, and PCV) as a result of the dietary adding of 300 mg of basil oil and 600 mg of peppermint oil during laying period compared to the control group. Whereas, there were no significant ($p>0.05$) differences due to all dietary supplement treatments on blood biochemical parameters (globulin, cholesterol, and glucose) than the control group. It is of interest to note that basil oil supplementations (300 and 600 mg) and peppermint oil supplementation (600 mg) resulted in a significant($p<0.05$) increase regarding the levels of total protein and albumen and A/G ratio compared to the control group. Previous studies had different explanations about essential oils effects on hematological and biochemical blood parameters. Hadi and Jassim (2013) found a decrease in the levels of cholesterol and an increase in the levels of total proteins, albumen and globulin when the growing quail birds were dietary supplemented with 1.5 g of dried basil leave powder, justifying the decrease in cholesterol due to its active substances that impede the process of fat metabolism in the digestive system which reduce cholesterol absorption and decrease its level in the blood by increasing its excretion by bile salts. In addition, the same study showed that the high concentration of albumen was because of the role of the basil plant in digestion and absorption processes, mentioning that active phenols in basil plant raised blood globulin levels by its formation and transporting by the lymphatic tissues including the spleen as well as, flavonoids in basil plant are effective in stimulating digestive enzymes and pancreatic secretion to form carbohydrates and amino acids and increase their digestion, absorption and increase total protein in the blood plasma.

Another study (Elnaggar and El-Tahawy, 2018) reported that RBC and WBC tended to increase in the blood of the broiler birds which fed a basal diet supplemented with 10 and 20 g of sweet basil powder as compared to the treatment of 0.5 and 1 gm of sweet basil oil, but there were an increase in total protein and globulin levels and decrease in triglycerides levels respecting the treatments of powder and oil sweat basil supplementation compared to the control group. In laying hens, Sayedpiran et al. (2011) found that using 2% blends of ziziphora, menta, peppermint and nettle did not affect blood biochemical compared to the control group. Whereas, Ali and Ali (2019) found high counts of RBC, WBC and high levels of Hb, PCV, glucose, total protein and cholesterol when the layer hen birds were fed a basal diet supplemented with different levels (25, 50 and 75 ml/kg) of peppermint oil, explaining the role of active ingredients of peppermint oil (menthol and thymol) to increase the surface area and length of the villi which increases the absorption of nutrients and their transporting through the blood which in turn increase those blood parameters. Besides, the activity of menthol and thymol in the volatile oil of peppermint decreases the enzymatic activity of hydroxymethel glutaryl coenzyme A and hepatic reductase that regulate the synthesis of cholesterol (Arab Ameri et al., 2016).

A study by Abbas et al., (2021) pointed out no significant effect of basil and peppermint oils in the diet on hematological parameters of blood (Hb, RBC and WBC) while there was a significant effect of basil and peppermint essential oils on the serum total protein, albumen, globulin and cholesterol, besides, there was no effect on glucose and on A/G ratio by the dietary supplements.

Biochemical indices results (table 6) according to the line effect, it could be noticed that the golden line had the highest values of Hb, PCV%, cholesterol and glucose compared to the brown line, while the brown line recorded the highest values of total protein, albumen, globulin, and A/G ratio compared to golden line. This result confirms the genotypic effect on the blood parameters as stated that the hematological and biochemical parameters differ among different lines of poultry birds.(Gyenis et al., 2006; Pavlik et al., 2009). On the other hand, our results agree with a previous study (Meshabaz et al., 2017) which was conducted on three lines of quail and their reciprocal crosses and reported a significant negative correlation between total protein and cholesterol, insuring that protein plays a reverse role to cholesterol levels because the last represents one of the most important compounds of fat in the body.

Table 5: Hematological indices of laying quail hens fed different dietary experimental treatments at 16 weeks of age.

Parameters	**Line**	**Experimental diets**					**Mean**	**SEM**	***P-value****
		Control	**BEO (mg/kg)**		**PEO (mg/kg)**				
		0.0	**300**	**600**	**300**	**600**			
Hb (g/dI)	**B**	14.61	15.10	15.45	15.82	16.21	15.44^{B}	0.2141	T= 0.256
	G	16.41	15.76	15.62	15.62	15.90	15.86^{A}	0.1239	L= 0.039
	Mean	**15.51**	**15.43**	**15.54**	**15.72**	**16.05**	**15.65**	**0.1298**	T×L=0.023
RBC (x10^6/mm^3)	B	3.06	3.19	3.00	3.18	3.19	3.12	0.0342	T = 0.655
	G	3.14	3.03	3.14	3.15	3.13	3.13	0.0327	L=0.976
	Mean	**3.10**	**3.11**	**3.07**	**3.17**	**3.16**	**3.12**	**0.0230**	T×L=0.344
WBC (x10^3/mm^3)	B	29.67	29.03	33.06	27.37	29.57	29.74	0.8158	T =0.247
	G	28.74	30.78	30.25	30.77	30.27	30.16	0.2675	L= 0.572
	Mean	**29.21**	**29.90**	**31.65**	**29.07**	**29.92**	**29.95**	**0.4206**	T×L=0.143
PCV (%)	B	39.64	40.09	40.21	39.64	40.59	40.04^{B}	0.3026	T =0.985
	G	43.24	41.34	42.14	42.24	41.84	42.16^{A}	0.6018	L=0.031
	Mean	**41.44**	**40.72**	**41.17**	**40.94**	**41.22**	**41.10**	**0.4083**	T×L=0.884

^{abc}Means in the same row with no common superscript are different at $p < 0.05$; ^{AB}Means in the same column with no common superscript are different at $p < 0.05$. SEM: Standard error of the mean,

P value*; T= Treat effect; L= Line effect; T×L= Interaction effect; BEO: basil essential oil; PEO: peppermint essential oil; B: Brown; G: Golden.

Table 6: Blood biochemical parameters of laying quail hens fed different dietary experimental treatments at 16 weeks of age.

Blood Parameters	**Line**	**Experimental diets**					**Mean**	**SEM**	***P-value****
		Control	**BEO (mg/kg)**		**PEO (mg/kg)**				
		0.0	**300**	**600**	**300**	**600**			

Total Protein (g/dI)	**B**	4.71	5.36	5.72	4.87	5.52	5.24^{A}	0.1342	T=0.002
	G	4.66	4.89	5.05	4.76	4.94	4.86 ^{B}	0.0657	L= .001
	Mean	**4.68^{b}**	**5.13^{a}**	**5.38^{a}**	**4.81^{b}**	**5.23^{a}**	**5.05**	**0.0844**	T×L=0.147
Albumin (g/dI)	B	1.91	2.36	2.59	1.99	2.49	2.27^{A}	0.0939	T =0.003
	G	1.86	2.06	2.22	1.86	2.06	2.01^{B}	0.0641	L=0.004
	Mean	**1.88^{b}**	**2.21^{a}**	**2.41^{a}**	**1.93^{b}**	**2.27^{a}**	**2.14**	**0.0627**	T×L 0.411
Globulin (g/dI)	B	2.80	3.00	3.12	2.87	3.03	2.96^{A}	0.0469	T = 0.184
	G	2.80	2.84	2.83	2.89	2.87	2.85^{B}	0.0186	L=0.023
	Mean	**2.80**	**2.92**	**2.97**	**2.88**	**2.95**	**2.91**	**0.0279**	T×L=0.224
A/G Ratio	B	0.68	0.78	0.84	0.69	0.82	0.76^{A}	0.0237	T =0.022
	G	0.66	0.72	0.78	0.64	0.72	0.71^{B}	0.0233	L=0.049
	Mean	**0.67^{b}**	**0.75^{a}**	**0.81^{a}**	**0.66^{b}**	**0.77^{a}**	**0.74**	**0.0175**	T×L=0.877
Cholesterol (mg/dI)	B	168.33	167.35	167.67	169.33	167.35	168.01^{B}	0.7147	T =0.719
	G	177.28	173.84	171.57	173.28	175.34	174.26^{A}	1.0564	L=0.001
	Mean	**172.80**	**170.59**	**169.62**	**171.31**	**171.34**	**171.13**	**0.9490**	T×L=0.729
Glucose (mg/dI)	B	175.09	172.19	178.63	170.09	172.19	173.64^{B}	2.3417	T = 0.486
	G	180.43	181.95	186.06	177.92	176.95	180.66^{A}	1.3881	L=0.046
	Mean	**177.76**	**177.07**	**182.35**	**174.01**	**174.57**	**177.15**	**1.5506**	T×L=0.985

^{abc}Means in the same row with no common superscript are different at $p < 0.05$; ^{AB}Means in the same column with no common superscript are different at $p < 0.05$. SEM: Standard error of the mean, P value*; T= Treat effect; L= Line effect; T×L= Interaction effect; BEO: basil essential oil; PEO: peppermint essential oil; B: Brown; G: Golden.

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Authors' contribution

Sajida A. Al-Shaheen, Rabia J. Abbas, and Tarek I. Majeed proposed the hypothesis, designed the study, and performed the methodology. Rabia J. Abbas participated in statistical analysis and revised the draft and final manuscript approved by the authors. Sajida A. Al-Shaheen was responsible for writing the original draft. Tarek I. Majeed contributed to the sample collection and data collection. All authors read and approved the published version of the manuscript.

Competing interests

The authors declare that they have no competing interests

Data availability statement

The data presented in this study are available on request from the corresponding author.

Ethical considerations

Ethical issues (including plagiarism, consent to publication, misconduct, data fabrication and/or forgery, double publication and/or submission and replication). Exactly done by all authors.

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