



## Effect of licorice extract on growth performance, meat yield and plasma analysis of Japanese quail (*Coturnix coturnix japonica*)

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### Abstract

This study was carried out to evaluate the effects of the addition of different concentrations of licorice extract (LE) in drinking water on the growth performance, carcass characteristic and some blood parameters of Japanese quails aged 2 to 7 weeks. A total number of 90 Japanese quail chicks 14-day old were randomly distributed into three experimental treatments, each one was subdivided into 3 replicates (10 birds / replicate). Birds in the first group provided drinking water without any addition and considered as control, whereas birds in second (T1) and third (T2) treatments were provided with 100 or 450mg LE/liter drinking water, respectively. The results indicated that males received 450 mg LE/liter showed the highest ( $P<0.05$ ) final body weight and body weight gain followed by those received 100 mg LE/liter compared with the control group. However, the final body weight and body weight gain of female quail did not effected by licorice extract concentrations. In terms of feed intake and feed conversion ratio, males that received 450 mg LE /liter recorded the lowest ( $P<0.01$ ) feed intake followed by control and treatment 1 (100mg LE/liter) and showed better ( $P<0.01$ ) feed conversion ratio compared to the other treatments. Also, the feed intake of females showed the same trend of males without significant differences in feed conversion ratio among all treatments. LE concentration had no effect on carcass percentages of both males and females compared to control. The highest of triglycerides and Aspartate Aminotransferase AST were observed in males of control and 450mg LE groups compared to the other treatment. Moreover, female Alanine Transaminase ALT and AST decreased in LE treatments than the controls. However, Tri iodothyronine T3 and Thyroxin T4 hormones increased significantly ( $P<0.05$ ) in treatment 1 than control and treatment 2. In conclusion, the results of this study indicated that adding licorice extract to drinking water at100mg/L and 450mg/L improved some traits of growing quail's performance at 7 weeks of age.

**Keywords:** quails, growth performance, carcass, licorice, blood parameters.

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## 1. Introduction

Over the centuries, herbal medicinal products in Africa, China, India and other civilizations are considered the basis for medicaments (Chattopadhyay, 2006; Chattopadhyay and Bhattacharya, 2008). Historically, ancient Chinese, Indians, Greeks and Egyptians, have used herbal medicinal products as traditional medicine for more than 4,000 years for symptoms of viral respiratory tract infections and hepatitis (Shebl *et al.*, 2012). Licorice, (*Glycyrrhiza glabra*), is a plant belonging to the *Fabaceae* (legume family), which grow in many countries of the world. Licorice is one of the most popular herbs worldwide, used for both medicinal and culinary purposes (Bown, 1995). The root is a part of plant which possesses some nutritive value and medicinal properties. They are widely used as a cold beverage, in preparing some pharmaceutical preparations such as hematinic pills and to disguise the bitter taste of other remedies (Fenwick *et al.*, 1990; Shalaby *et al.*, 2004). Phytochemical analysis of licorice showed that it contains saponin triterpenes (glycyrrhizin, glycyrrhetic acid and licorice acid), flavonoids (liquiritin, isoflavonoids and formononetin) and other constituents such as coumarins, sugars, amino acids, tannins, starch, choline, ascorbic acid and phytosterols (Arystanova *et al.*, 2001). *Glycyrrhiza glabra* has been proved like antitussive, antidiabetic, hepatoprotective, antimicrobial, antiulcer, antiviral and anticancer indicating that it has diverse biological activity, (Harwansh and Patra, 2011). Pharmacological studies reported

that licorice and its extracted products are active ingredients and used for livestock (Amin, *et al.*, 2014; Rackova, *et al.*, 2007; Suchitra and Shakunthala, 2014). Therefore, licorice and its biologically active constituents represent various materials for the enhancement of poultry production through inclusion in the diet and drinking waters. Few studies are available regarding the use of licorice in poultry diets. Therefore, the objective of this study is to evaluate the physiological effects of licorice extract on growth performance and some blood parameters of Japanese quails.

## 2. Materials and methods

This study was carried out at the Poultry Production Department, Faculty of Agriculture, Assiut University, Egypt.

### 2.1 Experimental Birds

A total of 90 Japanese quail chicks 14-day old, were reared on battery cages under the normal climatic and hygienic conditions required for these birds. Quails were randomly distributed among three treatment groups. Each treatment was subdivided into 3 replicates, with 10 quails per cage (50 cm×40 cm × 30 cm). The ad libitum dietary regimen consisted of starter diet containing 23% crude protein and 3100 KCal ME /kg of diet (from hatch to 2weeks of age) then followed by a grower diet containing 21% crude protein and 3050 K Cal ME /kg of diet from (2 to 7Wk) was used.

### 2.2 Licorice extract preparation

Licorice roots powder was purchased from local market and prepared one day before the addition to the fresh tap drinking water. Licorice extracts was prepared by weighing 450mg and 100mg Licorice roots powder, and then soaked in tap water overnight for ensuring better extraction, according to (Al-Daraji, 2012).

### 2.3 Treatments

Birds in the first group was provided tap water without any addition and considered as a control group (C), while those birds in the second (T1) and third groups (T2) received water supplemented with 100 and/or 450 mg LE/liter, respectively. Licorice extracts were provided during the experimental period which lasted, from 2 to 7 weeks of age). Birds were wing banded and individually weighed at 2 and 7 weeks of age. Body weight gain was calculated during the period from 2-7 weeks of age as follow:

Average daily gain (ADG) = final weight - initial weight/ Period

At 7 weeks of age, 18 birds (9 males and 9 females) were randomly taken and used for carcass measurements and body organ weight (%), dressing percentage was calculated as follow:

Carcass% = carcass weight/Live weight × 100

Liver % = liver weight /Live weight × 100

Gizzard% = Gizzard weight/Live weight × 100

Heart % = Heart weight /Live weight × 100

The Feed was removed for 6 hours before slaughtering to empty the digestive tract. Birds were individually weighed, slaughtered by cutting the jugular vein and allowed to bleed completely

according to the method recommended by Odunsi *et al.* (1999).

### 2.4 Blood samples

Eighteen blood samples from male and female (represents 3 treatments and 3 replicates) were taken after slaughtering into heparinized tubes (2ml). Blood samples were then centrifuged at 3000 rpm for 15 minutes. Plasma was decanted into a plastic tube and stored at -20°C until the time of analysis. The frozen plasma was allowed to thaw at room temperature prior to any assay. To evaluate the general physiological status of treated birds, plasma total protein, albumin, cholesterol, triglyceride, Aspartate Aminotransferase (AST) and Alanine Transaminase (ALT), were determined using commercial kits (Bio-Diagnostics Company, Egypt) by spectrophotometer. Thyroid hormone (T3 and T4) concentrations were measured using ELISA.

### 2.5 Statistical analysis

Data were statistically analyzed by-Analysis of Variance (ANOVA) using the General Linear Model (GLM) of SAS (2009). Significant differences among treatment means were separated by Duncan's multiple range test (Duncan, 1955) with a 5% level of probability. All data obtained were analyzed using the following Model:

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

Where;  $Y_{ij}$  = the analyzed measurement.  
 $\mu$  = the overall mean.  $T_i$  = the effect of LE

treatments (i =0.0, 100and 450 mg/liter of drinking water).  $e_{ij}$ = random error.

### 3. Results and Discussion

#### 3.1 Productive performance

Live body weight and body weight gain of both male and female quails are presented in (Table 1). The results revealed that male was more responsive for LE than female in live body weight and body weight gain. Supplementation of LE at a concentration of 450 mg/liter significantly increased the final body weight and body weight gain of male compared to the control group. In contrast, the same concentrations of LE had no effect on the final body weight and final body weight gain of female Japanese quails during the period from 2 to 7 weeks of age. The increased body weight and gain could be attributed to that the medicinal plant extracts may act as digestibility enhancers, stimulate

digestive enzymes secretion, prevent tissue oxidation and modulate gut microbial populations, thus improving growth performance of birds (Brenes and Roura, 2010; Salary *et al.*, 2014). These results are in agreement with those of Lashin *et al.* (2017) who reported that the body weight of broiler chickens improved with increasing licorice levels compared to control group. Also, Al-Daraji (2012) indicated that the supplementation of LE at level of 450 mg/liter of drinking water significantly improved body weight and cumulative body weight. Moreover, Al-Zuhairy *et al.* (2015) reported that the supplementation of different levels of licorice powder in broiler diets significantly increased body weight gain compared with the control group. On the other hand, some researches indicated that there was no significant difference in body weight among birds received licorice in the diets (Moradi *et al.*, 2014) or via drinking water (Naser *et al.*, 2017) compared to untreated birds.

Table (1): Effect of licorice extract on the growth performance of male and female Japanese quails.

Traits/age	Sex	Treatments			P-value
		C	T1	T2	
Body weight(g)					
Initial body weigh	Male	80.3±2.3	78.8±3.8	82.3±3.2	0.70
	Female	84.3±1.8	85.3±2.3	82.7±3.1	0.78
Final body weight	Male	213.8 <sup>b</sup> ±2.4	220.9 <sup>ab</sup> ±4.5	233.2 <sup>a</sup> ±6.9	0.02
	Female	259.3±4.8	260.2±4.5	259.0±9.2	0.78
Body weight gain					
Final body weight gain	Male	133.6 <sup>b</sup> ±2.4	142.0 <sup>ab</sup> ±2.8	150.9 <sup>a</sup> ±6.4	0.02
	Female	175.1±4.6	174.9±2.9	176.3±6.7	0.96

(a,b,c) means with the different letters within the same row are significantly different. C= control group without supplementation. T1 =Birds received LE at 100 mg/liter of drinking water. T2 = Birds received LE at 450 mg/liter of drinking water.

Regarding the feed intake and feed conversion ratio of both male and female quails (Table 2), it is obvious that both male and female received 100 mg of

LE/liter in drinking water recorded the highest feed intake, while the lowest feed intake was observed for those received 450mg of LE/liter compared to controls during the period from 2-7 weeks of age. These results could be attributed to the positive effect of licorice extracts which increased feed palatability and stimulating appetite (Salary *et al.*, 2014). Similarly, Sohail *et al.* (2011) reported that dietary supplementation with antioxidants can improve the feed intake of birds and reduce oxidative stress induced by reactive oxygen substance under high environmental temperature. Licorice is

herbal medicinal product rich in antioxidants, thus it improves feed intake. These results agree with those of Salary *et al.* (2014) found that supplementation of licorice extracts in drinking water of broiler chicken caused a significant increase in feed intake at 21 and 42 days of age. Meantime, our results disagree with Moradi *et al.* (2014), who found that the addition of licorice (*Glycyrrhiza glabra*) at different concentrations (0.1, 0.2, and 0.3 % licorice extract via drinking water,) had no effect on feed intake broiler chicks. This could be due to strain or dose differences.

Table (2): Effects of licorice extract on feed intake and feed conversion ratio of male and female Japanese quails.

Traits/age	Sex	Treatments			P-value
		C	T1	T2	
(Total feed intake(g/birds) (2-7 weeks))					
2-7 weeks	Male	838.3 <sup>b</sup> ±2.4	854.3 <sup>a</sup> ±2.3	810.6 <sup>c</sup> ±2.7	<.0001
	Female	838.9 <sup>b</sup> ±2.1	853.3 <sup>a</sup> ±1.8	807.4 <sup>c</sup> ±3.0	<.0001
Feed conversion ratio					
2-7 weeks	Male	6.3 <sup>a</sup> ±0.1	6.0 <sup>a</sup> ±0.1	5.5 <sup>b</sup> ±0.2	0.0003
	Female	4.9±0.1	4.9±0.1	4.7±0.2	0.47

<sup>a,b,c</sup> means with the different letters within same row are significant different. C= control group without supplementation. T1 = Birds received LE at 100 mg/liter of drinking water. T2 = Birds received LE at 450 mg/liter of drinking water.

Regarding the feed conversion ratio, the level of LE (450 mg/liter) significantly ( $P<0.01$ ) improved the feed conversion ratio only of males compared to the lowest level of LE (100 mg/liter) and control groups. However, the female feed conversion ratio was not affected by treatments. The enhancement of FCR by supplementing of licorice extracts could be attributed to the positive role of medicinal plant extracts as digestibility enhancers, stimulate digestive enzymes

secretion, prevent tissue oxidation and modulate gut microbial populations, thus improving feed intake, feed conversion and finally growth performance of poultry (Brenes and Roura, 2010; Salary *et al.*, 2014). These results agree with, Awadein *et al.* (2010) noted that the addition of licorice for Manadrah hens before sexual maturity had an effect on the feed conversion ratio. Also, Salary *et al.* (2014) reported that supplementation of licorice extracts in drinking water of

broiler chicken caused significant improvement of feed conversion ratio at 21 days of age ( $P < 0.05$ ). On the other hand, some investigators noted contradictory results, such as Moradi *et al.* (2014) found that the addition of licorice (*Glycyrrhiza glabra*) in different concentrations in drinking water had no significant effect in feed conversion ratio. Similar results were reported by (Khamisabadi *et al.*, 2015).

### 3.2 Carcass traits

The percentage of carcass, liver, gizzard

and heart of both male and female quails are presented in (Table 3). Data showed that the mean percentages of carcass, liver, gizzard and heart were not affected by LE treatment in both male and female. These results are in agreement with those of Pooryousef and Hosseini (2012) who indicated that carcass percentage and carcass parts ratios were not affected by the addition of licorice root extract levels in Japanese quail diets. Sedghi *et al.* (2010) added LE to broiler diets at 2, 1 and 0.5 g/kg and did not find any effect on the relative weight of carcass breast, femur, liver and heart.

Table (3): Effect of licorice extract meat yield of male and female Japanese quails.

Traits	Sex	Treatments			P-value
		C	T1	T2	
Carcass (%)	Male	65.7±3.3	71.5±0.9	70.7±1.0	0.26
	Female	61.8±0.7	63.9±0.5	64.1±0.5	0.12
Liver (%)	Male	2.2±0.03	2.4±0.1	2.1±0.3	0.49
	Female	2.8±0.3	2.9±0.1	3.0±0.1	0.77
Gizzard (%)	Male	1.80±0.08	1.80±0.1	1.90±0.3	0.92
	Female	1.90±0.23	1.69±0.10	1.98±0.2	0.21
Heart (%)	Male	0.88±0.03	0.80±0.03	0.96±0.1	0.38
	Female	0.8±0.02	1.0±0.1	0.8±0.1	0.18

C= control group without supplementation. T1 = Birds received LE at 100 mg/liter of drinking water. T2 = Birds received LE at 450 mg/liter of drinking water.

The same trend was reported by Rashidi *et al.* (2018) where no effect was observed as a result of water inclusion of licorice extracts (LE) at 500 ppm on carcass percentage and cut up of broiler chicks. On the contrary Awadein *et al.* (2010) found a significant increase in the relative weight of heart in Mandarrah hens received LE at 0.1% or 0.5% to diet comparing to the control group. Lashin *et al.* (2017) clarified that carcass characteristics were improved in broiler chickens received drinking water

containing licorice extracts at levels of 1, 2 and 4 mg/kg BW. Fawbro broiler chicks received drinking water containing 450 mg/l licorice extract significantly increased the dressing percentage, when measured with or without giblets (Al-Daraji, 2013).

### 3.3 Plasma analysis

Male plasma analyses are presented in Table (4). The results showed insignificant differences in plasma

proteins (total protein, albumin and globulin), cholesterol, ALT, T3 and T4 hormones among the treatment. These results are in agreement with the finding of Jagadeeswaran *et al.* (2014) who

reported that broiler’s serum protein, albumin, globulin and albumin: globulin ratio at 2, 4 and 6 weeks of age were insignificant when supplemented with *Glycyrrhiza glabra* extracts.

Table (4): Effect of licorice extract on plasma analysis of male Japanese quails.

Traits	Treatments			P-value
	C	T1	T2	
Total protein (g/dl)	5.1±0.2	4.8±0.1	5.2±0.1	0.14
Albumin (g/dl)	3.7±0.3	3.6±0.3	3.8±0.1	0.79
Globulin (g/dl)	1.4±0.2	1.2± 0.2	1.4±0.2	0.66
Triglycerides(mg/dl)	311.7 <sup>a</sup> ±6.2	258.2 <sup>b</sup> ±1.2	270.0 <sup>b</sup> ±7.4	0.006
Cholesterol (mg/dl)	224.3±11.6	227.9±2.5	224.1±3.4	0.91
ALT (g/dl)	41.3±1.2	41.0±0.6	42.0±0.6	0.71
AST (g/dl)	75.3 <sup>b</sup> ±3.2	73.7 <sup>b</sup> ±1.2	86.0 <sup>a</sup> ±1.5	0.03
T3 (ng/dl)	7.5±0.5	7.6±0.6	7.4±0.6	0.99
T4 (ug/dl)	0.6±0.1	0.5±0.1	0.5±0.1	0.50

<sup>a,b</sup> means with the different letters within row are significant different. C= control group without supplementation. T1 = Birds received LE at 100 mg/liter of drinking water. T2 = Birds received LE at 450 mg/liter of drinking water.

The plasma triglycerides concentration of males received different levels of LE via drinking water decreased significantly (P<0.006) compared to the controls. These results are in agreement with the finding of, Myandoab and Mansoub (2012) who found that the addition of licorice root extract via drinking water for Japanese quail, at day 42 of age, showed significant differences in serum cholesterol and triglyceride among groups. Contrary, the results presented by, Rashidi *et al.* (2018) showed that licorice extract (LE) on the broiler, did not significantly affect either serum triglyceride or cholesterol. However, AST level was significantly (P<0.05) increased in the male group that provided 450 mg LE/liter of drink water compared to the other treatment groups. These results are in agreement with Al-Daraji (2012)

reported that aspartate amino transaminase activity (AST) exhibited differences among treatment groups. Data were illustrated by Salary *et al.* (2014) indicated that addition licorice in a concentration of 0.4 % significantly (P<0.05) increased the plasma level of alanine aminotransferase (ALT) compared to the other treatments at 21 days of age. Plasma analysis measured in females are presented in Table (5). The results revealed that no significant differences were observed in total proteins, albumin, globulin, triglycerides and cholesterol among all treatment groups. These results are in disagreement with, Jagadeeswaran *et al.* (2014) who indicated that broiler’s serum total protein, albumin, globulin and albumin: globulin ratio in 2, 4 and 6 weeks of age had no significant

differences among groups. Sedghi *et al.* (2010) indicated that supplementation of licorice extract to broiler diets at levels of 2, 1 and 0.5 g/kg had no effects in triglyceride HDL, LDL, consecutively. Meantime, there was a significant (P<0.05) reduction in serum cholesterol compared to the control.

Table (5): Effect of licorice extract on plasma analysis of female Japanese quails.

Traits	Treatments			P-value
	C	T1	T2	
Total protein (g/dl)	5.7±0.3	5.6±0.2	5.4±0.2	0.72
Albumin (g/dl)	3.9±0.2	3.8±0.1	3.8±0.4	0.93
Globulin (g/dl)	1.8±0.4	1.8± 0.3	1.6±0.4	0.87
Triglycerides(mg/dl)	285.5±7.7	270.0±5.9	282.2±6.2	0.41
Cholesterol (mg/dl)	217.6±6.2	223.5±3.4	224.3±0.8	0.61
ALT (g/dl)	56.0 <sup>a</sup> ±0.6	51.7 <sup>b</sup> ±0.3	52.5 <sup>b</sup> ±0.3	0.01
AST (g/dl)	80.7 <sup>a</sup> ±2.2	68.3 <sup>b</sup> ±2.6	68.0 <sup>b</sup> ±2.0	0.05
T3(ng/dl)	7.6 <sup>b</sup> ±0.3	9.6 <sup>a</sup> ±0.3	7.5 <sup>b</sup> ±0.5	0.04
T4 (ug/dl)	0.5 <sup>b</sup> ±0.1	0.7 <sup>a</sup> ±0.03	0.5 <sup>b</sup> ±0.03	0.05

<sup>a,b,c</sup> means with the different letters within row are significant different. C= control group without supplementation. T1 = Birds received LE at 100 mg/liter of drinking water. T2 = Birds received LE at 450 mg/liter of drinking water.

While the plasma activity of liver enzymes decreased significantly (P<0.01) in female groups that received different levels of LE compared to control groups. The decrease of liver enzymes concentration may be attributed to the mechanism of glycyrrhizin which reduces the progression of liver damages. Glycyrrhizin treatment induces a significant ALT decrease in human with chronic hepatitis C where six times treatment/week appears more effective than three times/week van Rossum *et al.* (2001). These results disagree with Al-Daraji (2012) who noted that receiving drinking water supplemented with 150, 300 or 450 mg LE /liter, respectively resulted in higher AST concentration. Levels of T3 and T4 hormones showed a significant (P<0.05) increase, in the T1 group than those of control and T2

groups. The increase of T3 and T4 hormone concentration may be attributed to the increase in the activity and the improvement of thyroid tissue architecture Fazio *et al.* (2004). These results disagree with the findings reported by Satoh *et al.* (2002.) observed that licorice induced a decrease in T3 level, while it had no significant change on T4 concentration. Also, our results disagree with Abd El mgeed *et al.* (2009) reported that using licorice extracts significantly decreased T3 and T4 concentration in albino rat plasma. In conclusion, the addition of LE to the drinking water at two levels of 100 and 450 mg/liter improved body weight, body weight gain, feed intake and feed conversion ratio of males. Also, blood characteristics enhancement in some traits were observed.

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