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Effect of Peppermint (*Mentha piperita*) on Performance, Hatchability and Egg Quality Parameters of Laying Quails *(Coturnix coturnix japonica)*

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Abstract: The aim of this research is to determine the effects of dietary peppermint leaves on egg production, feed consumption, feed conversion ratio, egg quality parameters and hatching parameters in quails. Totally 180 laying quails of 15 weeks age were used. Animals were divided into 6 groups (30 animals in each group). Five of them were supplemented by different levels of peppermint up to 50 g kg^{-1}. The control group received no peppermint. The differences on feed conversion ratio, egg production, egg quality parameters were not significantly different between the groups. The 20 g kg^{-1} peppermint supplementation group consumed less daily feed. Among the hatching parameters, the values regarding late embryonic mortality and pipped were lowest in control group. It was concluded that peppermint supplementation into the ration up to 50 g kg^{-1} caused no important adverse effect except yolk index value in quails and 20 g kg^{-1} peppermint supplementation was produced better results than the other groups regarding feed consumption values.

Key words: Peppermint, quail, performance, hatchability, egg quality

INTRODUCTION

Plants are used for medical treatment since, the prehistoric time (Dragland *et al*., 2003). There are some important bioactive components (alkaloids, bitters, flavonoid, bioflavonoid, glycosides, mucilage, saponins, tannins (Vandergrift, 1998) phenols, phenolic acids, guinones, coumarins, terpenoids, essential oils, lectins and polypeptides) (Cowan, 1999) in the structure of nearly all the plants. Plants are extracted in order to obtain these chemicals but the extracts can vary with the chemicals to be used (water, ethanol, methanol, chloroform, dichloromethanol, ether, acetone) for the reaction (Cowan, 1999). These compounds in the plants had some important roles in protecting the plant against microorganisms, insects, fungus and herbivores (Cowan, 1999). The amount differences of these compounds in every plant and the interaction between them have important role on the mechanism of action of the plant. The effect of these compounds and the polysaccharides on the metabolism is still not fully known (Guo *et al*., 2003). Utilization of the growth factors and antibiotics has been banned in EU since, the beginning of 2006. As a consequence, plant origin new materials were extensively examined to be used instead of synthetic feed additives (Wang and Bourne, 1998).

The plant peppermint (*Mentha piperita*) is commonly used in treatment of loss of appetite, common cold, bronchitis, sinusitis, fever, nausea, vomiting and indigestion as an herbal agent (Akdogan *et al*., 2004). Peppermint is very well known as one of the medicinal herbs and used in many different forms for health purposes. Peppermint was used for its some antibacterial (Moreira *et al*., 2005), acaricidal (Kim *et al*., 2004), anti-inflammatory (Carmen *et al*., 2000), antioxidant (Runnie *et al*., 2004), insecticide (Rajaa *et al*., 2001), antispasmodic (Carmen *et al*., 2000), vasodilatory (Runnie *et al*., 2004), manipulator of rumen fermentation (Ando *et al*., 2003), ambulation-promoting effect (Umezua *et al*., 2001), decreasing the sperm activity (Akdogan *et al*., 2004), antivirutic (Cowan, 1999) exceptional odor intensity (Gaudin, 2000) properties for centuries. Peppermint oil comprises 30-55% Menthol, 14-32% Menthone, 1.5-10% Isomenthone, 2.8-10% Menthylacetate, 1-9% Menthofuran and 3.5-14% Cineol (Grigoleit and Grigoleit, 2005). Despite its palatability for animals, there are not many researches made on its practical usage as natural form feeding stuff.

However, utilization of peppermint herbs with different percentages in the quail diets has not been studied so far. The aim of this research is to determine the possible positive and negative effects of dietary

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peppermint in quail's diet. Peppermint was supplemented into the rations and this experiment was carried out to determine the effects of peppermint in ground herbal form to be used as feed additive in quail nutrition. In order to make use of the naturally existing chemicals in the structure of peppermint, it is decided to use herbal form rather than processed form. The rationale of this selection is the fact that plants are extracted in order to obtain chemicals (phenols, phenolic acids, guinones, coumarins, terpenoids, essential oils, lectins and polypeptides) but the extracts can vary with the chemicals to be used for the extraction (Cowan, 1999).

MATERIALS AND METHODS

A total of 180 Japanese quails (*Coturnix coturnix japonica*) of 15 weeks age were used in this experiment. Peppermints were obtained from a local herbalist in Afyonkarahisar province of Turkey. Animals were divided into 6 groups (30 animals in each group). Each group was then divided into 6 subgroups having four females and one male in each. The 1st group was left as control (PPM0) without any supplementation of peppermint. Quail in the other 5 groups (PPM 10, PPM 20, PPM 30, PPM 40 and PPM 50) were fed with diet supplemented by 10, 20, 30, 40 and 50 g kg^{-1} of peppermint, respectively. The experiment continued for 70 days and egg production and mortalities were recorded daily at the same time period of the day. Diets used were formulated to be isonitrogenic and isoenergic according to the NRC (1994) recommendations. Energy and protein values of peppermint herb were taken as 5.02 MJ kg^{-1} and 11 crude protein, respectively (Table 1).

Experimental diets were based on maize and wheat with a dry matter content of 22.3% crude protein, 13.62 MJ metabolisable energy (MJ kg^{-1}) as calculated basis. Birds were individually weighed at the beginning and at the end of the study and body weight gain was calculated. Feed consumption, FCR, egg production (EP) and egg albumen (EW) were determined weekly. Egg production, sound eggs, hair cracks, fully cracks, eggs without shell and abnormal eggs were recorded daily. The collected eggs were classified as normal or damaged; the latter included the following: fully cracks eggs (an egg with broken shell and destroyed membrane), hair cracks eggs (an egg with broken shell but intact membrane), the eggs without shell (an egg without shell but with intact membrane). Cholesterol analyses of the eggs were performed (Uyanık *et al*., 2002) and color index of the yolk (Roche color index), egg shape index, yolk index, egg albumen index, Haugh units were determined (Card and Nesheim, 1972). Palatability of eggs were checked at the end of the experiment by using 6 eggs boiled 5 min sampled from each of the 6 subgroups and evaluated from 5-10 points by a committee of consisting seven individuals. Hatchability was determined by hatching 140 eggs from each group at the end of the experiment. Eggs were individually weighed and all the eggs in the groups were

Table 1: The ingredient and calculated composition of experimental diets

Feed materials	PPM0	PPM10	PPM 20	PPM 30	PPM 40	PPM 50
Maize	34.70	37.00	34.00	36.00	35.00	34.00
Wheat	30.00	27.00	28.00	27.00	27.00	26.00
Full fat soy bean	9.40	10.00	14.00	10.50	13.00	17.00
Soybean meal	17.50	16.00	13.00	14.00	11.00	8.00
Oregano	-	1.00	2.00	3.00	4.00	5.00
Fish meal	1.30	2.03	2.00	2.77	3.46	3.31
Lime stone	5.30	5.35	5.33	5.20	5.10	5.20
Dicalcium phosphate	1.07	0.90	0.94	0.80	0.70	0.75
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin premix*	0.25	0.25	0.25	0.25	0.25	0.25
Mineral premix*	0.10	0.10	0.10	0.10	0.10	0.10
Methionine*	0.13	0.12	0.13	0.13	0.14	0.14
Calculated composition						
Metabolisable energy (MJ kg^{-1})	12.13	12.11	12.12	12.02	12.04	12.05
Dry matter (g kg^{-1})	89.10	89.20	89.20	89.10	89.10	89.20
Crude protein (g kg^{-1})	19.90	19.90	19.90	19.80	19.80	19.80
Crude fibre (g kg^{-1})	2.60	2.60	2.70	2.50	2.50	2.60
Crude fat (g kg^{-1})	3.33	3.46	4.10	3.54	3.97	4.61
Calcium (g kg^{-1})	2.47	2.50	2.50	2.47	2.47	2.49
Available phosphorus (g kg^{-1})	0.35	0.34	0.35	0.35	0.35	0.35
Methionine + cystine (g kg^{-1})	0.71	0.70	0.71	0.71	0.71	0.70
Lysine (g kg^{-1})	1.19	1.17	1.17	1.15	1.15	1.13
Linoleic acid	1.60	1.70	2.00	1.70	1.90	2.20

*Guaranteed levels of vitamin per 2.5 kg and mineral supplements per 1 kg product: vit. A: 12 000.000 UI; vit. D_3: 2 000.000 UI; vit. E: 35.000 mg; vit. K_3: 4000 mg; vit. B_1: 3000 mg; vit. B_2: 7.000 mg; vit. B_6: 5.000 mg vit. B_{12}: 15 mg; niacin: 20.000 mg; D-Biotin: 45 mg Apo Carotenoic acid ester: 500 mg, Folik Asit:1 000 mg, Kolin Klorid: 125 000 mg Vit C: 50 000 mg. Kal D-Pantothenate: 10.000 mg, Ksanthaxantine: 1500 mg copper: 5.000 mg; cobalt: 200 mg; selenium: 150 mg; manganese: 80.000 mg; zinc: 60.000 mg; iodine: 1.000 mg; iron: 60.000 mg; DL-Methionine: 99% pure

numbered before incubation. Eggs were set at random in one single-stage incubator and were incubated at a temperature of 37.8 with 55% relative humidity for 14 days. They were then transferred at random to Hatcher trays, which were located at the bottom of the same incubator and they were maintained at 37.2°C and 75% relative humidity until hatching. The numbers of hatched chicks were counted after 18 days of incubation and the chicks were weighed each of the subgroups. After the artificial incubation all unhatched eggs were cracked and each incubated egg was classified as: infertil, Early embryonic mortality, Mid term embryonic mortality, Late term embryonic mortality and Embryos that died after external pipping. The hatchability of total eggs in the groups was determined. Serum cholesterol values were measured with commercially available assay kits (Chema Diagnostica, Italy).

All statistical analyses were made using SPSS program designed for windows (SPSS, 1998). Evaluation of the data was performed by one-way analysis of variance while, significant differences among treatment means were tested using linear and quadratic contrasts at the 5% probability level.

RESULTS AND DISCUSSION

Since, no literature was found on peppermint leaves utilization in quail and other poultry diets, some other studies regarding different plants and extracts were considered and compared with our findings. There were no differences between the groups according to body weight and there weren't seen dead animal during the whole study. There were statistically significant according to feed consumption. Peppermint supplementation 20 g kg^{-1} group consumed lesser feed than the other groups. Feed Conversion Ratio (FCR) egg production and egg weight values between groups found to be insignificant in this study (Table 2). In a study where the effects of plant extracts (including the peppermint extract) were examined in broilers. Hernandez *et al.* (2004) reported that no change was seen regarding the feed conversion ratio. These findings are in accordance with ours. Al-Ankari *et al.* (2004) supplemented habek mint plant, a kind of a peppermint, to broiler diets with different ratios and determined 15 g kg^{-1} supplemented group to have better FCR and live weight values than the others.

Yolk color index value of the control group was seen as lowest rate moreover additions of peppermint to the diets were effect color index positively (Table 2). This effects could be carotenoids in the peppermint. No significant difference was seen between groups in terms of haugh unit, taste scores, shape index and albumen index. Bozkurt (2005) observed the similar change for Haugh unit value in a study where different plant extracts were used. These results were in accordance with ours. Florou-Paneri *et al.* (2006) examined the effects of supplementation of Rosemary in diets and determined the change in Haugh unit value to be significant. Florou-Paneri *et al.* (2006) found no significant difference between the groups in terms of egg shape index, yolk index and albumen index. There were seen differences among the groups regarding to yolk index value. According to the lowest yolk index value was determined in PPM30 Peppermint supplementation group, while, the highest value was seen in PPM10 peppermint supplementation group. Supplementation of peppermint to diets decreased the yolk index value (Table 2).

Egg cholesterol values were statistically differences between the groups. According to egg cholesterol values were determined to be higher in PPM10 and PPM20 peppermint supplementation groups whereas serum cholesterol values were highest in the control group (Table 3). Regarding the studies on Turkeys and broilers, it was reported that serum cholesterol level was not affected in turkey birds (Bampidis *et al.*, 2005a) and broilers (Sarıca *et al.*, 2005) fed by the ration supplemented with two plant extracts.

Differences on carcass yield, was not significant no significant difference was observed between the groups in terms of yield, sound egg, fully cracked, hair cracks, egg without shell and abnormal egg values (Table 3). In some researches, no significant difference was determined in treatment groups regarding the carcass weight of quails (Denli *et al.*, 2004; Cetingul *et al.*, 2007), broiler chickens (Cabuk *et al.*, 2006; Sarıca *et al.*, 2005; Basmacıoglu *et al.*, 2004), turkey birds (Alcicek *et al.*, 2003) and sheep (Bampidis *et al.*, 2005b) which were fed by supplemented rations. These reports are in harmony with our findings. On the other hand, Alcicek *et al.* (2003, 2004) reported that live weight and carcass yield of broilers was highest in the group which was fed by mixture of herbal essential oils supplemented ration comparing to control.

While, the hatchability of fertile eggs didn't statistically differ, numerically the highest value was seen in the control group. The highest fertility was seen in PPM40 and PPM50 peppermint supplementation groups. Hatchability of fertile eggs of the control group was numerically much more than the other groups (Table 3). This reminds that supplementation of peppermint leaves to diets could effect fertility. On the other hand, in a study conducted on rats, peppermint tea supplementation to drinking water was determined to affect fertility negatively (Akdogan *et al.*, 2004).

Table 2: Effects of peppermint on live weight, performance, internal, external egg quality, hatchability and fertility

	Treatments[1]						Significance level[2]			
	PPM0	PPM10	PPM20	PPM30	PPM40	PPM50	SEM	Combined	Linear	Quadratic
Body weight of male quail at 105 day of age (g)	202.8±8.2	196.1±8.6	196.3±6.4	214.5±6.7	217.2±7.4	221.3±11	44.92	0.140	0.115	0.084
Body weight of male quail at 175 day of age (g)	196.8±4.5	200.5±9.3	193.3±4.0	209.5±4.5	196.1±6.3	215.1±6.6	33.55	0.116	0.520	0.439
Body weight of female quail at 105 day of age (g)	229.3±3.1	232.5±5.0	2.31.0±5.1	226.7±3.0	237.1±4.5	240.1±11	32.34	0.612	0.664	0.756
Body weight of female quail at 175 day of age (g)	232.8±3.8	232.4±4.6	224.3±4.6	230.6±4.9	238.8±5.0	227.5±2.5	23.71	0.284	0.593	0.929
Mortality	0	0	0	0	0	0	-	-	-	-
Daily feed consumption (g)	23.2±0.9^{ab}	23.3±0.2^{ab}	20.5±0.5^{c}	23.8±0.5^{a}	23.0±0.5^{ab}	21.7±0.4^{bc}	2.895	0.001	0.599	0.539
Feed conversion ratio (g feed/g egg)	1.90±0.1	1.94±0.0	1.99±0.1	1.77±0.1	1.93±0.1	1.86±0.1	0.407	0.404	0.494	0.443
Egg production (%)	87.4±2.5	90.1±1.2	83.5±3.1	84.1±2.1	86.9±2.0	82.7±5.2	16.15	0.292	0.543	0.106
Egg weight (g)	12.31±0.2	12.28±0.2	12.16±0.1	12.33±0.2	12.74±0.1	12.39±0.3	1.065	0.418	0.443	0.299
Egg yolk color index	10.13±0.3^{b}	10.91 ±0.2^{a}	10.53±0.3^{ab}	10.76±0.2^{ab}	10.34±0.2^{ab}	10.43 ±0.2^{ab}	1.276	0.196	0.018	0.939
Egg Haugh Unit	87.96±0.7	88.80±0.7	88.31±0.9	88.94±1.0	86.12±1.3	89.03±1.1	5.326	0.283	0.552	0.488
Egg Taste score	7.56±0.4	8.00±0.4	7.44±0.4	6.94±0.4	7.56±0.4	7.19±0.2	2.057	0.462	0.464	0.135
Egg shape index	78.69±0.6	77.17±0.7	78.50±0.7	77.17±0.6	78.11±0.7	78.52±0.9	3.806	0.438	0.148	0.866
Egg albumen index	9.68±0.2	9.39±0.3	9.43±0.4	10.03±0.4	8.74±0.4	9.49±0.4	2.044	0.306	0.909	0.671
Egg yolk index	47.15±0.6^{ab}	47.91±0.5^{a}	45.92±0.6^{bc}	44.99±0.6^{c}	45.59±0.7^{bc}	46.27±0.5^{abc}	3.180	0.007	0.659	0.000

^{abcd}; Means in the same column with no common superscript differ significantly, $p<0.05$, Treatments[1]; PPM0: without any supplementation of peppermint, PPM10: Supplemented 10 g kg^{-1} Peppermint, PPM20: Supplemented 20 g kg^{-1} Peppermint, PPM30: Supplemented 30 g kg^{-1} Peppermint, PPM40: Supplemented 40 g kg^{-1} Peppermint, PPM50: Supplemented 50 g kg^{-1} Peppermint; [2]Numbers are probability values

Table 3: Effects of peppermint on cholesterol, carcass, external egg quality, hatchability and fertility

	Treatments[1]						Significance level[2]			
	PPM0	PPM10	PPM20	PPM30	PPM40	PPM50	SEM	Combined	Linear	Quadratic
Egg yolk cholesterol	12.12±1.0^{b}	16.26±1.2^{a}	15.98±1.1^{a}	13.36±0.7^{b}	13.02±0.7^{b}	10.89±0.6^{b}	4.996	0.000	0.000	0.262
Serum cholesterol	111.53±10^{a}	84.89±5.9^{b}	93.13±2.4^{ab}	103.27±9.3^{ab}	84.05±8.8^{b}	82.38±2.8^{b}	40.04	0.043	0.158	0.383
Male quail carcass yield	61.47±0.5	58.69±0.7	59.56±1.2	61.07±0.4	59.08±2.4	61.03±1.2	6.857	0.502	0.131	0.976
Sound eggs (%)	87.03±2.6	90.36±1.5	82.50±3.0	83.45±3.0	84.52±3.5	80.36±5.5	18.58	0.387	0.444	0.104
Egg Hair cracks	0.18±0.1	0.18±0.1	0.18±0.1	0.36±0.2	0.54±0.3	0.36±0.2	1.009	0.679	0.646	0.179
Egg Fully cracked	0.42±0.14	0.06±0.06	0.12±0.08	0.36±0.16	1.01±0.64	0.30±0.17	1.574	0.253	0.227	0.191
Egg Without shell	0.42±0.17	0.18±0.18	0.06±0.06	0.30±0.30	0.12±0.12	0.18±0.12	0.954	0.737	0.356	0.508
Egg Abnormal	0.36±0.13	0.30±0.17	0.00±0.0	0.18±0.12	0.30±0.23	0.06±0.06	0.770	0.407	0.619	0.319
Fertility	87.89±5.01	84.09±8.77	87.96±3.77	86.58±5.98	90.62±3.08	96.73±0.81	28.47	0.627	0.266	0.486
Hatchability of fertile eggs	78.27±4.7	68.86±9.6	72.04±4.3	68.98±6.2	67.04±4.0	76.89±6.0	33.47	0.204	0.339	0.151
Early embryonic mortality	0.48±0.48^{ab}	1.59±1.59^{ab}	2.95±1.02^{ab}	3.26±1.17^{a}	0.92±0.63^{ab}	0.00±0.00^{b}	5.287	0.119	0.045	0.296
Mid term embryonic mortality	1.02±0.65	1.59±1.59	2.66±0.54	0.00±0.00	0.93±0.58	0.00±0.00	3.420	0.164	0.138	0.353
Late embryonic mortality	1.54±0.7^{b}	2.34±1.1^{b}	9.91±3.6^{a}	3.37±1.8^{ab}	10.30±4.0^{a}	2.80±1.0^{ab}	13.20	0.039	0.369	0.038
Pipped	6.56±1.2^{b}	25.63±6.4^{a}	12.44±3.3^{ab}	24.40±5.3^{a}	25.69±5.4^{a}	17.04±4.8^{ab}	26.18	0.003	0.089	0.019

^{abcd}; Means in the same column with no common superscript differ significantly, $p<0.05$, Treatments[1]; PPM0: without any supplementation of peppermint, PPM10: Supplemented 10 g kg^{-1} Peppermint, PPM20: Supplemented 20 g kg^{-1} Peppermint, PPM30: Supplemented 30 g kg^{-} Peppermint, PPM40: Supplemented 40 g kg^{-1} Peppermint, PPM50: Supplemented 50 g kg^{-1} Peppermint); [2]Numbers are probability values

Early embryonic mortality values were not important as combined measure but linear measure was important. Late embryonic mortality and pipped values were determined combined and quadratic measure to be lowest in control group (Table 3). Therefore, this result showed that hatchability percentage of the groups fed by peppermint supplementation diets decreased towards the end of the hatch.

In a study made by Bozkurt (2005), it was stated that hatchability of fertile eggs, fertility were improved in the groups fed by herbal mix oil supplemented feed comparing to control group ($p<0.05$).

As a result, supplementation of peppermint to diets decreased the yolk index value. Although, egg yields didn't statistically differ, the values of control and PPM10 peppermint supplementation groups were numerically higher than the others. Peppermint supplementation to diets didn't affect fertility negatively. Moreover, the decrease in FC values in PPM20 peppermint supplementation group attracted attention.

CONCLUSION

It was concluded that peppermint supplementation into the ration causes some adverse effects on yolk index value and embryonic mortality. Therefore, it shouldn't be used in quail breeder flocks. However, it could be safely used in laying quail diets up to 50 g kg^{-1}.

REFERENCES

Akdogan, M., M. Ozguner, A. Kocak, M. Oncu and E. Cicek, 2004. Effects of peppermint teas on plasma testosterone, follicle-stimulating hormone and luteinizing hormone levels and testicular tissue in rats. J. Urol., 64: 394-398. DOI: 10.116. PMID: 15302514.

Al-Ankari, A.S., M.M. Zaki and S.I. Al-Sultan, 2004. Use of Habek Mint (*Mentha longifolia*) in Broiler Chicken Diets. Int. J. Poult. Sci., 3 (10): 629-634. http://www.pjbs.org/ijps/fin248.pdf.

Alcicek, A., M. Bozkurt and M. Cabuk, 2003. The effect of an essential oil combination derived from selected herbs growing wild in Turkey on broiler performance. South Afr. J. Sci., 33: 89-94.

Alcicek, A., M. Bozkurt and M. Cabuk, 2004. The effect of a mixture of herbal essential oils, an organic acid or a probiotic on broiler performance. South Afr. J. Sci., 34: 217-222.

Ando, S., T. Nishida, M. Ishida, K. Hosoda and E. Bayaru, 2003. Effect of peppermint feeding on the digestibility, ruminal fermentation and protozoa. Livest Product Sci., 82: 245-248. INIST: 16476, 354000112372460140.

Bampidis, V.A., V. Christodoulou, P. Florou-Paneri, E. Christaki, P.S. Chatzopoulou, T. Tsiligianni and A.B. Spais, 2005a. Effect of dietary dried oregano leaves on growth performance, carcase characteristics and serum cholesterol of female early maturing turkeys. Br. Poult. Sci., 46 (5): 591-601. DOI: 10.1080/00071660500256057. PMID: 16359114.

Bampidis, V.A., V.P. Christodoulou, P. Florou-Paneri, E. Christaki, A.B. Spais and P.S. Chatzopoulou, 2005b. Effect of dietary dried oregano leaves supplementation on performance and carcass characteristics of growing lambs Anim. Feed Sci. Technol., 121: 285-295.

Basmacioglu, H., O. TokuSoglu and M. Ergul, 2004. The effect of peppermint and rosemary essential oils or alpha-tocopheryl acetate on performance and lipid oxidation of meat enriched with n-3 PUFA's in broilers. South Afr. J. Sci., 34: 197-210.

Bozkurt, M., 2005. Investigation of Utilization Possibilities of Etheric Oils as Growth Factor in Broiler and Laying Hens. Turkey. DOI: TAGEM/GY/01/11/7.4/049 http://www.tagem.gov.tr/HABERLER/program%20degerlendirme/2008/HYSUD/kanatli/kanatli_2008.pdf.

Cabuk, M., M. Bozkurt, A. Alcicek, S.Y. Akba and K. Kucukyilmaz, 2006. Effect of a herbal essential oil mixture on growth and internal organ weight of broiler from young and old breeder flocks. South Afr. J. Sci., 36 (2): 135-141.

Card, L.E. and M.C. Nesheim, 1972. Poultry Production. 11th Edn. Lea and Febiger, Philadelphia. 1 USA.

Carmen, G., C. Monica and O.T. Cozar, 2000. Comparative analysis of some active principles of herb plants by GC: MS Talanta, 53: 253-262. DOI: 10.1016/S0039-9140 (00)00458-6.

Cetingul, I.S., I. Bayram, A.B. Akkaya, C. Uyarlar, M. Yardimci, E.H. Sahin and E. Sengor, 2007. Utilisation of oregano (*Origanum vulgaris*) in laying quails (*Coturnix coturnix japonica*) (2): The effect of oregano on performance carcass yield liver and some blood parameters. Arch. Zootech., 10: 52-59. http://www.ibna.ro/AZ10/07%20Cetingul.pdf.

Cowan, M.M., 1999. Plant products as antimicrobial agents. Clin. Microbiol. Rev., 10: 564-582. PMID: 10515903. http://cmr.asm.org/cgi/reprint/12/4/564.

Denli, M., F. Okan and A.N. Uluocak, 2004. Effect of dietary supplementation of herb essential oils on the growth performance, carcass and intestinal characteristics of quail (*Coturnix coturnix japonica*). South Afr. J. Anim. Sci., 34 (3): 174-179. http://web.ebscohost.com/ehost/pdf?vid=2&hid=2&sid=24fbf3ad-cf55-44d4-9330-0258d9ace371%40sessionmgr7.

Dragland, S., H. Senoo, K. Wake, K. Holte and R. Blomhoff, 2003. Several Culinary and Medicinal Herbs are Important Sources of Dietary Antioxidants Nutr., 133: 1286-1290. PMID: 12730411. http://jn.nutrition.org/cgi/content/full/133/5/1286.

Florou-Paneri, P., D. Dotas, I. Mitsopoulos, V. Dotes, E. Botsoglou, I. Nikolakakis and N. Botsoglou, 2006. Effect of feeding rosemary and a-tocopheryl acetate On hen performance and egg quality. J. Poult. Sci., 43: 143-149. http://www.jstage.jst.go.jp/article/jpsa/43/2/143/_pdf.

Gaudin, J.M., 2000. Synthesis and Organoleptic Properties of p-Menthane Lactones Tetrahedron, 56: 4769-4776. DOI: 10.1016/S0040-4020 (00)00397-5.

Grigoleit, H.G. and P. Grigoleit, 2005. Pharmacology and preclinical pharmacokinetics of peppermint oil. Phytomedicine, 12: 612-616. DOI: 10.1016/j.phymed.2004.10.007. PMID: 16121523.

Guo, F.C., H.F.J. Savelkoul, R.P. Kwakkel, B.A. Williams and M.W.A. Verstegen, 2003. Immunoactive medicinal properties of mushroom and herb polysaccharides and their potential use in chicken diets. W. Poult. Sci. J., 59 (12): 427-440. DOI: 10.1079/WPS20030026.

Hernandez, F., J. Madrid, V. Garcia, J. Orengo and M.D. Megias, 2004. Influence of Two Plant Extracts on broiler performance digestibility and digestive organ size. Poul. Sci., 83 (2): 169-174. http://ps.fass.org/cgi/reprint/83/2/169.

Kim, S.I., J.Y. Hwan, J.H. Tak and Y.J. Ahn, 2004. Acaricidal activity of plant essential oils against Dermanyssus gallinae (Acari: Dermanyssidae). Vet. Parasitol., 120: 297-304. DOI: 10.1016/j.vetpar. 2003.12.016. PMID: 15063940.

Moreira, M.R., A.G. Ponceb, C.E. Vallea and S.I. Roura, 2005. Inhibitory parameters of essential oils to reduce a foodborne pathogen. LWT, 38: 565-570. DOI: 10.1016/j.lwt.2004.07.012.

NRC, 1994. Nutrient requirements of poultry national research council, National Academy Press Washington DC. USA. http://www.nap.edu/ openbook.php?isbn=0309048923.

Rajaa, N., S. Alberta and S. Ignacimuthua, 2001. Efect of plant volatile oils in protecting stored cowpea *Vigna unguiculata* (L.) Walpers against *Callosobruchus maculatus* (F.) (*Coleoptera*: *Bruchidae*) infestation South Dorn. J. Stored Prod. Res., 37: 127-132. INIST: 12829,35400009402497.0030.

Runnie, I., M.N. Salleh, S. Mohameda, R.J. Headb and M.Y. Abeywardena, 2004. Vasorelaxation induced by common edible tropical plant extracts in isolated rat aorta and mesenteric vascular bed. J. Ethnopharmacol., 92: 311-316. PMID: 15138017.

SPSS, 10.0 Package Program, 1998. User's Guide, SPSS Inc, Chicago, Illinois, USA. http://www.hcp. med.harvard.edu/statistics/survey-soft/docs/blc_ eob.html.

Sarıca, S., A. Ciftci, E. Demir, K. Kilinc and Y. Yıldırım, 2005. Use of antibiotic growth prometer and two herbal natural feed additives with and without exogenous enzymes in wheat based broiler diets South Afr. J. Anim. Sci., 35 (1): 61-72.

Umezua, T., A. Sakatab and H. Itob, 2001. Ambulation-promoting effect of peppermint oil and identification of its active constituents Pharmacology. Biochem. Behavior, 69: 383-390. DOI: 10.1016/S0091-3057(01) 00543-3. PMID: 11509195.

Uyanık, F., S. Kaya, A.H. Kolsuz, M. Eren and N. Sahin, 2002. The effect of chromium supplementation on egg production egg quality and some serum parameters in laying hens. Turk. J. Vet. Anim. Sci., 26: 379-387. http://journals.tubitak.gov.tr/veterinary/issues/vet-02-26-2/vet-26-2-30-0105-18.pdf.

Vandergrift, B., 1998. Biotechnology in the feed industry. In: Proc. Altech's 14th Annual Symposium Altech Technical Publications Nottingham University Press. Nicholasville. K.Y., pp: 293-300.

Wang, R.D. and S. Bourne, 1998. Biotechnology in the feed industry. In: Proc. Altech's 14th Annual Symposium Altech Technical Publications Nottingham University Press. Nicholasville, K.Y., pp: 273-292.