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EFFECT OF DIFFERENT LEVELS OF THYME LEAVES POWDER ON PRODUCTIVE AND PHYSIOLOGICAL PERFORMANCE OF GROWING JAPANESE QUAI

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ABSTRACT: This study assessed the effects of using different levels of thyme leaves powder (TLP) supplemented in growing quails birds diets on productive performance, blood indices, carcass characteristics, antioxidant capacity, digestive enzymes, immunity, quality of quail meat and economic efficiency. A total number of 192, unsexed birds (9-day-old) were allocated into four treatments, each treatment contain six replicates of eight birds each. Birds fed a basal diet containing 24% CP with2900 Kcal M.E./ kg diet, a basal diet with 0.5%TLP; a basal diet with 1.0%TLP; a basal diet with 1.5%TLP; as control group T1, T2, T3 and T4; respectively. Results showed that TLP-diets exhibited significantly improvement in live body weight (LBW), body weight gain (BWG), growth rate (GR) and feed conversion ratio (FCR) values, without a change in feed intake (FI).As well as, there was an increased significantly in digestive enzymes (trypsin, amylase and lipase) and thyroid hormones (T3 and T4) activities, carcass and dressing percentages, antioxidant capacity (T-AOC and GSH-PX) and immune response. The treated groups enhanced the protein profile (T-protein and: Globulin (glob.), with no significant in Albumin (Alb). was found. While, significant decrease was recorded in T- cholesterol (T-chol.), triglycerides (TG) and low-density lipoprotein (LDL) values. Moreover, overall acceptability of quail meat and economic efficiency were improved with TLP diets. In the current study suggests that thyme leaves powder can be used as a feed supplement to improve the growth performance; some carcass traits and blood constituents; enhancing immune-antioxidant status; as well as the highest values of economic efficiency of growing Japanese quail.

Keywords: thyme, quail, performance, blood indices, antioxidant, immunity, and economic efficiency.

INTRODUCTION

Herbal substances and their products are utilized in poultry nutrition to substitute synthetic alternatives with the aim of enhancing the efficient utilization of feed nutrients, consequently leading to increased growth rates and enhanced feed efficacy (Hussain et al., 2021). Furthermore, the bioactive constituents present in herbs or medicinal plants have the potential to enhance digestion and boost immune responses in broiler chickens (Soltaninejad et al., 2022). These bioactive compounds play a crucial role in influencing the productivity and health of poultry primarily through the stabilization of the normal gut microbiota, prevention of pathogen colonization (Tekeli et al., 2006), as well as the enhancement of production and activity of digestive enzymes (Lee, 2005). Thyme (Thymus Vulgaris L.) stands out as a prominent medicinal plant categorized under the Lamiaceae family (Masada, 1976). It has been noted that carvacrol (5-isopropyl-2-methyl phenol) and thymol (5-methyl-1-2-isopropyl phenol) are the key phenolic components present in Thymus Vulgaris, constituting approximately 20-25% of thyme oil extracts. Numerous studies have highlighted the diverse biological activities of thyme, such as its antifungal properties (Soliman and Badeaa, 2002), antibacterial effects (Essawi and Srour, 2000; Dob et al., 2006), and antioxidant capabilities (Tepe et al., 2005). Positive outcomes have been observed from feeding diets containing thyme in terms of growth performance in quail (Tiihonen et al., 2010; Raya et al., 2014) and broiler chickens (Ocak, et al., 2008; Toghyani et al., 2010). Alallawee et al., (2020) deduced that the inclusion of thyme in diets may enhance quail growth and serve as a natural source of antioxidants. Additionally, Maulod et al., (2022) pointed out that supplementing diets with 1% thyme powder can improve growth performance, carcass characteristics, and blood lipid profiles in Japanese quail. Early findings by Genedy and Zewil (2003) demonstrated an enhancement in feed conversion ratio (FCR) in growing Japanese quail when fed a diet containing thyme flowers. The improvement in FCR observed in quail consuming thyme may be attributed to increased body weight gain (BWG) and enhanced nutrient digestibility without impacting feed intake (Raya et al., 2014). The Japanese quail, being the smallest avian species raised for meat and egg production, holds global significance not only as a research bird but also as a source of meat and eggs. Thus, the primary aim of this research was to assess the impact of supplementing growing Japanese quail with thyme leaf powder on their productive and physiological performance.

MATERIALS AND METHODS

The research on live animals adhered to the guidelines approved by Egypt's Organizational Animal Welfare and Use Committee (Code No. of the research proposal: AEC 2349).

A total number of 192 quail chicks (nine days old) were randomly divided into four groups with six replicates of 8 birds each. Where, per cage of batteries 8 birds were reared until 37 days of age. All birds were fed and watered and same conditions; humidity, lighting, ventilation and temperature were applied. All birds were fed TLP from 9 days until slaughter (37 days of age). The first group (control group) fed diet contain 24%CP with 2900 Kcal. ME /kg diet as recommended by NRC, (1994). The second, third and fourth groups received TLP as 0.5, 1.0, and 1.5%; respectively. The composition of the experiment diets is presented in Table (1). BW, BWG, GR, FI and FCR were determined. At the end of the study (37 days), the defeathered carcass was weight and the different internal organs (gizzard, liver, heart, and gut) were recorded. Carcass and dressing percentages were determined. The absolute weights of lymphoid organs; bursa and spleen (immune organs) were also determined. During slaughtering, all tubes of blood were centrifuged 3000 rpm for 15 minutes. Serum total protein, albumin, glucose were determined according to commercial reagent kits protocols. Serum globulin concentration was calculated. Lipid profile including total cholesterol (Chol.), high-density lipoprotein (HDL), low-density lipoprotein (LDL) ,and Triglycerides (TG) were determined by James (2001).Glutathione peroxidase (GSH-PX) and total antioxidant capacity (T-AOC) were determined by Paglia and Valentine (1967). Digestive enzymes (amylase and lipase) were determined by Junge et al., (2001) and trypsin was determined according to Bovine Trypsin ELISA kit MBS706461. , Thyroid hormones; Triiodothyronine (T3) and thyroxin (T4) levels were analyzed by the ELISA technique using commercial kit. Quality of quail meat and economic efficiency were also determined

according to Ragab,(2007) depending upon the local market prices during the experimental time . The recorded data were analyzed by using the Statistics tool analysis of variance by using Infostat Program (Di Rienzo, 2017), and to compare statistical differences between means were also estimated by Duncan, (1955).

RESULTS AND DISCUSSION

Chemical composition of thyme leaves powder:

The data displayed in Table (2) illustrates that TLP includes (air-dried, %) 8.5, 19.8, 6.8, 20.9, 16.3, and 27.7 for moisture, CP, EE, CF, ash, and NFE; respectively. It is evident that the CF content in TLP is relatively high (20.9%), potentially acting as a constraining factor for its incorporation in poultry diets. Moreover, the calorie content in TLP is notably low (27.71%, NFE). Existing literature indicates a considerable variability in the chemical composition of thyme. Turcu et al., (2020) documented CP and CF values of 14.67% and 24.63% for thyme, respectively. Additionally, the overall chemical composition of thyme (all plant) is reported as 91.65, 15.38, 2.09, 17.08, and 9.43% for DM, CP, EE, CF, and ash %; respectively (Vlaicu et al., 2022).

Growth performance:

As shown in Table (3), the values of BW, BWG, FCR and GR were significantly affected by TLP treatments However; the experimental diets did not affect FI values. Meanwhile quails fed diet with 0.5% TLP powder achieved the best BW (229.27g), BWG (175.79g), improved FCR (3.36) and GR (123.77). The findings align with Maulod et al., (2022) who suggested that incorporating 1% thyme powder in the diet could effectively enhance growth performance in Japanese quail. The enhanced BWG and FCR observed in thyme-supplemented groups may be attributed to the antioxidants and phenolic substances present in thyme, which have the potential to reduce harmful bacteria populations in the gastrointestinal tract and enhance the absorption of amino acids (Hernandez et al., 2004). Vlaicu et al., (2023) noted the presence of active substances like thymol in thyme, which enhance digestive enzyme activity, thereby improving FCR and overall performance in poultry .Previous research by Raya et al., (2014) indicated that the improved FCR in quail fed thyme-containing diets could be linked to enhanced BWG and improved nutrient digestibility. El-Ghousein and Al-Beitawi (2009) also reported a positive impact of thyme-containing diets on the growth performance of quail, possibly due to thyme's antibacterial properties. Conversely, several studies, including Lovkova et al., 2001; Williams and Losa, 2001; Cross et al., 2007; and Adam et al., 2020, found no significant influence of thyme on broiler performance. In quails, Eidrisha et al., (2022) demonstrated that birds fed with 5g/kg achillea powder had significantly higher LBW compared to those fed 5 and 10g thyme/diet. Our results indicate a nonsignificant increase in FI induced by TLP-diets, consistent with the findings of Lee et al., (2003), who reported that 200ppm thymol in the diet did not impact the FI of female broilers. Additionally, Fallah and Mirzaei (2016) showed that using 5g/kg thyme powder in the diet did not affect the FI of broilers compared to the control group. Conversely, Ragaa et al., (2016) observed a significant decrease in FI in groups treated with thyme, formic acid, and thyme plus formic acid compared to the control group, while these experimental groups exhibited a significant increase in BWG.

Digestive organs:

In the current study, there were significant increased in the values of digestive system (g), liver(g), gizzard (g), stomach (g) and small intestine weight (g) respecting to TLP dietary supplemented groups compared to the control group. While, there were no significant differences in the values of small intestine length (cm), cecum length (cm) and weights (g) compared to the control group (Table 4). The results also revealed that the treatment with 1.5%. TLP achieved the highest values of liver (6.68%), gizzard (5.79g), Stomach (1.76g), small intestine length (78.26 cm), small intestine weight (6.04g), cecum Length (11.61 cm) and weight (3.0lg). The obtained results are in agreement with that reported by Sadeghi et al, (2012) who found that thyme and turmeric increased small intestine relative weight. In

contrast with the findings of the present study, Ocak et al., (2008) reported that no changes were detected in the gut at relative weights of broiler fed with 0-2% thyme leaves. Also, some previous studies showed that gizzard relative weight was not affected by turmeric herb or cinnamon essential oil (Hernandez et al., 2004; Durrani et al, 2006; Sadeghi et al., 2012).

Carcass traits:

As display in Table (5), slaughter traits (front and rear weights (g), carcass and dressing weights (g) and abdominal fat (g) weight were significantly affected by treatments. While there were insignificant difference among quails groups fed different dietary TLP levels for giblet weight, g (Table 5). Data indicated that dietary TLP treatments significantly caused an improvement on carcass and dressing percentages, compared to the control group. While, abdominal fat weight significantly decreased as TLP groups increased, and 1.5% TLP group achieved the lowest one (0.68g). As shown in Table (5) diets containing TLP increased significantly bursa and spleen (immunological parameters), and the highest values were in birds fed 1.5% TLP. Results indicated that supplementing the quail's diet with TLP resulted in significant improvement in carcass and dressing percentages. While, abdominal fat weight significantly decreased as dietary TLP level increased. Meanwhile, giblets weight and percentage had no significant effect. The present findings in the same line with Maulod et al., (2022) who showed that 1% thyme powder containing diets can be used as an improving significantly carcass characteristics in Japanese quail. Besides, Kalantar et al., (2017) who noticed significantly improvements in dressing weight of broiler chickens when fed thyme powder. Also, Khaksar et al., (2012) discovered that Japanese quail fed with thyme essential oil had greater carcass and breast percentages. While, Ocak et al., (2008) found no impact of feeding thyme leaves on carcass weights and edible organs weights of broiler chicks, but there was increased significantly the abdominal fat pad at 42 days of age. In a similar vein, Dahal and Farran (2011) found that feeding broiler chicks a diet containing thyme had no effect on the carcass. Neither thyme powder nor essential oil changed the relative weight of the pancreas, liver, or heart (Hernandez et al., 2004; Sarica et al., 2005; Basmacioglu et al., 2010). Furthermore, thyme powder fed to broiler chicks at 2.5 and 5 g/kg did not significantly affect dressing, gizzard, or liver percentages when compared to the control group, as demonstrated by Adam et al., (2020). Furthermore, Eidrisha et al., (2022), the addition of ashillea and thyme powder to the diet did not significantly alter the weights of the preslaughter, carcass, gizzard, liver, legs, head, lung, and entire giblet when compared to the control.

Immune effects related lymphoid organs:

Data tabulated in Table (5) explained the effect of treatments on the absolute, weights of both bursa of Fabricius as a primary lymphoid organ and the spleen as a secondary lymphoid-organ. There was significant better effect of TLP dietary, supplementation on bursa and spleen weights compared to the control group. The abovementioned result was confirmed by the data with El-baz et al., (2022) who found an increase in the relative weight of the bursa in broiler chickens fed diet with clove essential oils, where the relative weight of spleen and thymus were not affected with the experimental treatments. Also, Hanieh et al.,(2010) illustrated that essential oil supplementation in White Leghorn chickens increased the relative weights of the immune organs.

Blood parameters:

For serum biochemical indices, there were significant increase in total protein (TP) and globulin (Glo) due to TLP dietary supplementation treatments compared to control groups; meanwhile, significant decrease in glucose values was found. On the other hand, treatments did not significantly affect albumin values Alb (Table 6). The serum protein profile is commonly acknowledged to serve as an indicator of the overall health and nutritional status of an individual. Albumin assumes a crucial function in fat metabolism through its ability to bind with fatty acids, there by ensuring their solubility in plasma (Tothova et

al., 2016). Conversely, globulin primarily comprises immunoglobulins that are generated by the immune system (Eckersall, 2008). The findings of the current investigation are consistent with those of Al-Ghousein and Al-Beitawi (2009), who demonstrated that incorporating thyme (0.5, 1.0, 1.5, and 2%) into the basal diets of broiler chickens led to a significant increase in serum levels of total protein (TP) and globulin (Glo). Conversely, Elnagger and El-Tahawy (2018) observed a significant reduction in glucose concentration when broilers were fed diets containing sweet basil, thyme, and their respective oils. Moreover, Kheiri et al., (2018) highlighted that quail birds fed a diet supplemented with 2g of thyme plant/kg exhibited a significant elevation in serum TP and albumin (Alb) levels compared to the control group. Furthermore, Toson et al., (2023) demonstrated that administering licorice extract to broiler chicks resulted in increased plasma concentrations of TP and Alb, along with decreased levels of cholesterol, triglycerides (TG), and uric acid. Conversely, Eidrisha et al., (2022) found that dietary intake of thyme, achillea plant, and their combination did not elicit a significant impact on TP, Alb, Glo, and the Alb/Glo ratio in comparison to the control group. Similarly, Tayeb et al., (2019) observed no significant variations in serum TP and Glo levels among broiler chicks fed diets containing 5 or 10g of thyme powder/kg in comparison to the control group. The current investigation demonstrated in Table (6) indicates that the inclusion of TLP had a significant impact on the lipid profile, leading to a positive influence on serum lipid levels by elevating HDL and reducing total cholesterol, triglycerides, and LDL concentrations. Previous research by Moustafa et al. (2020) revealed a notable decrease in serum triglycerides in broiler chicks consuming a diet containing 100 mg of thyme essential oil per kilogram compared to the control group. Similarly, Aldik et al. (2020) observed a significant reduction in serum LDL levels in birds fed with thyme leaves at either 4 or 6g per kilogram of diet compared to the control. Moreover, avian subjects receiving 10g of thyme and 10g/kg of achillea exhibited substantially lower LDL levels than the control group. Recent findings by Maulod et al. (2022) indicated a significant decrease in cholesterol, triglycerides, and LDL levels with dietary thyme interventions, while HDL levels increased significantly. Furthermore, Eidrisha et al., (2022) reported that quails provided with 10g of thyme per kilogram of diet, 5g of achillea leaves powder, and the combination exhibited a significant decrease in total cholesterol values. Conversely, Toghyani et al., (2010) noted that broiler chicks fed diets containing 5 and 10g of thyme powder per kilogram had no discernible impact on total blood cholesterol levels compared to the control group. Additionally, Najafi and Torki (2020) found no significant alterations in triglyceride levels in broiler chickens fed with thyme essential oil at a concentration of 200 mg per kilogram compared to the control group. Moreover, Toghyani et al., (2010) reported that broiler chicks consuming 5 or 10g of thyme powder per kilogram of diet did not exhibit any effects on serum triglycerides. In contrast, the inclusion of 2g of thyme per kilogram of feed in quail birds did not result in any changes in triglyceride levels (Kheiri et al., 2018).

Digestive enzymes, antioxidant parameters and thyroid hormones:

Data in Table 6 showed that quails fed diets with 1.0 and 1.5% TLP showed significantly the best values for trypsin (121.20; 123.52 u\l), amylase (589.67; 604.17 u\l) and lipase (96.27; 98.93 u\l) compared to 0.5% TLP group (113.37 u\l, Trypsin; 542.48 u\l Amylase; 89.38 u\l, Lipase). While, control treatment recorded the lowest ones for trypsin, amylase and lipase, respectively being, 99.29, 517.55, and 73.06 u\l respectively**.** With respect, antioxidant parameters, diets with TLP enhanced significantly T-AOC and GSH-PX values as compared to the control treatment, and the group treated by 1.5% TLP achieved the best values of T-AOC and GSH-PX; being 1.39 and 1363.30 ugg, respectively. Table (6) shows the effect of TLP on serum Triiodothyronine (T3) and Thyroxin (T4). The birds fed diets with TLP have significantly higher concentration of

T3 and T4 compared to the control group. Indicating that TLP as a natural antioxidant, enhance the concentration of thyroid hormones, reflecting positively affect of metabolism. Regarding digestive enzymes, our results are similarly with Hashemipour et al., (2013)who exhibited that dietary with an equal mixture of carvacrol and thymol (active components in thyme essential oil) in 4 dosages (0, 60, 100 and 200 mg/kg) in broiler diets linearly increased activities of trypsin, lipase and protease in the pancreas and intestinal. In the same line,, Abd El-Wahab et al.,(2022) reported that quail chicks fed diet with 200ppm marigold flower extract (MFEX) had significantly higher lipase compared to the control and 0.6% marigold flower powder (MFP). While, 250 ppm MFEX group recorded the highest trypsin level. Recently Aly et al., (2023a) stated that quail chicks fed a diet with 27 ppm L-menthol crystal (LMC) and 2.5% peppermint leaves powder (PLP) have significantly higher trypsin and amylase levels compared with the control groups, without any significant different in lipase levels in all treated groups. With laying quail, Aly et al., (2023b) stated that the group fed diets with 2.0PLP%, followed by27 ppm LMC and 2.5%PLP showed significantly higher trypsin compared with the control diet. Regarding antioxidant capacity, our results in the same line with those previously reported by Lin et al., (2003) who found that feeding chickens on diets with herbs extracts resulted in an increasing in the activity of antioxidant enzymes (GSH-PX and SOD) and a depression in MAD level. Recently Toson et al ., (2023) indicated that broiler's diets with licorice extract led to higher value of antioxidant concentration, and highest value of T-AOC capacity has been observed in the chicks fed 3g licorice extract. All antioxidant indices (T-AOC, GSH-Px and TBAR) were significantly improved by PLP and LMC treatments, in growing quail (Aly et al., 2023a) and laying quail (Aly et al., 2023 b). According to Bolukbasi et al., (2006) explained that carvacrol and thymol may be responsible for the antioxidant effect of thyme oil. They added that thyme oil (200 mg/kg diet) resulted in a significant reduction in TBARS (thiobabituric acid reactive species). Abd El-Wahab et al., (2022) stated that calendula flowers involve polyphenol compounds and beta carotene, which have antioxidant effects on enhancement of oxidation enzymes (TBARS, T-AOC and GSH-Px). With respect of thyroid hormones, our results showed that quail chicks fed 1.5% TLP recorded significantly higher T3 (38.87 ng\ml) and T4 (3.08 ug\dl) compared to the control groups and other treatments. Meanwhile, T3 and T4 values significantly as the levels of TLP increased. Similarly, Alallawee et al.,(2020) demonstrated that broiler chicks fed diet with 200 mg mint leaves powder /kg diet had highly affected plasma T3 and T4 level. Quail diets with varying levels of PLP and LMC enhanced thyroid hormone activity (T3 and T4) as reported by Aly et al., (2023a) in growing quail, the same results were found in laying quail Aly et al., (2023b).

Quality of quail meat:

The impacts of dietary TLP supplemented diets on the sensory evaluation for the quail's meat are illustrated in Table (7). Data for subjective evaluation of quail meat due to TLP experimental diets indicated that the color, flavor, texture, appearance and overall acceptability scores were not significant. While, taste recorded significantly higher value with TLP diets compared to the control group. In the present study there are numerical increases of color, appearance and overall acceptability due to the increasing TLP levels compared to the control group, where, flavor and texture, recorded higher values with1.0 and 1.5 %TLP compared to 0.5%TLP and the control group. The potential effect of herbal plants from the *Labiatae* family contain phenolic compounds on improving the oxidative stability of poultry meat was previously investigated (Kilany et al., 2018; Ahmadian et al., 2020; Valicu et al.,2021) .It was also reported that thymol reduced the oxidation of fatty acids indicating by the lowest malondialdehyde level in meat (Placha et al., 2014). Also, the addition of 0.5% thyme powder to broiler for 35 days improved the antioxidant activities in meat by reducing

the lipid peroxidation of meat (Ahmadian et al., 2020). Gheisar et al., (2015) reported that the TBARS value of breast meat was significantly reduced by the herbal plant blond containing thyme, oregano and rosemary. Additionally, Vlaicu et al.,(2022) showed that herbal plants (basil, thyme and sage) as natural sources of additives could be effective in improving broiler thigh meat quality, due to a positive effect on antioxidant compounds and lipid quality of meat. In this regard, Yule and McBride, (1976) found that feeding greater than 5% rapeseed meal could produce off-flavors in chicken meat. Also, Steedman et al., (1979) indicated that feeding rapeseed meal (15% rapeseed+ 5% herring meal+ 1 % DL methionine +.05% choline chloride) causing significantly lower scores for the color, flavor and over all acceptability than scores for other treatments. Recently, Elbaz et al. (2023) found that broiler diets supplemented with oils (soy oil, corn oil, olive oil and fish oil) positively affected meat quality by enhancing color measurements, while the best was in birds fed olive oil. Similarly, Ayed et al., (2015) found significant difference in color measurement of broiler chicken meat fed on diets supplements with different oils.

Economic Efficiency (EEF):

As shown in Table (8), quails fed diets with 0.5%. TLP achieved the highest EEF (145.831%) followed by 1.0% TLP (125.00%), and 108.33%. for group with 1.5% TLP. While, the worst one was recorded for the control group (100%). It can be noted that 0.5%TLP was the best diet regarding the economic point of view, and this result supported by the best growth performance for quail fed 0.5%. TLP. In the early results reported by Genedy and Zewil (2003) who observed an improvement in FCR of growing Japanese quail due to feeding thyme Flowers containing diet .In this regard, El nagar and El-Tahawy (2018) indicated that the economic efficiency improved when broiler fed diet with sweet basil, thyme and their oils. Similarly, El-Kashef et al., (2017 a&b) and Hussian et al.,(2021) found that the higher economic efficiency was in quail and broiler chicks fed medicinal plants compared the control group. The highest EEF value was recorded for quail chicks fed diet with5g of achillea plant/kg diet (Eidrisha et al .,2022). Similarly, (Aly et al., 2023 a&b) stated that the highest EEF recorded quail with 27ppm LMC group (165%) in quail chicks. While, the best value was 161%for laying quail fed diet with 1.5% PLP.

CONCLUSION

It can be concluded that 0.5% TLP was the best diet regarding the economical point of view and this result supported by the best growth performance for quail fed, also 0.5%. TLP.

Table (1): Composition and analysis of experimental diets containing thyme leaves powder (TLP) in growing Japanese quail.

Ingredients	**Control**	**0.5%TLP**	**1% TLP**	**1.5% TLP**
Yellow corn	50.00	50.00	50.00	50.00
Soybean meal (44 %)	41.00	41.00	41.00	41.00
Wheat, bran	2.00	1.50	1.00	0.50
Vegetable oil	2.50	2.50	2.50	2.50
L-Lysine	0.15	0.15	0.15	0.15
DL-methionine	0.25	0.25	0.25	0.25
Lime-stone	2.00	2.00	2.00	2.00
Bone meal	1.50	1.50	1.50	1.50
Salt (NaCl)	0.30	0.30	0.30	0.30
Thyme leaves powder (19.8)	0.00	0.50	1.00	1.50
Premix, poultry*	0.30	0.30	0.30	0.30
Total	100	100	100	100
Cost \ 100 Kg(L.E.)**	2745.3	2759.7	2774.0	2788.4
Calculated Analysis* **				
DM %	85.247	85.2593	85.2715	85.2838
CP %	23.70	23.73	23.75	23.77
ME, Kcal/kg diet	2882	2876	2869	2863
Ca %	1.31	1.31	1.31	1.31
P non- phytate %	0.33	0.33	0.33	0.33
EE %	4.80	4.82	4.84	4.86
CF %	3.55	3.60	3.65	3.70
Lysine %	1.47	1.47	1.47	1.46
Methionine %	0.61	0.61	0.61	0.61
Met+cys %	1.01	1.00	1.00	1.00

*Each 3.0 kg of premix supplies one ton of the diet with: Vit. A,12000000I.U; Vit.E, 10g; *Vit. D3, 2500000 I.U; Vit. K3,2.5g; Vit.B1,1g;Vit.B2,5g;Vit.B6,1.5g; Vit.B12,10g; Biotin50mg; Folic acid,1g; Nicotinic acid,30g; Capantothenate,10g; Zn,55g; Cu,10g; Fe,35g;Co,250mg;Se, 150mg; I,1g; Mn,60g; and antioxidant,10g.

** According to the local market prices of 2023.

***According to NRC, 1994.

Table (2): proximate analysis of thyme leaves powder (TLP) on air – dry matter basis.

Components	**Percent (%)**
Moisture	8.5
Crude protein	19.8
Crude Fat	6.8
Crude Fiber	20.9
Ash	16.3
NFE	27.7

Table (3): Effect of dietary thyme leaves powder (TLP) on growth performance in growing Japanese quail.

Items / Treat.	Control	0.5% TLP	1% TLP	1.5% TLP	SE	P-value
Initial LBW(g)	52.39	53.48	52.99	52.99	0.53	0.55
LBW37d (g)	211.14^{c}	229.27^{a}	225.14^{ab}	219.98^{b}	2.69	0.0001
BWG 9-37(g)	158.77^{c}	175.79^{a}	171.82^{ab}	166.72^{b}	2.52	0.0001
FI 9-37 (g)	576.83	584.32	586.53	587.78	3.86	0.1886
FC 9-37 (g/g)	3.68^{a}	3.36^{c}	3.46^{ab}	3.56^{a}	0.056	0.0013
GR_{9-37}	120.28^{b}	123.77^{a}	123.24^{a}	121.92^{ab}	0.77	0.0128

Abbreviations: LBW: live body weight. BWG: body weight gain. FI: feed intake. FCR: feed conversion ratio. GR; growth rate, TLP: thyme leaves powder. [a-c] Means within the same row with different superscript are significantly different.

Table (4): Effect of dietary thyme leaves powder (TLP) on digestive organs in growing Japanese quail.

Items / Treat.	Control	0.5% TLP	1.0% TLP	1.5% TLP	SE	P-value
Digestive System (g)	23.70^{b}	27.53^{a}	29.73^{a}	30.16^{a}	0.88	0.0001
Liver(g)	4.95^{b}	6.10^{a}	6.37^{a}	6.68^{a}	0.35	0.0056
Gizzard(g)	4.02^{c}	4.65^{b}	5.23^{ab}	5.79^{a}	0.21	0.0001
Stomach(g)	1.24^{b}	1.40^{ab}	1.68^{a}	1.76^{a}	0.13	0.0232
Small intestine length (cm)	72.08	73.85	77.11	78.26	2.55	0.2999
Small intestine weight (g)	4.15^{c}	5.33^{b}	5.71^{ab}	6.04^{a}	0.2	0.0001
Cecum length (cm)	10.67	10.92	11.08	11.61	0.5	0.5968
Cecum weight (g)	2.12	2.6	2.74	3.01	0.46	0.577

SE: Standard Error. [a-c] Means within the same row with different superscript are significantly different.

Table (5): Effect of dietary thyme leaves powder (TLP) on carcass traits in growing Japanese quail.

Items	Control	0.5%TLP	1% TLP	1.5% TLP	SE	*P*-Value
Front (g).	89.58^{c}	105.03^{a}	100.74^{ab}	98.10^{b}	2.19	0.0006
Front (%).	42.07^{b}	45.93^{a}	44.87^{a}	44.42^{a}	0.82	0.012
Rear (g).	49.56^{b}	54.21^{a}	55.34^{a}	53.44^{a}	1.18	0.014
Rear (%).	23.28	23.7	24.68	24.07	0.61	0.36
Carcass (g).	139.78^{b}	159.18^{a}	159.18^{a}	151.99^{a}	2.74	0.0003
Carcass (%).	65.64^{b}	69.61^{a}	69.89^{a}	68.60^{a}	1.02	0.018
Giblets (g).	12.05	11.75	10.09	9.93	0.94	0.28
Giblets (%).	5.62	5.12	4.49	4.3	0.42	0.11
Dressing (g).	151.83^{b}	170.93^{a}	166.93^{a}	161.92^{a}	2.96	0.0012
Dressing (%).	71.26^{a}	74.73^{a}	74.38^{a}	72.90^{ab}	0.92	0.034
Abdominal Fat (g).	1.22^{a}	0.96^{ab}	0.84^{b}	0.68^{c}	0.1	0.0031
Bursa (g).	0.16^{b}	0.26^{a}	0.27^{a}	0.29^{a}	0.02	<0.0001
Spleen (g).	0.15^{c}	0.19^{b}	0.21^{b}	0.24^{a}	0.01	<0.0001

[a-e]: Means within the same row with different superscript are significantly different**.** SE: Standard Error, Treat. Treatment.

Table (6): Effect of dietary thyme leaves powder (TLP) on blood biochemical parameters in growing Japanese quail.

Items / Treat.		Control	0.5% TLP	1.0% TLP	1.5% TLP	SE	P-value
Glucose and Protein Profile	Glucose (mg\ld)	145.50 ^{a}	133.67 ^{b}	120.50 ^{bc}	110.50^{c}	7.54	0.0118
	T.P (g\ld)	3.91^{b}	5.34^{a}	5.46^{a}	5.68^{a}	0.58	0.1438
	ALb(g\ld)	1.8	1.77	1.67	1.69	0.07	0.5206
	Glo (g\ld)	2.11^{b}	3.57^{ab}	3.79^{ab}	3.99^{a}	0.57	0.0982
Lipids Profile	Chol (mg\ld)	182.17 ^{a}	162.33 ^{b}	159.00 ^{b}	157.33^{b}	7.09	0.0617
	TG (mg\ld)	144.17 ^{a}	128.83 ^{b}	122.50 ^{b}	117.83^{b}	6.52	0.0363
	HDL (mg\ld)	68.05^{c}	76.58^{b}	86.48 ^{a}	89.98^{a}	1.98	0.0001
	LDL (mg\ld)	100.68 ^{a}	91.07 ^{b}	78.10 ^{c}	74.50 ^{c}	5.75	0.0086
Digestive Enzymes	Trypsin (u\l)	99.29 ^{c}	113.37 ^{b}	121.20 ^{a}	123.52 ^{a}	2.38	0.0001
	Amylase(u\l)	517.55^{c}	542.48^{b}	589.67 ^{a}	604.17 ^{a}	21.22	0.0202
	Lipase (u\l)	73.08 ^{c}	89.97 ^{b}	96.27 ^{a}	98.93 ^{a}	2.02	0.0001
Antioxidant Parameters	TAOC (µgg)	0.78 ^{c}	0.93 ^{b}	1.26 ^{a}	1.39 ^{a}	0.12	0.0021
	GSH-PX (µgg)	1259.5^{c}	1295^{b}	1359.43^{a}	1363.3^{a}	34.44	0.1056
Thyroid Hormone	T3(ng\ml)	31.77 ^{b}	31.77 ^{b}	38.23 ^{a}	38.87 ^{a}	1.15	0.0002
	T4 (ug\dl)	2.22 ^{c}	2.76 ^{b}	2.97 ^{ab}	3.08 ^{a}	0.09	0.0001

Abbreviations: : Chol: cholesterol, TG: triglycerides, T3: triiodothyronine; T4:thyroxine; TAC:total antioxidant capacity; HDL:high-density lipoprotein; LDL:low-density lipoprotein; GPX :glutathione peroxidase; Glo : Globulin ;T .P :Total protein ; Alb :Albumin., SE: Standard Error., a-c: Means within the same row with different superscript are significantly different.

Table (7): Effect of dietary thyme leaves powder (TLP) on quality of quail meat in growing Japanese quail.

Items / Treat.	Control	0.5% TLP	1.0% TLP	1.5% TLP	SE	P-value
Color	6.93	7.20	7.47	7.27	0.28	0.57
Taste	6.96 ^{b}	6.97 ^{b}	7.97 ^{a}	7.27 ^{ab}	0.28	0.033
Flavor	6.74	6.27	6.80	7.40	0.50	0.41
Texture	7.56	7.30	8.13	7.63	0.23	0.081
Appearance	7.37	7.47	7.80	7.20	0.24	0.30
Overall Acceptability	7.11	7.13	7.73	7.17	0.23	0.13

a-c: Means within the same row with different superscript are significantly different.

Table (8): Effect of dietary thyme leaves powder (TLP) on economic efficiency in growing Japanese quail.

Items / Treat.	Control	0.5%TLP	1% TLP	1.5% TLP
Av. Feed intake, Kg feed/ Kg LBW	3.68	3.36	3.46	3.56
Price Kg feed (L.E.) *b	27.45	27.60	27.74	27.88
Total feed cost C= (a×b)	101.02	92.74	95.98	99.25
Price / one Kg gain (d.E.) **	125.00	125.00	125.00	125.00
Net revenue (L.E) = d-c = e	23.98	32.26	29.02	25.75
Economic efficiency *** (e/c)	0.24	0.35	0.30	0.26
Relative efficiency ****	100.00	145.83	125.00	108.25

* Based on average price of diets during the experimental time. ** According to the local market price at the experimental time. *** Net revenue per unit feed cost. **** Assuming economic efficiency of control group equal 100.

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الملخص العربي

تأثير مستويات مختلفة من مسحوق أوراق الزعتر علي الأداء الإنتاجي والفسيولوجي للسمان الياباني النامي

سمية إبراهيم رجب ، محمود محمد محمد علي ، محمد سعد بهنس
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هدفت الدراسة إلي تقييم تأثير التغذية علي مسحوق أوراق الزعتر علي الأداء الإنتاجي ، صفات الذبيحة ، بعض مقاييس الدم ، معايير مضادات الأكسدة ، مؤشرات المناعة، تقييم صفات اللحم و الكفاءة الاقتصادية .استخدم عدد ١٩٢ طائر غير مجنس عمر ٩ أيام ،وزعت عشوائيا بالتساوي علي ٤ معاملات بكل معاملة ٦ مكررات بكل منها ٨ طيور ، الأولي كنترول ،(٢٤% بروتين ،٢٩٠٠كيلو كالوري طاقة ممثلة / كجم عليقة) ،طيور المعاملات الثانية ،الثالثة ، الرابعة غذيت على عليقة الكنترول مضاف إليها مسحوق أوراق الزعتر بمستويات ٠.٥ ، ١ ،١.٥% علي الترتيب . أظهرت النتائج أن إضافة مسحوق أوراق الزعتر أدى معنويا إلي تحسين وزن الجسم الحي ، صفات الذبيحة ،بعض صفات الدم ، قدرة مضادات الأكسدة ،المؤشرات المناعية،تحسين صفات اللحم ،وتعظيم الكفاءة الإقتصادية للسمان الياباني النامي. وتوصي هذه الدراسة بإمكانية استخدام مسحوق أوراق الزعتر كإضافة طبيعية في علائق السمان الياباني النامي لتحسين الأداء الإنتاجي،بعض صفات الذبيحة وقياسات الدم ،تحفيز الحالة المناعية ومضادات الأكسدة ،تحقيق أعلي قيمة للكفاءة الاقتصادية.