

EFFECT OF ADDING GREEN TEA AND ITS AQUEOUS EXTRACT AS NATURAL ANTIOXIDANTS TO LAYING HEN DIET ON PRODUCTIVE, REPRODUCTIVE PERFORMANCE AND EGG QUALITY DURING STORAGE AND ITS CONTENT OF CHOLESTEROL

By

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Abstract: *The aim of this study was to investigate the effect of adding green tea and its aqueous extract as natural antioxidants to local laying hen diets on productive, reproductive performance and egg quality during storage and its content of cholesterol. In this study, a total number of 168 Inshas hens and 21 Inshas cocks, 34 weeks of age were randomly distributed into 7 groups and fed on the experimental diets. The experimental diets were as follows: three levels of green tea leaves (1, 3 and 5% of the diet) in comparison to their water extract at 0.5, 1.5 and 2.5 L / 100 kg diet, respectively), in comparison with the basal diet.*

The results of this study showed that adding between 1-5(%) green tea leaves (GTL) or between 0.5-2.5 (L/100 kg diet) green tea aqueous extract (GTE) to Inshas hen diets improved their productive performance, without significant differences between all tested levels of additives. The improvements in egg production, egg mass and feed conversion values, due to 1% GTL, compared to the control were 5.59%, 6.79% and 7.84%, respectively. While the corresponding level (0.5 L/100 kg diet) of aqueous extract (GTE) resulted in 6.78%, 7.46% and 8.65% improvement, respectively. None of the treatments had adverse effect on the change of hen body weight. More than 1% green tea leaves (3 and 5%) and more than 0.5 L/100 kg diet green tea extract (1.5 and 2.5) were required to improve significantly ($P \leq 0.05$) both of external and internal egg quality parameters. The improvement in shell thickness values (mm), due to 3% GTL or the corresponding level (1.5 L/100 kg diet) of water extract (GTE), compared to the control was 6.88%. Yolk color score was not influenced significantly by

any of the treatments. However, there was a gradual increase in yolk color score with increasing levels of green tea leaves (GTL). Addition of 3 and 5% (GTL) or 1.5 and 2.5L/100 kg (GTE) to the diets could improve the reproductive performance of both Inshas hens and cocks. The improvement in hatchability of fertile eggs due to 3% GTL was 6.11%, while the corresponding level (1.5 L/100 kg diet) of water extract (GTE) resulted in 5.03% improvement. Water extract of green tea leaves (GTE) resulted in least TBARS of semen plasma, therefore more protection against peroxidative damage of sperm membranes. The improvements in sperm concentration (million/mm³) and dead sperm (%) due to 3% GTL, compared to the control were 11.16% and 20.87%, respectively. While the corresponding level (1.5 L/100 kg diet) of water extract (GTE) resulted in 23.51% and 12.07%, respectively. None of the treatments had significant effect on nutrient digestibility. Addition of 3 and 5% (GTL) or between 0.5 and 2.5 L/100 kg (GTE) to Inshas hen diets decreased significantly ($P \leq 0.05$) both total blood plasma cholesterol and total lipids and also 1.5 L/100 kg (GTE) was required to increase ($P \leq 0.05$) the beneficial blood plasma H.D.L.as compared with that of control. In addition there was no adverse effect on both liver and kidney functions. Green tea leaves (GTL) and (GTE) at all tested levels decreased significantly ($P \leq 0.05$) total cholesterol content in egg yolk, LDL, total lipids and triglycerides as compared with the control, while, 5% GTL and 1.5 L/100 kg GTE were required to increase significantly ($P \leq 0.05$) H.D.L. as compared with the control. Results also ascertained that adding green tea to hen diet kept egg content of pH, total bacterial count and coliform group and egg yolk malonaldehyde lower than that of the control up to 10 days storage at room temperature (20 to 23°C), and 60% RH, resulting in better egg quality compared with the control.

Based on the results of the experiment, it is concluded that green tea powder inclusion in the diet for layers at 1.0-3.0% level or 0.50-1.5 L/100 kg water extract of green tea (GTE) can reduce the cholesterol content and TBA value of the egg yolk, implying its potential effect on egg quality parameters, especially during storage, in addition to improving the productive and reproductive performance of both hens and cocks.

INTRODUCTION

Antioxidants are compounds capable of delaying, reducing or preventing auto-oxidation processes (Shahidi and Wanasundara, 1992). Synthetic antioxidants were widely used in the food industry but consumers concern over their safety and toxicity pressed the food industry to find natural sources of antioxidant (Monahan and Troy, 1997). Therefore, the

importance of screening naturally occurring alternatives, which are safe, effective as dietary supplements or as processing aids, and relatively cheap, is increasing (Tang *et al.*, 2001). Green tea leaves (*Camellia sinensis*) contain antioxidative catechins (Miura *et al.*, 2001; Varilek *et al.*, 2001). Tea catechins have a variety of health benefits, *i.e.* antioxidative (Lin *et al.*, 1996), antimutagenic (Jain *et al.*, 1989), anticarcinogenic (Sano *et al.*, 1999), antimicrobial and hypolipidemic effects (Yoshino *et al.*, 1996), and anti-inflammatory effects (Varilek *et al.*, 2001). Moreover green tea has been noted for having many different physiological effects, *i.e.* antioxidant, antiallergen and anti-viral properties, its role in controlling high cholesterol and blood sugar and its ability to prevent cancer (Muramatsu *et al.*, 1986; Mukoyama *et al.*, 1991; Matsumoto *et al.*, 1993; Yoshino *et al.*, 1994; Yamamoto, 2000 and 2002). Al- Harthi (2004) reported that addition of 0.2% green tea yielded significantly better egg production and egg mass than the control group and they added that there were evidences indicating that green tea decreased yolk cholesterol and can decrease the losses in the weight of eggs stored under room temperature.

The aim of this study was to investigate the effect of adding green tea and its aqueous extract as natural antioxidants to local Inshas chicken diets on productive, reproductive performance and egg yolk cholesterol as well as egg quality during storage.

MATERIALS AND METHODS

The present study was carried out at Sakha Animal Research Station, Animal Production Research Institute, Ministry of Agriculture, Egypt. The chemical analyses were carried out at Laboratories of the Animal Production Research Institute, Ministry of Agriculture, Egypt. The main target of this study was to evaluate the effect of adding green tea and its extract as natural antioxidants to local Inshas chicken diets on productive, reproductive performance and egg yolk cholesterol as well as egg quality during storage.

A total number of 168 Inshas hens and 21 Inshas cocks, 34 weeks of age were randomly distributed into 7 groups of 24 hens and 3 cocks each and then subdivided into three replicates (8 hens + 1 cock/ replicate). Each group was fed on one of the 7 experimental diets, three levels of green tea leaves (1, 3 and 5% of the diet) in comparison to their water extracts at 0.5, 1.5 and 2.5 L / 100 kg diet, respectively), in addition to the basal diet (control). Green tea was purchased from local market and added to the diet in a powder form. The aqueous extract of green tea was prepared by the decoction technique (Nagao, *et al.*, 2005), with little modification. Where,

500 g of green tea leaves were mixed with 1200 ml of distilled water and boiled under reflux condenser for 15 min. The extract was filtered using a Buchner funnel and Whatman no. 1 filter paper, and concentrated under reduced pressure at 40°C using the rotary evaporator under reduced pressure to a final volume of 250 ml. Therefore each ml was extracted from 2 g of green tea leaves.

The experimental period lasted 90 days. The experimental diets were formulated to be isonitrogenous (~16% CP) and isocaloric (~2700 Kcal ME/Kg diet), and to at least satisfy the nutrient requirements according to **Agriculture Ministry Decree (1996)**. The birds were reared under the same managerial conditions in open-sided house on floor and photoperiod of 17 hours daily. The birds were fed *ad libitum* and the water was available all the time. Feed intake (FI), egg production (%) and egg weight were recorded daily. Five representative eggs from each treatment were collected monthly throughout the experimental period in order to determine egg and shell quality. Shape index and yolk index were determined according to **Romanoff and Romanoff (1949)** as follows:

$$\text{Shape index (\%)} = (\text{width} / \text{length}) \times 100$$

$$\text{Yolk index (\%)} = (\text{height} / \text{diameter}) \times 100$$

Egg shell thickness, including shell membranes, was measured using a micrometer at the equator. Haugh unit score was applied from a special chart using egg weight and albumin height which was measured by using a micrometer according to **Haugh (1937)**, **Kotaiah and Mohapatra (1974)** and **Eisen *et al.* (1962)**. The egg yolk visual color score was determined by matching the yolk with one of the 15 bands of the “1961, Roche Improved Yolk Color Fan”. Effect of storage time on malonaldehyde concentration; MDA, yolk pH and egg bacterial content was studied at 0, 5, 10 and 12 days after storage of three eggs from each treatment at (20 to 23°C), and 60% RH. Malonaldehyde (MDA) was measured according to **Marshall *et al.* (1994)**. The values of malonaldehyde were expressed in terms (mg/kg egg yolk) as reported by **Botsoglou, *et al.*, (1997)** and **Wang and Pan (2003)**. Yolk pH during storage was measured as reported by **(Kirunda and McKee, 2000)**. The previous analyses were done at Lab. of Food Science, Faculty of Agriculture, Cairo Univ., Giza. Total bacterial counts were undertaken during the storage of eggs as described by **Gürler and Fehlhaber, (2004)**. The egg mixtures were plated on Tryptone soya agar (TSA) and incubated at 37°C for 24 hours. After incubation the colony forming units (CFU) were counted, the bacterial count was expressed as log₁₀ CFU/ml of egg content. Coliform count was detected according to ISO 4832:2002 (**Kaloyanov, *et al.*, 2008**). Five eggs from each

treatment were collected monthly throughout the experimental period and yolk samples were separated from the broken eggs, calculated and extracted according to **Folch *et al.* (1957)**. At the end of the study, individual blood plasma samples were taken from 3 hens within each treatment for analysis. Total lipids, cholesterol, LDL, HDL and triglycerides were colorimetrically determined in both of blood plasma and egg yolk, while AST, albumin, alkaline phosphatase, creatinine, uric acid and total billurubin were determined in blood plasma using commercial kits (Bio-Diagonosis Co., Cairo, Egypt), following the same steps as described by manufacturers. At 42 weeks of age 3 birds / treatment were injected intra-muscular with 0.5 ml of 10% suspension packed sheep red blood cells (SRBC). Pre-injection antibody titers were zero. Blood samples were collected at 7 days post immunizing with SRBC. Antibody titer against SRBC was determined using the micrometer procedure described by **Vanderzjpp and Leenstra (1988)**.

A total of 210 eggs (30 eggs X 7 groups) were incubated monthly in a forced draft incubator for three times. Fertility, hatchability and chick hatching weight were recorded. Semen samples were collected at the end of each month, for three times from three cocks of each group by abdominal massage technique according to the method of **Burrows and Quinn (1937)**. Semen ejaculate volume was measured by tuberculin syringe graduated to nearest 0.01 ml according to **Allen and Champion (1955)**. Advanced motility recorded according to percentage of sperm forward motion. Sperm abnormalities were determined according to **Vontienhoven and Steel (1957)**. Seminal plasma was obtained by centrifugation of semen samples at 3500 rpm for 20 min at 4°C, and was stored at -20°C until later analysis. Thiobarbituric acid reactive substances (TBARS) were measured in the seminal plasma by using the method of **Tappel and Zalkin (1959)**.

Digestion coefficients of nutrients were determined at the end of the study using 3 cocks from each group. Faecal nitrogen was determined according to the method outlined by **Jakobsen *et al.* (1960)**, while the urinary organic matter fraction was calculated according to **Abou-Raya and Galal (1971)**. The chemical composition of green tea leaves, feed and excreta were carried out according to the methods of **A.O.A.C. (2005)**. ME content of green tea determined using **Scott *et al.* (1976)** equation ($ME = 53 + 38 (\% CP + 2.25 \times \% EE + 1.1 \times NFE)$). Amino acids and mineral contents of green tea were determined according to **(A.O.A.C., 2005)** in the Central Laboratory for Food & Feed (CLFF), Agricultural Research Center, Ministry of Agriculture, Giza, Egypt.

Total phenols were determined by using Folin Ciocalteu method according to Gao, *et al.*(2000), in Food Science & Technol. Dep., Fac. Of Agric., Cairo Univ. Ascorbic acid and caffeine were quantified by using HPLC as mentioned by Nagao, *et al.* (2005). Fractionation and identification of phenolic compounds in green tea were determined according to **Wang, *et al.*, (2000)** and **Ferrara, *et al.*, (2001)**. Tested green tea leaves contained (on air dry basis) 7.8 % moisture, 92.2% dry matter (DM), 82.4% organic matter (OM), 18.15% crude protein (CP), 8.72% ether extract (EE), 19.32% crude fiber (CF), 9.80% ash, 36.21% nitrogen free extract (NFE), 3002 kcal/kg calculated ME, amino acids: 1.35% aspartic, 0.64% threonine, 0.67% serine, 1.98% glutamic, 0.68% proline, 0.76% glycine, 0.78% alanine, 0.78% valine, 0.55% isoleucine, 1.17% leucine, 0.57% tyrosine, 0.78% phenylalanine, 0.32% histidine, 0.85% lysine, 0.74% arginine, 0.37% methionine, 0.14% cystine, minerals: 4.66% Ca, 1.62% total P, 8651 mg/kg Mn, 146.3 mg/kg Zn and 858.1 mg/kg Se. It contained the following active constituents: 1.01% total phenols, 105 mg/kg caffeine, 50 mg/kg catechin, 35 mg/kg epicatechin, 185 mg/kg epicatechingatlate and 17.5 mg/kg ascorbic acid.

Data from all the response variables were subjected to one way analysis of variance (**SAS, 2000**). Variables having a significant F-test ($P \leq 0.05$) were compared using Duncan's Multiple Range Test (**Duncan, 1955**).

Model:

$$X_{ij} = \mu + T_i + e_{ij}$$

Where: X_{ij} = Any observation.

μ = Overall mean.

T_i = Treatments ($i=1, 2 \dots$ and 7).

e_{ij} = Experimental error

RESULTS AND DISCUSSION

Laying hen performance:

Table (2) showed that both green tea leaves (GTL) and green tea extract (GTE), at all tested levels, improved significantly ($P \leq 0.05$) egg production, egg mass (starting from 3% GTL), feed conversion values and decreased significantly ($P \leq 0.05$) feed intake values as compared to the control. Average egg weight and the change in body weight of the hens were not influenced significantly ($P \leq 0.05$) by any of the treatments. There were no significant ($P \leq 0.05$) differences between both (GTL) and (GTE) levels.

It is concluded that adding between 1-5(%) green tea leaves or between 0.5-2.5 (L/100 kg diet) green tea extract to Inshas hen diets improved their productive performance. The improvements in egg production, egg mass and feed conversion values, due to 1% GTL, compared to the control were 5.59%, 6.79% and 7.84%, respectively. While the corresponding level (0.5 L/100 kg diet) of hot water extract (GTE) resulted improvement of 6.78%, 7.46% and 8.65%, respectively.

Biswas and Wakitam (2001) reported, on the contrary to the result of this experiment, that 0.3% green tea powder lowered average egg weight ($P < 0.05$). While, **Uganbayar, et al., (2005)** supported the results in that up to 2.0% green tea powder in layer diets had no adverse effect on egg production rate and egg weight as compared with the control. On the contrary to the results of this experiment, **Sadao and Yuko (2008)** found that there was no significant difference in egg weight, rate of egg production or egg mass between the control group and the group of laying hens fed on diets supplemented with 1% green tea, while 5 and 10% resulted in lowest ($P < 0.05$) values. Their results agreed with the results of this experiment regarding feed intake and the weight of the hen, where they reported that feed intake decreased significantly with an increase in the intake of green tea powder ($P < 0.05$) and as a result improving feed conversion value. They found also that there was no significant difference in the weight of the hen between the control group, the 1% and 5% groups. However, the weight of the hen in 10% groups did decrease. They revealed that the decrease in feed intake may be due to the bitterness of catechin or caffeine liquefied from green tea leaves. Obtained results as response to green tea as a natural antioxidant agreed with those obtained by **Abdel-Azeem (2005)** who found that addition of powdered green tea flowers (PGTF) at 0.25,0.50 and 0.75% to growing Japanese quail diet improved ($P < 0.05$) feed conversion, especially at 0.75 %. He attributed the effect on feed conversion to the biological role of flavonoids present in PGTF which, acts as antimicrobial, anti-fungal, antiseptic activities and anti-inflammatory or the role of PGTF as antioxidants. **Ali, et al., (2007)** found that addition of 0.25% thyme and 0.25% anise as natural antioxidants, in layer diets (Inshas and Dokki4), numerically increased egg number and improved feed conversion. Also, **Radwan, et al., (2008)** found that addition of 1.0% thyme, rosemary, oregano or 0.5% curcuma longa, as natural antioxidants, in layer diets (El-Salaam strain) increased egg production, egg mass and improved feed conversion. **Sahin, et al., (2010)** found that 200 or 400 mg of epigallocatechin-3-gallate (EGCG), a polyphenol derived from green tea,

exerts antioxidant effects and linearly increased feed intake from 29.6 to 30.9 g/d and egg production from 84.3 to 90.1%/d of heat-stressed quail.

Egg quality:

Table 3 showed that green tea leaves (GTL) at 3 and 5% improved significantly ($P \leq 0.05$) both shell% and shell thickness (mm) as compared with the control, while yolk index (%) required more than 3% (GTL). All levels of green tea extract (GTE) improved significantly ($P \leq 0.05$) shell% as compared with the control, while shell thickness (mm) required more than 0.5 (L/100 kg diet) green tea extract. Green tea extract (GTE) increased yolk index (%) significantly ($P \leq 0.05$) only at 1.5 and 2.5 (L/100 kg diet). Albumen (%) decreased as response to both (GTL) and (GTE) addition. Shape index (%) from external egg quality parameters and Haugh unit score, yolk color score and yolk (%) from internal egg quality parameters were not influenced significantly by any of the treatments. However, there was a gradual increase in yolk color score with increasing levels of green tea leaves (GTL).

It was concluded that more than 1% green tea leaves (3 and 5%) or more than 0.5 (L/100 kg diet) green tea extract (1.5 and 2.5) will be required to improve significantly ($P \leq 0.05$) both of external and internal egg quality parameters. The improvement in shell thickness values (mm), due to 3% GTL or the corresponding level (1.5 L/100 kg diet) of hot water extract (GTE), compared to the control was 6.88%.

Biswas and Wakitam (2001) supported the obtained results as they found that low level of green tea powder (0.3%) improved Haugh Unit. But on the contrary to the results of this study they found that albumen percentage was higher ($P < 0.05$) and yolk percentage was lower ($P < 0.05$) in green tea powder group.

On the contrary to the results of this experiment, **Uganbayar, *et al.*, (2005)** found that eggshell thickness was reduced significantly ($P < 0.05$) in the layer group fed the diets containing green tea powder regardless of dietary levels (0.5%, 1.0%, 1.5% and 2.0%). Their results were in agreement to the results of this experiment regarding the yolk color score, where they found that the yellowness of egg yolk was increased in the layers fed the 2.0% green tea diet compared with that of control diet.

Radwan, *et al.*, (2008) supported the positive effect of the natural antioxidants, where they found that addition of 1.0% curcuma longa as natural antioxidants in layer diets (El-Salaam strain) numerically increased values of shell weight and egg shape index. In addition, it increased percentage of yolk

weight and improved yolk color compared to control group. On other hand, **Sadao and Yuko (2008)** reported that there were no significant differences in the yolk color fan score or strength of the egg shell for the 4 treatments (0, 1, 5 and 10% of the hen diets green tea powder). However, they noticed that egg shell strength, thickness of the egg shell and HU values decreased with increasing green tea powder intake, especially with the 10% group. Regarding yolk color, the authors revealed that there is 13.29 mg% of beta-carotene in green tea leaves and according to **Naber (1979)**, beta-carotene is an important precursor for vitamin A, which upon colorization is categorized as a yellow. But the amount found in egg yolks is just one tenth of the amount of xanthophylls; hence, its influence on color is reported to be insignificant. Effect of high levels of green tea powder on yolk color score and Haugh unit score was similar to the results of this study.

Reproductive performance:

a. Reproductive performance of Inshas hens:

Table (4) showed that both fertility (%) and body weight of hatched chicks were not influenced significantly ($P \leq 0.05$) by addition of (GTL) and (GTE), while hatchability (%), especially of fertile eggs was improved significantly ($P \leq 0.05$) due to addition of 3 and 5% (GTL) and 1.5 and 2.5 L/100 kg (GTE) to Inshas hen diets. There was no significant ($P \leq 0.05$) difference between the two levels of each.

b. Reproductive performance of Inshas cocks:

Table (5) showed that semen volume (ml), semen motility (%) and the abnormal sperm (%) were not affected significantly ($P \leq 0.05$) by addition of either (GTL) or (GTE). Sperm concentration was improved significantly ($P \leq 0.05$) by addition 5% (GTL) and 1.5 and 2.5 L/100 kg (GTE) to Inshas cock diets (Table 5). Life sperm (%) was increased ($P \leq 0.05$) due to all additives. The best values were for 5% (GTL) and 2.5 L/100 kg (GTE) as compared with the control. Green tea leaves at 3 and 5% and GTE at 2.5 L/100 kg decreased significantly ($P \leq 0.05$) dead sperm (%) as compared with the control. Green tea leaves (GTL) at 5% or 2.5 L/100 kg (GTE) resulted in least ($P \leq 0.05$) TBARS values as compared with the control. However, all levels of (GTE) decreased significantly ($P \leq 0.05$) the concentration of TBARS as compared with the control.

It is concluded that addition of 3 and 5% (GTL) or 1.5 and 2.5L/100 kg (GTE) to the diets could improve the reproductive performance of both Inshas hens and cocks. The improvement in hatchability of fertile eggs due to 3% GTL, compared to the control was 6.11%, while the corresponding level (1.5

L/100 kg diet) of hot water extract (GTE) resulted in 5.03%, respectively. Hot water extract of green tea leaves (GTE) resulted in least TBARS of semen plasma, therefore more protection against peroxidative damage of sperm membranes. The improvements in sperm concentration (million/mm³) and dead sperm (%) due to 3% GTL, compared to the control were 11.16% and 20.87%, respectively. While the corresponding level (1.5 L/100 kg diet) of hot water extract (GTE) resulted in 23.51% and 12.07%, respectively.

Obtained results as response to green tea as a natural antioxidant agreed with those obtained by Ali, *et al.*, (2007) who found that addition of thyme as a natural antioxidant, in layer diets (Inshas and Dokki4) tended to improve fertility and hatchability. In addition, **Radwan**, *et al.*, (2008) found that addition of 1.0% oregano, rosemary or 0.5% curcuma longa, as natural antioxidants, in layer diets (El-Salaam strain), significantly increased the percentages of fertility, while 1.0% thyme or 0.5-1.0% curcuma longa significantly increased the percentages of hatchability compared to control group. The positive effects of natural antioxidants on reproductive performance were supported by **Radwan, et al.**, (2007) who added artichoke leaves meal, as a natural antioxidant, to Mandarah hen diets (at 2, 4, 6, 8, 10 and 12% of the diet). They found that 6, 8 and 10% artichoke leaves meal resulted in the highest fertility and hatchability percentages and that body weight of the hatched chicks was not affected by the treatments during the experimental periods. They also found that inclusion of natural antioxidants resulted in a slightly higher ejaculate volume than the basal diet, which supports the results of this study (0.39-0.44 vs.0.37 ml for the control). They also found that motility (expressed as the percentage of motile spermatozoa with moderate to rapid progressive movement) was non-significantly higher for groups fed on diets containing natural antioxidants, as compared with the control. Also the percentages of abnormal sperms decreased numerically due to natural antioxidants inclusion when compared with the control. They concluded that natural antioxidants may have beneficial effect on semen quality. The improving effects of the natural antioxidants on percentages of fertility, hatchability and semen quality may be explained by **Kelso *et al.***, (1996) and **Aitken**, (1994) who reported that avian spermatozoa are characterized by the presence of high concentrations of polyunsaturated fatty acids within the phospholipids. The presence of such polyunsaturated fatty acids requires an efficient antioxidant system to protect sperm membranes against peroxidative damage.

Nutrient digestibility:

Supplementing laying hen diets with either (GTL) or (GTE) had no significant effect on nutrient digestibility (Table 6). Treatments resulted in almost close values as compared with the control, except for NFE and OM, where the treatments resulted in higher numerical values (74.8-77.2 vs. 73.5%) and (79.9-80.6 vs. 79.7%) for NFE and OM, respectively.

The improving effect of natural antioxidants on nutrient digestibility coefficients was supported by **Radwan, et al., (2008)** who found that addition of 1.0% oregano as a natural antioxidant, in layer diets (El-Salaam strain) resulted in the highest values of all nutrient digestibility coefficients; except ether extract. **Abdel-Azeem (2005)** explained the improvement in the average weight of Japanese quail due to addition of powdered green tea flowers (PGTF) at 0.25, 0.50 and 0.75% to flavonoids compounds of green tea as reported by **Lin et al. (1998)** that influence the intestinal micro flora by either reducing microbial activity or by favorably promoting eubiosis of the micro flora resulting in better nutrient utilization and absorption.

Blood plasma constituents:

Plasma albumin, total bilirubin and the activity of (AST; aspartate aminotransferase), plasma creatinine and antibody titer values were not influenced significantly by green tea supplementation as compared with the control (Table 7). Green tea leaves at 3 and 5% and all tested levels of GTE (0.5, 1.5 and 2.5 L/100 kg) decreased significantly ($P \leq 0.05$) both total cholesterol and total lipids as compared with the control. While, 5% GTL and all tested levels of GTE decreased significantly ($P \leq 0.05$) LDL Uric acid values were decreased ($P \leq 0.05$) due to addition of 5% GTL and 1.5 L/100 kg GTE. Blood plasma HDL, triglycerides and alkaline phosphatase were affected significantly ($P \leq 0.05$) only by GTE not GTL. Where, 1.5 and 2.5 L/100 kg GTE increased ($P \leq 0.05$) HDL, while decreased ($P \leq 0.05$) triglycerides. Alkaline phosphatase (liver function) values were decreased ($P \leq 0.05$) as response to all GTE levels (0.5, 1.5 and 2.5 L/100 kg) as compared with the control. Malonaldehyde, as oxidative stress biomarker (**Sahin et al., 2010**), was decreased ($P \leq 0.05$) as response to all green tea additives (GTL and GTE) as compared with the control.

It is concluded that addition of 3 and 5% (GTL) or between 0.5 and 2.5L/100 kg (GTE) to Inshas hen diets decreased significantly ($P \leq 0.05$) both total blood plasma cholesterol and total lipids and that 1.5 L/100 kg (GTE) was required to increase ($P \leq 0.05$) the beneficial blood plasma HDL as compared with the control. In addition there was no adverse effect on liver

and kidney functions. The reduction in blood plasma cholesterol and the increase in blood plasma HDL due to 1.5 L/100 kg diet hot water extract (GTE), compared to the control were 4.66% and 7.14%, respectively.

Although the results of **El-Deek and Al-Harhi (2004)** showed that addition of green tea at 5g/kg feed had no significant effect on chemical composition of plasma total lipids and cholesterol and plasma AST and ALT activities, the results of **Abdel-Azeem (2005)** agreed with results of this study, where they found that addition of powdered green tea flowers (PGTF) at 0.25,0.50 and 0.75% to growing Japanese quail diet improved ($P<0.05$) antibodies titer production and that raising the level of PGTF from 0.25 to 0.75 % significantly ($P<0.05$) decreased blood lipids fractions and increased high density lipoprotein (HDL). The decreasing effect of green tea on blood lipids was explained by **Hasegawa *et al.* (2003)** and **Lee *et al.* (1992)** who observed that green tea found to inhibit lipogenesis in adipose tissue *and* that rats fed diets containing 0.15 % caffeine and 6.1% powdered green tea showed a reduction of white adipose tissue weight. Green tea was found to increase excretion of fecal bile acids cholesterol (**Yang and Koo, 2000**) and reduce pancreatic lipase activity and gastric lipase which resulted in a drastic decrease in gastric lipase resulting in reducing fat digestion (**Deng *et al.* 1998 and Juhel *et al.* 2000**). **Lin *et al.* (1998)** reported that total serum cholesterol and triglycerides were significantly ($P<0.05$) decreased in rats fed diets containing 2.5 % green tea. **Raederstorff *et al.* (2003)** indicated that epigallocatechin found in green tea affect lipid metabolism by interfering with micellar solubilization of cholesterol in digestive tract, which in turn decrease cholesterol absorption. The numerical increase in antibody titer production may be due to the high level of iron was found to increase excretion of fecal bile acids cholesterol (**Yang and Koo, 2000**) and reduce pancreatic lipase activity and gastric lipase which resulted in a drastic decrease in gastric lipase resulting in reducing fat digestion (**Deng *et al.* 1998 and Juhel *et al.* 2000**). **Lin *et al.* (1998)** reported that total serum cholesterol and triglycerides were significantly ($P<0.05$) decreased in rats fed diets containing 2.5% green tea. **Raederstorff *et al.* (2003)** indicated that epigallocatechin found in green tea affect lipid metabolism by interfering with micellar solubilization of cholesterol in digestive tract, which in turn decrease cholesterol absorption. Also, **Gomikawa, *et al.* (2008)**, reported that catechins presented in green tea inhibited cholesterol absorption in intestine of rats. The numerical increase in antibody titer production may be due to the high level of iron in green tea (342 mg / Kg) as reported by (**Abdel-Azeem, 2005**) or that polyphenols of green tea were effective in reversing the decreased in white blood cells and thymus, as well as increased immunocyte number as reported by **Cao-Ming and Cao**

(1998). The effect on liver function was supported by (Abdel-Azeem, 2005) who attributed that to the present of active compounds in PGTF which have preventive effect against liver injury.

Obtained results as response to green tea as a natural antioxidant were agreed to those obtained by Ali, *et al.*, (2007) who found that addition of thyme and anise as natural antioxidants, in layer diets (Inshas and Dokki4) increased antioxidant capacity in plasma, while decreased LDL, total cholesterol, triglyceride and total lipids. It could be also noticed that green tea consumption has been associated with decreasing cardiovascular risk, also, lowering LDL-cholesterol in adults, and this effect is related to green tea catechins (Moran, *et al.*, 2003). In addition, Radwan, *et al.*, (2008) found that addition of 1.0% thyme or rosemary as natural antioxidants, in layer diets (El-Salaam strain) resulted in the highest values of antibody titter against sheep red blood cells. Thyme or rosemary at 1.0% significantly decreased plasma total lipid and total cholesterol. The significant decreasing effect of green tea **on the amount of blood malonaldehyde**, as oxidative stress biomarker was revealed by Sahin, *et al.*, (2010) who indicated that supplemental epigallocatechin-3-gallate (EGCG), a polyphenol compound derived from green tea, alleviates oxidative stress through modulating the hepatic nuclear transcription factors. Also, Eid, *et al.*, (2008), purported that the vitamin E presented in green tea, which is considered a natural antioxidant play an important role under the oxidative stress condition by decreasing lipid peroxidation level and thus enhancing the anti-oxidant defense.

Egg yolk constituents:

Green tea leaves (GTL) and (GTE) at all tested levels decreased significantly ($P \leq 0.05$) egg yolk content of total cholesterol, L.D.L., total lipids and triglycerides as compared with the control (Table 8). While, 5% GTL and 1.5 and 2.5 L/100 kg GTE increased significantly ($P \leq 0.05$) H.D.L. as compared with the control. The increase in egg yolk H.D.L due to 1.5 L/100 kg diet hot water extract (GTE), compared to the control was 3.96%. The results of egg yolk constituents were supported by Biswas and Wakitam (2001) who revealed that some favorable physicochemical characteristics of eggs such as low cholesterol yolk was caused by green tea powder (0.3%) feeding. Also, Uganbayar, *et al.*, (2005) found that green tea powder (0.5%, 1.0%, 1.5% and 2.0% of the diet) tended to reduce egg yolk cholesterol, particularly, at 2%. Obtained results as response to green tea as a natural antioxidant were agreed to those obtained by Ali, *et al.*, (2007) who found that addition of thyme and anise as natural antioxidants,

in layer diets (Inshas and Dokki4) decreased LDL, total cholesterol, triglyceride and total lipids in yolk extract. **Radwan, *et al.*, (2008)** found that addition of 1.0% thyme, rosemary or curcuma longa as natural antioxidants, in layer diets (El-Salaam strain) significantly decreased yolk total lipid, in comparison to the control group.

Egg quality during storage:

Tables 9, 10, 11 and 12 represent the effect of storage time on egg content pH and its content of total bacterial count, coliform group and malonaldehyde content, respectively, as response to different treatments.

Egg content pH, in general, increased with increasing storage time (Table 9). Addition of green tea kept the pH of egg content lower than that of the control, where egg content pH of the control was 7.81 vs. a range of 7.57-7.65 for the treatments. Increasing storage time increased egg total bacterial count and coliform group of the hens fed the control diet, while the treatments decreased both with increasing storage time (Tables 10 and 11). All tested green tea forms and levels decreased total bacterial count and coliform group as compared with the control (3.33-3.53 vs. 4.02 and 1.94-2.36 vs. 2.71 for total bacterial count and coliform group, respectively). Egg yolk malonaldehyde increased with increasing storage time (Table 12). Addition of green tea resulted in less ($P \leq 0.05$) malonaldehyde than that of the control, where the values ranged between 0.540 and 0.560 vs. 0.599 for the control. It is noticed that after 10 days of storage, GTE was more effective than GTL, where it resulted (all tested levels) in lower ($P \leq 0.05$) amounts of malonaldehyde than GTL and the control.

In this regard **Uganbayar, *et al.*, (2005)** concluded that green tea powder in the diet of layers at 2.0% level can reduce thiobarbituric acid value (TBA) of egg yolk, implying its potential effect on egg quality parameters. **Radwan, *et al.*, (2008)** found that addition of 1% oregano or rosemary or 0.5 and 1.0% curcuma longa, as natural antioxidants, in layer diets (El-Salaam strain), during laying period significantly decreased malonaldehyde formation in egg yolk and had positive effect on oxidative stability of shell eggs storage at room temperature ($16^{\circ}\text{C} \pm 2$). **Samli, *et al.*, (2005)** supported the effect of egg storage time on pH of albumen and yolk, where it increased in stored eggs compared with the fresh eggs. The authors observed rapidly increased pH in albumen with 2 d storage time and extended from 7.47 to 9.2 at 29°C during 5 d of storage. They indicated that the increase in pH observed in yolk was not as large as in albumen, and it differed from 5.75 to 6.08 during 10 d of storage at 29°C . They explained that most of these changes in egg quality were attributed to

water loss by evaporation through the pores in the shell and the escape of carbon dioxide from albumen. The effect on egg total bacterial count and coliform group was revealed by **Hara (1993)**, **Yoshino *et al.*, (1996)** and **Varilek *et al.*, (2001)** who indicated that green tea content of polyphenols, phenolic acids, catechins, B-carotene and flavonoids have antimicrobial effect. Also, **Chou, *et al.* (1999)** and **Hirasawa, *et al.*, (2002)**, ascertained that the green tea exhibited antimicrobial activity against a various Gram-positive and Gram-negative bacteria species, due to the presence of catechins and catechin derevatives.

Based on the results of the experiment, it is concluded that green tea powder inclusion in the diet for layers at 1.0-3.0% level or 0.50-1.5 L/100 kg water extract of green tea (GTE) can reduce the cholesterol content and TBA value of the egg yolk, implying its potential effect on egg quality parameters, especially during storage, in addition to improving the productive and reproductive performance of both hens and cocks.

Table (1) Composition and calculated analysis of the experimental diets

Ingredients (%)	Control	Green tee levels		
		1%	3%	5%
Yellow corn	59.70	59.00	57.16	55.46
Soybean meal (44%)	24.02	24.50	23.00	22.9
Wheat bran	5.40	4.72	6.33	6.33
Green tea	--	1.00	3.00	5.00
Corn oil	1.00	1.00	1.00	1.00
Limestone	7.77	7.67	7.40	7.20
Di calcium phosphate	1.45	1.45	1.45	1.45
NaCl	0.30	0.30	0.30	0.30
Premix ¹	0.30	0.30	0.30	0.30
DL-Methionine	0.06	0.06	0.06	0.06
Total	100	100	100	100
Calculated analysis:				
Crude protein %	16	16	16	16
Metabolizable energy (Kcal ME /Kg diet)	2700	2700	2700	2700
CF %	3.72	3.86	4.27	4.61
Available P %	0.40	0.40	0.40	0.40
Calcium %	3.30	3.30	3.30	3.30
Lysine %	0.90	0.90	0.88	0.89
Methionine %	0.35	0.35	0.35	0.35
Methionine +Cystine%	0.62	0.62	0.62	0.62
Sodium %	0.135	0.135	0.136	0.136

1. Each 3 kg of Vit. & Min. Mixture contains: Vit. A, 10000,000 IU; Vit. D₃, 2000,000 IU; Vit. E, 10,000 mg; Vit. k₃, 1000 mg; Vit. B₁, 1000 mg; Vit. B₂, 5000 mg; Vit. B₆, 1500 mg; Vit. B₁₂, 10 mg; Pantothenic acid, 10,000 mg; Niacin, 30,000 mg; Folic acid, 1000 mg; Biotin, 50 mg; Choline, 250,000 mg; Manganese, 60,000 mg; Zinc, 50,000 mg; Copper, 10,000 mg; Iron, 30,000; Iodine, 1000 mg; Selenium, 100 mg; Cobalt, 100 mg; Ca CO₃ to 3,000 gm.

Table (2) Effect of experimental treatments on productive performance of Inshas hens

Treatments	Items					
	Egg production (%)	Average egg weight (g)	Egg mass (g/d)	Feed intake (g/d)	Feed conversion (g feed/g egg)	Change in body weight (g)
Control	51.60 ^b	49.33	25.47 ^b	94.37 ^a	3.70 ^a	184.6
GTL (kg/100 kg diet)						
1	54.67 ^a	49.77	27.20 ^{ab}	92.67 ^b	3.41 ^b	187.9
3	55.50 ^a	49.67	27.57 ^a	92.53 ^b	3.36 ^b	194.6
5	56.20 ^a	50.13	28.17 ^a	92.33 ^b	3.28 ^b	197.7
GTE (L/100 kg diet)						
0.5	55.10 ^a	49.67	27.37 ^a	92.37 ^b	3.38 ^b	192.3
1.5	55.60 ^a	49.83	27.73 ^a	91.87 ^b	3.32 ^b	186.1
2.5	56.97 ^a	50.30	28.63 ^a	92.53 ^b	3.24 ^b	192.3
SEM	±0.462	±0.092	±0.275	±0.211	±0.038	±1.409
P value	0.03	0.07	0.042	0.024	0.004	0.10

a,b= Means on the same column differently superscripted are significantly different (P≤ 0.05).

SEM = Standard error of means

Table (3) Effect of experimental treatments on egg quality of Inshas hens

Treatments	External egg quality			Internal egg quality				
	Shell (%)	Shell thickness (mm)	Shape index (%)	Haugh unit score	Yolk color score	Yolk index (%)	Yolk (%)	Albumen (%)
Control	10.22 ^d	0.349 ^c	75.71	74.9	5.1	45.09 ^{cd}	32.35	57.43 ^a
GTL (kg/100 kg diet)								
1	10.33 ^{cd}	0.367 ^{bc}	76.22	75.1	5.3	44.90 ^d	32.81	56.86 ^b
3	10.71 ^{ab}	0.373 ^{ab}	76.29	72.4	5.4	46.57 ^{abc}	32.85	56.44 ^b
5	10.83 ^{ab}	0.391 ^a	75.41	72.4	5.7	47.75 ^a	32.53	56.64 ^b
GTE (L/100 kg diet)								
0.5	10.56 ^{bc}	0.351 ^c	75.70	73.3	5.2	45.91 ^{bcd}	32.45	56.99 ^{ab}
1.5	10.80 ^{ab}	0.373 ^{ab}	76.11	72.9	5.4	46.99 ^{ab}	32.56	56.63 ^b
2.5	11.03 ^a	0.375 ^{ab}	75.93	73.3	5.3	47.86 ^a	32.49	56.44 ^b
SEM	±0.059	±0.003	±0.193	±0.650	±0.072	±0.257	±0.069	±0.082
P value	<.0001	0.001	0.9	0.9	0.3	0.001	0.4	0.006

a, b ...= Means on the same column differently superscripted are significantly different ($P \leq 0.05$).

SEM = Standard error of means

Table (4) Effect of experimental treatments on reproductive performance of Inshas hens

Treatments	Fertility (%)	Hatchability (%)	Hatchability of fertile eggs (%)	BW of hatched chicks (g)
Control	87.04	72.59 ^c	83.36 ^c	34.76
GTL (kg/100 kg diet)				
1	90.00	77.04 ^{bc}	85.62 ^{bc}	34.99
3	90.00	79.63 ^{ab}	88.45 ^{ab}	34.98
5	92.22	83.33 ^a	90.36 ^a	35.14
GTE (L/100 kg diet)				
0.5	88.89	76.67 ^{bc}	86.26 ^{bc}	35.03
1.5	89.26	78.15 ^{abc}	87.55 ^{ab}	34.98
2.5	90.74	82.22 ^{ab}	90.62 ^a	35.11
SEM	±0.62	±0.95	±0.63	±0.07
P value	0.50	0.02	0.002	0.9

a, b ...= Means on the same column differently superscripted are significantly different ($P \leq 0.05$).

SEM = Standard error of means

Table (5) Effect of experimental treatments on semen quality of Inshas cocks

Treatments	Volume (ml)	Sperm concentration (million/mm ³)	Motility (%)	Life sperm (%)	Dead sperm (%)	Abnormal sperm (%)	TBARS (nmol/ml)
Control	0.37	2.51 ^c	72.78	83.44 ^c	10.11 ^a	6.44	1.74 ^a
GTL (kg/100 kg diet)							
1	0.39	2.67 ^c	74.44	85.33 ^b	9.67 ^{ab}	5.00	1.64 ^{ab}
3	0.39	2.79 ^{bc}	75.56	86.78 ^{ab}	8.00 ^{bc}	5.22	1.54 ^{ab}
5	0.44	3.77 ^a	78.33	88.11 ^a	6.44 ^{cd}	5.44	0.93 ^c
GTE (L/100 kg diet)							
0.5	0.39	2.78 ^{bc}	76.67	85.67 ^b	9.00 ^{ab}	5.33	1.54 ^b
1.5	0.39	3.10 ^b	75.00	85.56 ^b	8.89 ^{ab}	5.56	1.50 ^b
2.5	0.42	3.88 ^a	78.33	88.22 ^a	6.33 ^d	5.44	0.86 ^c
SEM	±0.008	±0.118	±0.567	±0.397	±0.35	±0.18	0.075
P value	0.32	□.0001	0.20	0.001	0.001	0.55	□.0001

a, b ...= Means on the same column differently superscripted are significantly different (P ≤ 0.05).

SEM = Standard error for means

Table (6) Effect of experimental treatments on nutrient digestibility

Treatments	Items					
	DM (%)	OM (%)	EE (%)	CF (%)	CP (%)	NFE (%)
Control	80.5	79.7	76.7	23.2	79.0	73.5
GTL (kg/100 kg diet)						
1	80.3	79.9	76.0	23.3	79.8	75.7
3	80.6	80.5	75.6	23.0	79.2	75.9
5	81.4	80.6	76.9	23.3	79.4	77.2
GTE (L/100 kg diet)						
0.5	80.4	80.0	75.7	23.1	78.8	74.8
1.5	79.9	80.1	77.3	23.4	79.7	76.6
2.5	81.2	80.5	74.2	22.7	79.2	76.9
SEM	±0.16	±0.21	±0.72	±0.22	±0.28	±0.48
P value	0.156	0.921	0.958	0.989	0.982	0.453

SEM = Standard error of means

Table (7) Effect of experimental treatments on blood plasma constituents of Inshas hens

Items	Control	GTL (kg/100 kg diet)			GTE (L/100 kg diet)			SEM	P value
		1	3	5	0.5	1.5	2.5		
Total cholesterol (mg/dl)	150.3 ^a	150.4 ^a	145.7 ^b	144.9 ^b	143.2 ^b	143.3 ^b	142.2 ^b	±0.82	0.002
H.D.L. (mg/dl)	71.4 ^b	72.8 ^b	73.0 ^b	73.6 ^b	73.6 ^b	76.5 ^a	77.2 ^a	±0.48	0.0003
L.D.L. (mg/dl)	73.8 ^a	70.7 ^{ab}	70.4 ^{ab}	68.6 ^b	69.5 ^b	64.9 ^c	65.0 ^c	±0.75	0.0005
Total lipids (mg/dl)	205 ^a	202 ^{ab}	200 ^{bc}	200 ^{bc}	197 ^{bc}	197 ^{bc}	196 ^c	±0.81	0.008
Triglycerides (mg/dl)	103 ^a	102 ^a	101 ^{ab}	100 ^{ab}	99 ^{ab}	97 ^b	93 ^c	±0.80	0.001
Albumin (g/dl)	1.74	1.72	1.71	1.70	1.68	1.69	1.71	±0.01	0.07
AST (U/ml)	264	263	263	266	263	263	262	±0.67	0.81
Alkaline phosphatase (U/L)	5.18 ^a	5.19 ^a	5.09 ^{ab}	5.13 ^{ab}	4.93 ^c	5.03 ^{bc}	4.95 ^c	±0.03	0.002
Creatinine (mg/dl)	0.497	0.495	0.490	0.494	0.487	0.495	0.499	±0.002	0.632
Uric acid (mg/dl)	4.71 ^a	4.64 ^{abc}	4.70 ^{ab}	4.63 ^{bc}	4.70 ^{ab}	4.60 ^c	4.64 ^{abc}	±0.01	0.04
Total billurubin (mg/dl)	0.409	0.407	0.414	0.412	0.411	0.410	0.416	±0.001	0.30
Antibody titter	5.67	6.33	6.33	7.33	6.33	6.33	6.67	±0.15	0.10
malonaldehyde (mg/ml)	1.503 ^a	1.323 ^b	1.28 ^b	1.24 ^{bc}	1.230 ^{bc}	1.223 ^{bc}	1.173 ^c	±0.02	□ .0001

a, b= Means on the same row differently superscripted are significantly different (P ≤ 0.05).

SEM = Standard error of means

Table (8) Effect of experimental treatments on some constituents of egg yolk extract

Treatments	Total cholesterol (mg/g)	H.D.L. (mg/g)	L.D.L. (mg/g)	Total lipids (mg/g)	Triglycerides (mg/g)
Control	23.87 ^a	10.09 ^d	12.12 ^a	307 ^a	125 ^a
GTL (kg/100 kg diet)					
1	22.71 ^b	10.12 ^d	11.72 ^b	282 ^b	119 ^b
3	20.90 ^{cd}	10.28 ^{cd}	10.05 ^c	274 ^{bc}	117 ^{bc}
5	20.33 ^e	10.65 ^{ab}	8.77 ^e	263 ^{de}	114 ^{cd}
GTE (L/100 kg diet)					
0.5	21.38 ^c	10.21 ^d	10.30 ^c	283 ^b	118 ^{bc}
1.5	20.46 ^{de}	10.49 ^{bc}	9.22 ^d	271 ^{cd}	116 ^{bed}
2.5	19.21 ^f	10.87 ^a	7.94 ^f	258 ^e	112 ^d
SEM	±0.33	±0.07	±0.32	±3.47	±0.94
P value	□ .0001	□ .0001	□ .0001	□ .0001	0.0001

a, b= Means on the same column differently superscripted are significantly different (P ≤ 0.05).

SEM = Standard error of means

Table (9) Effect of experimental treatments on egg content pH During storage time

Treatments	Storage time				
	Zero time	5 days	10 days	12 days	Average
Control	7.42	7.85 ^a	7.99 ^a	7.99 ^a	7.81 ^a
GTL (kg/100 kg diet)					
1	7.44	7.62 ^b	7.75 ^b	7.80 ^b	7.65 ^b
3	7.42	7.52 ^b	7.70 ^b	7.62 ^b	7.57 ^b
5	7.43	7.63 ^b	7.74 ^b	7.70 ^b	7.63 ^b
GTE (L/100 kg diet)					
0.5	7.42	7.61 ^b	7.64 ^b	7.74 ^b	7.60 ^b
1.5	7.44	7.58 ^b	7.67 ^b	7.75 ^b	7.61 ^b
2.5	7.43	7.52 ^b	7.63 ^b	7.70 ^b	7.57 ^b
SEM	±0.011	±0.029	±0.031	±0.030	±0.020
P value	1.00	0.008	0.01	0.009	0.0008

a, b ...= Means on the same column differently superscripted are significantly different ($P \leq 0.05$).

SEM = Standard error of means

Table (10) Effect of experimental treatments on egg content of total bacterial count (log₁₀) During storage time

Treatments	Storage time				
	Zero time	5 days	10 days	12 days	Average
Control	3.86 ^a	3.96 ^a	4.14 ^a	4.11 ^a	4.02 ^a
GTL (kg/100 kg diet)					
1	3.77 ^{ab}	3.65 ^b	3.46 ^b	3.22 ^{cd}	3.53 ^b
3	3.61 ^c	3.58 ^{bc}	3.40 ^{bc}	3.51 ^b	3.52 ^b
5	3.59 ^c	3.53 ^{cd}	3.39 ^{cb}	3.27 ^c	3.45 ^c
GTE (L/100 kg diet)					
0.5	3.66 ^{bc}	3.49 ^{cd}	3.39 ^{bc}	3.30 ^c	3.46 ^{bc}
1.5	3.60 ^c	3.51 ^{cd}	3.34 ^c	3.26 ^{cd}	3.43 ^c
2.5	3.54 ^c	3.44 ^d	3.22 ^d	3.13 ^d	3.33 ^d
SEM	±0.028	±0.038	±0.063	±0.071	±0.047
P value	0.003	□ .0001	□ .0001	□ .0001	□ .0001

a, b ...= Means on the same column differently superscripted are significantly different ($P \leq 0.05$).

SEM = Standard error of means

Table (11) Effect of experimental treatments on egg content of Coliform group (log10) During storage time

Treatments	Storage time				
	Zero time	5 days	10 days	12 days	Average
Control	2.55 ^a	2.64 ^a	2.82 ^a	2.81 ^a	2.71 ^a
GTL (kg/100 kg diet)					
1	2.40 ^b	2.20 ^{bcd}	2.19 ^{bc}	1.89 ^{cd}	2.17 ^{cd}
3	2.39 ^b	2.30 ^b	2.24 ^b	2.51 ^b	2.36 ^b
5	2.34 ^{cb}	2.30 ^b	2.14 ^c	1.80 ^d	2.15 ^{cd}
GTE (L/100 kg diet)					
0.5	2.34 ^{cb}	2.26 ^{cb}	2.12 ^{cd}	2.02 ^c	2.19 ^c
1.5	2.27 ^{cb}	2.12 ^d	2.05 ^d	1.90 ^{cd}	2.09 ^d
2.5	2.24 ^c	2.15 ^{cd}	2.05 ^d	1.92 ^{cd}	2.09 ^d
SEM	±0.025	±0.038	±0.056	±0.081	±0.047
P value	0.005	□ .0001	□ .0001	□ .0001	□ .0001

a, b= Means on the same column differently superscripted are significantly different ($P \leq 0.05$).

SEM = Standard error of means

Table (12) Effect of experimental treatments on egg yolk malonaldehyde (mg/kg yolk) During storage time

Treatments	Storage time				
	Zero time	5 days	10 days	12 days	Average
Control	0.502	0.554 ^a	0.638 ^a	0.703 ^a	0.599 ^a
GTL (kg/100 kg diet)					
1	0.492	0.522 ^b	0.521 ^b	0.703 ^a	0.560 ^b
3	0.498	0.513 ^b	0.538 ^b	0.692 ^a	0.560 ^b
5	0.494	0.509 ^b	0.524 ^b	0.691 ^a	0.554 ^b
GTE (L/100 kg diet)					
0.5	0.500	0.513 ^b	0.531 ^b	0.615 ^b	0.540 ^c
1.5	0.496	0.532 ^b	0.561 ^b	0.631 ^b	0.555 ^b
2.5	0.493	0.521 ^b	0.552 ^b	0.620 ^b	0.547 ^{bc}
SEM	±0.001	±0.004	±0.010	±0.009	±0.004
P value	0.08	0.0098	0.0008	□ .0001	□ .0001

a, b= Means on the same column differently superscripted are significantly different ($P \leq 0.05$).

SEM = Standard error of means

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الملخص العربي

تأثير إضافة الشاي الاخضر ومستخلصه المائي كمضادات أكسدة طبيعية الي علائق الدجاج البياض على الاداء الانتاجي والتناسلي و جودة تخزين البيضة و محتواها من الكولستيرول

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يهدف هذا البحث الى دراسة تأثير إضافة الشاي الاخضر ومستخلصه المائي كمضادات اكسدة طبيعية في عليقة الدجاج البياض على الاداء الانتاجي والتناسلي و كذلك تخزين البيضة و محتواها من الكولستيرول.

في هذه الدراسة تم استخدام عدد 168 دجاجة بياضة و 21 ديك عمر 34 أسبوع من سلالة انشاص المحلى والتي وزعت عشوائيا الى 7 مجاميع غذيت على علائق التجربة التي احتوت على 3 مستويات من الشاي الاخضر (1، 3، 5%) مقارنة بمستخلصاتها المائية (0.5، 1.5، 2.5 لتر /100 كجم عليقة) علي التوالي بالاضافة الي عليقة الكنترول دون اضافات.

اوضحت نتائج هذه الدراسة أن اضافة اوراق الشاي الاخضر بمستويات من 1 – 5% أو 0.5 – 2.5 لتر /100 كجم عليقة من المستخلص المائي للشاي الاخضر الي علائق دجاج انشاص البياض حسنت الاداء الانتاجي و لم يكن هناك فروق معنوية بين مستويات الشاي الاخضر أو المستخلص علي الانتاج. و قد أوضحت النتائج أن اضافة 1% شاي اخضر ادت الي تحسن بمقدار 5.59% لانتاج البيض، 6.79% لكتلة البيض، 7.84% معدل التحويل الغذائي مقارنة بالكنترول علي التوالي. بينما المستوي المقابل من المستخلص المائي للشاي ادي الي تحسن بمقدار 6.78% لانتاج البيض، 7.46% لكتلة البيض، 8.65% لمعدل التحويل الغذائي علي التوالي. و لم يكن للمعاملات اي تأثير ضار علي وزن الجسم. و تطلب التحسين المعنوي لكل من مقاييس جودة البيضة الخارجية و الداخلية من 3-5% اوراق شاي أخضر أو 1.5-2.5 لتر /100 كجم عليقة مستخلص. حيث أن اضافة 3% اوراق شاي أو المستوي المقابل من المستخلص (1.5 لتر /100 كجم عليقة) أدت الي تحسن في سمك القشرة بمقدار 6.88% مقارنة بالكنترول. و لم يكن للمعاملات تأثير معنوي علي لون الصفار و لكن كان هناك زيادة تدريجية في لون الصفار بزيادة مستوي اضافة اوراق الشاي. اضافة 3 و 5% من اوراق الشاي أو المستوي المقابل من المستخلص المائي (1.5 و 2.5 لتر /100 كجم عليقة) حسنت الاداء التناسلي لكل من الاناث و الذكور. فقد كان التحسين في نسبة الفقس من البيض المخصب مقارنة بالكنترول بمقدار 6.11%

نتيجة اضافة 3% أوراق شاي في حين كان التحسن بمقدار 5.03% في حالة اضافة المستوي المقابل من المستخلص (1.5 لتر / 100 كجم عليقة). اضافة المستخلص المائي للشاي ادت الي انخفاض معنوي في TBARS لبلازما السائل المنوي و بالتالي المحافظة علي الحيوانات المنوية من الاكسدة. اضافة 3% أوراق شاي مقارنة بالكنترول ادت الي تحسين بمقدار 11.16% في تركيز الحيوانات المنوي و 20.87% في خفض نسبة الحيوانات المنوية الميتة في حين ادي المستوي المقابل من المستخلص (1.5 لتر / 100 كجم عليقة) الي 23.51% و 12.07% علي التوالي. لم يكن للمعاملات تأثير معنوي علي معاملات الهضم. كما ان اضافة 3 و 5% أوراق شاي أو اي من مستويات المستخلص المائي الي علائق الدجاج البياض أدت الي خفض معنوي لمستوي كل من الكولستيرول الكلي و الدهون الكلية بالدم، و تطلب زيادة (HDL) زيادة معنوية مقارنة بالكنترول 1.5 لتر / 100 كجم عليقة مستخلص مائي علي الاقل. و لم يكن هناك تأثيرات ضارة علي وظائف كل من الكبد و الكلي. أوراق الشاي الاخضر و المستخلص المائي لها بكل المستويات المختبرة ادت الي خفض معنوي في كل من الكولستيرول الكلي لصفار البيض و (LDL) و الدهون الكلية و الجليسيريدات الثلاثية مقارنة بالكنترول، بينما 5% أوراق شاي أخضر أو 1.5 لتر / 100 كجم عليقة مستخلص أدت الي رفع مستوي HDL في صفار البيضة . اضافة كل من أوراق الشاي الاخضر أو المستخلص المائي بجميع المستويات المختبرة أدت الي خفض في درجة الحموضة pH و المحتوي البكتيري الكلي للبيضة و المألونالدهيد مقارنة بالكنترول و بالتالي ادي الي جودة افضل للبيض أثناء فترة التخزين (1-10 أيام) علي درجة حرارة (20-23° س) و رطوبة نسبية 60%. نستنتج من هذه الدراسة أن اضافة أوراق الشاي الاخضر بمستوي 1-3% أو المستخلص المائي بمستوي 0.5-1.5 لتر / 100 كجم عليقة يمكن ان يؤدي الي خفض في محتوي صفار البيضة من الكولستيرول و TBA مما يؤدي الي تحسين جودة البيضة خاصة اثناء فترة التخزين بالاضافة الي تحسين كل من الاداء الانتاجي و التناسلي لاناث و ذكور الدجاج.