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Research Article

Assessment of Chia Seeds Supplementation on Growth Performance, Carcass Characteristics and Blood Metabolites of Japanese Quails

Talaat K. El-Rayes*[1]; Toka S. Nassar[1]; Mahmoud H. El-Deeb[2]

[1]Department of Animal Production, Faculty of Agriculture, Tanta University 31527, Tanta, Egypt.
[2]Animal Production Research Institute, Agriculture Research Center, Sakha Research Station, Egypt.
* Correspondence: talat.elrayes@gmail.com

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Abstract:

This study aimed to assess the impacts of chia (*Salvia hispanica* L.) seeds on growth performance, carcass characteristics and blood metabolites of Japanese quails. A total of 300 one-week-old male Japanese quails with initial body weight 31.31±0.34g were randomly distributed into 4 equal groups (75 birds into 5 replicates/group). The 1st group (control) was fed a diet without any chia seeds, while chia seeds were added at levels of 300, 600, and 900 g per ton of feed, respectively at the 2nd, 3ed and 4th groups. At the age of 5 wks, the best values of productive performance represented in body weight, weight gain, and feed conversion ratio were achieved in groups fed a diet supplemented with 600 g chia seeds/ton of diet. Feed consumption of Japanese quail is not affected by chia seeds supplementation levels up to 900g/ton of feed. No significant differences between all treatments for carcass characteristics were observed, except for the relative weight of carcass, gizzard and dressing which were improved by using chia seeds at the level of 600g/ton of feed. Additionally, dietary chia seeds at the level of 600 g/ton improved the concentration of plasma albumin, triglycerides, HDL, and LDL. It could be recommended that, a supplemented diet with chia seeds up to 600g/ton improved the productive performance traits, carcass characteristics and some blood biochemical of Japanese quails.

1. Introduction

Recently, with the economic developments that the whole world is witnessing, especially after the Russian-Ukrainian war and its consequences of the lack of feed raw materials, which negatively affected the development of poultry production in most countries of the world, especially developing countries that import most of their needs of feed raw materials, such as Egypt. It was necessary for these countries, in the wake of these global changes, to search for available alternatives that could be used safely to solve this crisis.

Quail farming has long been a vital agricultural industry in Egypt. Its enhancement is one of the primary goals of both the corporate and public sectors. Quail was prolific, grew quickly, had a small body size, produced a lot of meat and consumed small amounts of feed. The quail production industry has shown substantial progress in recent years. This tremendous advancement was accompanied by a large rise in output rates, whether for meat or eggs. Unfortunately, this development has unfavorable consequences, including a decrease in immune-response and antioxidant status. As a result, several synthetic feed additives were utilized as growth promoters in their diets to enhance productivity, adjust gut microbiota, manage diseases, and enhance immune response (Bedford, 2000; Whitehead, 2002). Different approaches have been implemented to increase the return on quail investment for the sustainability of the quail sector and its primary role in providing high-quality animal protein, and dietary modulation represents a noticeable way in altering animal performance (Akbari et al., 2016, 2018; El-Senousey et al., 2018). Medicinal and aromatic plant derivatives “plant extracts, essential oils, and bioactive compounds” are currently receiving a lot of interest as feed additives due to their benefit of being natural. According to this perspective, because of their antibacterial properties and stimulating effects on animal digestive systems, aromatic plants and the essential oils collected from them are becoming more significant (Ciftci et al., 2005).

In the poultry business, the usage of phytobiotic compounds in their diets became a widespread practice in order to support high performance by chickens. Useful phytochemicals can be categorized into a number of groups, including phenolics and polyphones (including simple phenols, phenolic acids, quinones, flavones, tannins, and coumarins), terpenoids, essential oils, alkaloids, lectins, and polypeptides. The good impact on feed intake, digestive secretions, immunological stimulation, antibacterial and coccidiostatical, antiviral, or anti-inflammatory activity of botanical supplements in poultry may be the source of these benefits (Cowan, 1999). To distinguish between the plant products used in veterinary medicine (prophylaxis and therapy of diagnosed health problems), Windisch and Kroismayr, (2006) redefined phytobiotic as plant-derived compounds added to feed to enhance the performance of agricultural cattle. In addition to their antimicrobial activity (Dorman and Deans, 2000), phytobiotic compounds exhibit antioxidants activities (Botsoglou et al., 2002) and can stimulate animal digestive systems (Ramakrishna et al., 2003) by increasing digestive enzymes secretion and improving the utilization of digestive products through enhanced liver functions (Hernandez et al., 2004). In this sense, chia (*Salvia hispanica* L.) is one of Lamiaceae family plants, grown for its seeds and oil, native to central and southern Mexico and Guatemala. Economic historians have pointed out that it was no less important than corn as a food crop; seeds were sometimes ground up, while the whole seeds are used for nutritious drinks and as a food source. Additionally, it has the potential to enrich poultry meat with fatty acids beneficial to human health without compromising the meat quality because this plant source has a high concentration of ω-3 fatty acids and has compounds that exhibit high antioxidant activity (Marineli et al., 2014).

Numerous experiments studied the effect of chia seeds or their essential oils as a feed additive on the performance traits and physiological status of poultry, their results were conflicting, as some of them confirmed that chia seeds or their essential oils improved performance (Antruejo et al., 2012; Alagawany et al., 2020; Mendonça et al., 2020 and Yildiz et al., 2022). While, others confirmed that the addition of chia seeds did not significantly affect the productive performance Ayerza and Coates, 2002; Urrutia et al., 2015 and Şengül, 2022). So, the goal of the current study was to evaluate the effect of chia seed (CS) as a feed supplement affected quail productivity, carcass traits, antioxidants status, and blood metabolites.

2. Materials and Methods

2.1. Experimental Design

2.1.1. Birds and management

Three hundred one-week-old male Japanese quails with initial body weight 31.31±0.34g were randomly divided into 4 experimental groups with five duplicates of fifteen birds. The first group served as control and fed a basal diet without any chia seeds (CS), while chia seeds were added at levels of 300, 600, and 900g per ton of feed in the second, third and fourth, groups, respectively. Throughout the five-week of study, all experimental groups were raised in conventional cages (100*50*40 cm) and reared under similar managerial and hygienic conditions.

2.1.2. Experimental diet

The basal diet was a commercial corn-soybean meal diet formulated to meet or exceed the nutritional requirement of growing Japanese quail as recommended by the National Research Council (NRC, 1994) as shown in Table (1).

2.2. Measurements

2.2.1. Performance traits

Live body weight (LBW), weight gain (WG), feed consumption (FC) and feed conversion ratio (FCR) were evaluated at the first and fifth wks of age, as fellow:

WG = Final LBW – Initial LBW

$$FCR = \frac{\text{Feed consumed (g) during a certain period}}{\text{Body weight gain (g) during the same period}}$$

Table (1): The composition and calculated analysis of basal diet.

Ingredients	g/kg
Yellow corn (8.5%)	518.0
Soybean meal (44%)	367.0
Corn gluten meal (62%)	52.10
Premix[1]	3.00
Soybean oil	29.00
Dicalcium phosphate	16.50
Limestone	7.00
Salt	3.00
Dl-Methionine	1.10
L. Lysine	1.30
Choline chloride	2.00
Total	1000
Calculated analysis [2]	
Crude protein (%)	23.78
ME, MJ/Kg	12.59
Digestible Lys	1.30
Digestible Meth + Cysteine	0.92
Digestible Thr	0.78
Calcium	0.80
Available phosphorus	0.45

[1] Each 3kg of premix contained: Vit. A 12000IU, Vit. D 2200IU, Vit. E 10mg, Vit. K_3 2000mg, Vit. B_1 1000mg, Vit. B_2 3000mg, Vit. B_6 1300mg, Vit. B_{12} 10mg, Pantothenic acid 10mg, Niacin 30mg, Folic acid 1000mg, Biotin 50mg, Choline chloride 300mg, Manganese 60mg, Zinc 50mg, Copper 10mg, Iron 30mg, Iodine 1000mg, Selenium 100mg, Cobalt 100mg and $CaCo_3$ to 3g.

[2] Calculated according to NRC (1994).

2.2.2. Carcass characteristics:

At the end of the trial, fifteen birds from each group (3 birds from each replicate) were randomly chosen for the slaughter test, weighed, and then slain by having their jugular veins severed in the morning. The birds were then scalded and defeated following total bleeding. Spleen, bursa, thymus, liver, heart, and gizzard were individually weighed after the carcasses had been carefully dissected and eviscerated. All organ weights were converted to an arcsine expression and represented as a percentage of body weight.

2.2.3. Blood biochemical:

At the end of the trial, blood samples were collected from 5-week-old Japanese quails into heparinized tubes and centrifuged for 15 min at 3000 rpm to obtain plasma. Plasma samples were examined for levels of total protein, albumin, globulin, triglycerides, cholesterols, high density lipoprotein HDL, low density lipoprotein LDL, very low density lipoprotein VLDL, and the activity of aspartate aminotransferase (ALT) and alanine aminotransferase (AST) enzymes using a microplate spectrophotometer with a commercial detection kit (Bio-diagnostic, Egypt), following the manufacturer's instructions.

2.3. Statistical analysis

Data were statistically analyzed by one-way ANOVA, using the general linear model procedure (SAS, 1996). Tests of significance for differences among

Table (2): Productive performance of Japanese quail affected by chia seeds supplementation levels.

Chia seeds supplementation levels (g/ton feed)	**Initial BW**	**BW at 5 weeks**	**WG at 5 weeks**	**FC at 5 weeks**	**FCR at 5 weeks**
0	31.80	194.54^{c}	162.74^{c}	775.20	4.76^{a}
300	30.40	206.23^{b}	175.83^{b}	772.98	4.39^{b}
600	31.19	217.21^{a}	186.02^{a}	783.27	4.21^{b}
900	31.84	209.36^{b}	177.52^{b}	777.72	4.38^{b}
SEM	±0.41	±1.60	±0.3.65	±5.37	±0.42
significant	NS	*	*	NS	*

-Means of each column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

-NS indicate not significant -* indicates significance at P<0.05 - SEM indicate standard error of the mean

Table (3): Carcass characteristics of Japanese quail affected by chia seeds supplementation levels.

Chia seeds supplementation levels (g/ton feed)	% Carcass	% Total giblets			%	% Lymphoid organs		
		Heart	Liver	Gizzard	Dressing	Bursa	Thymus	spleen
0	75.21^{b}	0.80	1.87	0.98^{b}	78.86^{b}	0.10	0.69	0.10
300	76.78^{ab}	0.82	1.89	1.16^{ab}	80.65^{ab}	0.90	0.66	0.08
600	78.09^{a}	0.86	1.95	1.25^{a}	82.15^{a}	0.12	0.53	0.09
900	75.99^{ab}	0.86	2.01	1.15^{ab}	80.01^{ab}	0.11	0.61	0.10
SEM	±0.81	±0.02	±0.16	±0.06	±1.22	±0.01	±0.05	±0.01
significant	*	NS	NS	*	*	NS	NS	NS

-Means of each column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.

-NS indicate not significant -* indicate significance at P<0.05 - SEM indicate standard error of the mea

treatments were done according to Duncan (1955). The statistical model was used for the analysis of variance to estimate the effect of chia seeds supplementation levels on Japanese quail performance and physiological status as follows:

$$Y_{ij} = U + T_i + e_{ij}$$

Where:

Y_{ij} = The observations. U = Overall mean.

T_i = Effect treatments (i = 1, 2, 3and 4).

e_{ij} = Residual effects (Random error).

3. Results

3.1. Productive performance traits

Data of Japanese quail chick's body weight, weight gain, feed consumption and feed conversion ratio as influenced by chia seeds supplementation level (0, 300, 600 and 900 g/ton feed) are illustrated in Table (2). Chia seeds (CS) supplementation significantly impacted body weight (BW, g), weight gain (WG, g), and feed conversion ratio (FCR, g/g) at 5 wks of the experimental period. Chicks fed diets supplemented with chia seeds at levels of 600 g/ton showed the highest BW, WG, and the best FCR values at 5 wks of the experimental period. Feed consumption (FC, g) of Japanese quail was not affected by chia seeds supplementation levels up to 900g/ton of feed.

3.2. Carcass characteristics

Data illustrated in Table (3) shows the effect of chia seeds supplementation levels on the carcass characteristics of Japanese quails.

Results indicated that there were no significant (P>0.05) differences between all treatments for carcass characteristics including the relative weights of heart, liver, and lymphoid organs (bursa, thymus and spleen). On the other hand, the relative weights of gizzard, carcass, and dressing % of the group that received dietary chia seeds at 600g/ton of feed were significantly (P≤0.05) increased by 27.55, 3.83 and 4.17 respectively, as compared to the control group.

3.3. Blood metabolites

Data illustrated in Table (4) shows the effect of CS supplementation levels on some blood biochemical parameters in the plasma of Japanese quail. No significant differences between all treatments were observed for the concentration of total protein, globulin, total cholesterol, and the activity of AST and ALT enzymes. On the other direction, the concentration of plasma albumin was significantly (P≤0.05) increased for Japanese quail fed diet supplemented with chia seeds at the level of 600g/ton of feed. Similarly, the concentration of HDL was significantly (P≤0.05) increased for birds a fed diet supplemented with chia seeds at the level of 600g/ton of feed, as compared to the control. On the other hand, there was a significant (P≤0.05) improvement in the concentrations of triglycerides, LDL, and VLDL by increasing the supplementation levels of chia seeds up to 900g/ton of feed.

Table (4): Blood biochemical of Japanese quail affected by chia seeds supplementation levels.

Chia seeds supplementation levels (g/ton feed)	TP mg/dl	Alb. mg/dl	Glob. mg/dl	ALT U/l	AST U/l	Trigly. mg/dl	Chols. mg/dl	HDL mg/dl	LDL mg/dl	VLDL mg/dl
0	4.05	1.45^{b}	2.08	7.13	8.31	183.67^{a}	183.12	120.29^{c}	29.65^{a}	33.13^{a}
300	3.47	1.59^{ab}	2.13	7.06	7.65	167.67^{b}	190.80	131.88^{b}	28.99^{a}	29.89^{b}
600	3.81	1.79^{a}	2.04	7.73	7.68	149.33^{c}	188.66	133.47^{b}	25.51^{b}	29.64^{b}
900	3.36	1.61^{ab}	2.11	8.30	9.55	125.00^{d}	193.66	145.95^{a}	23.65^{b}	24.04^{c}
SEM	±0.25	±0.08	±0.14	±0.69	±1.00	±22.5	±7.45	±7.62	±3.98	±3.48
significant	NS	*	NS	NS	NS	*	NS	*	*	*

- TP= Total protein, Alb= Albumin, Glob= Globulin, ALT= Alanine aminotransferase, AST= Aspartate aminotransferase, Trigly= Triglycerides Chols=Cholesterol, HDL= High-density lipoprotein, LDL= Low-density lipoprotein and VLDL= very low-density lipoprotein.
-Means of each column followed by the same letter are not significantly different at the 5% level according to Duncan's Multiple Range Test.
-NS indicate not significant -* indicates significance at P<0.05 - SEM indicate standard error of the mean

4. Discussion

The positive effect of CS on body weight and weight gain may be due to the higher content of various nutrients and functional ingredients such; fiber, unsaturated fatty acids, vitamins, minerals, steroids, alkaloids, saponins, tannins, terpenoids and flavonoids (Reyes-Caudillo et al., 2008; Haytowitz et al. 2011; Ciftci et al., 2012; Scapin et al., 2016 and Da Silva et al., 2017) which stimulates the growth rate. In addition, chia seeds contain a high amount of essential oils which function as a digestibility enhancer, balancing the gut microbial ecosystem and stimulating the secretion of endogenous digestive enzymes, thus improving growth performance in poultry (Lovkova et al., 2001; Williams and Losa, 2001; Cross et al., 2007). Many studies suggest that dietary essential oil can improve digestion and increase the performance of poultry. They have been shown to stimulate bile salt secretion and digestive enzyme activities of the intestinal mucosa and pancreas (Hernandez et al. 2004). Also, numerous studies showed that, the improvement of productive performance is due to the improvement of the morphological characteristics of the alimentary canal, such as an increase in the number of Goblet cells, as well as the number of villi, and the surface area exposed to secretion or absorption. As well as, the improvement of the microbial condition of the gastrointestinal tract, represented by an increase in the number of beneficial microbes (*Lactobacillus* and *Befedobacterium)* at the expense of harmful microbial populations such as *E. coli and Clostridium* (Viveros et al., 2011; Akbarian et al., 2013; Da Silva et al., 2016 and 2019). The current results are compatible with that observed by some authors who studied the effect of chia seeds or their essential oils as a feed additive on the performance traits of poultry and they revealed that chia seeds or their essential oils improved BW, WG and FCR (Antruejo et al., 2012; Alagawany et al., 2020; Mendonça et al., 2020 and Yildiz et al., 2022). On the other direction, some authors observed that chia seeds or their essential oils were not affected negatively on performance traits BW, WG and FCR (Ayerza et al., 2002 and Rasul et al., 2019). While, some authors did not find any significant effects of adding chia seed or its oil on the productive performance of poultry (Ayerza and Coates, 2002; Urrutia et al., 2015 and Şengül, 2022).

The improvement in carcass characteristics (carcass and dressing percentage) may attribute to the improvement in the growth rate that occurred as a result of the use of chia seeds in quail feeding. These results are in line with those observed by Rasul et al., (2019) who found that, carcass traits including the relative weights of dressing percentage, gizzard, and carcass were significantly improved by using 0.7% chia seeds in the diet of quail. Additionally, Mendonça et al. (2022) found that supplementation of 0.025 g chia oil/kg diet or 0.164 g chia seed/kg diet was able to improve significantly the relative weight of carcass (p<0.05).

From our results, chia seed did not alter liver function and did not exert any negative impact on liver weight, suggesting that chia does not contain high amounts of anti-nutritional compounds, which necessitate detoxification. Previous studies have yielded inconsistent results on the effect of dietary chia supplementation on plasma triglyceride levels, i.e., Rahimi et al. (2011) and Alagawany et al. (2020) reported a reduction, whereas Ahmed (2019) found an elevation in their levels. We found a reduction in the serum triglyceride levels of birds supplemented with chia seed, especially in the group supplemented with 900g/ton of feed, which is consistent with some previous works. This reduction may be attributed to the presence of omega-3 and omega-6 fatty acids (Antruejo et al., 2011; Rahimi et al., 2011; Alagawany et al., 2019; Alagawany et al., 2020) and the activity of natural antioxidants in chia (Ahmed 2019). Chia seed supplementation decreased the LDL levels, which is in agreement with the results obtained by the supplementation of chia seeds (Ahmed 2019 and Alagawany et al., 2020). This reduction confirmed the lower cholesterol levels observed in this study because HDL and LDL molecules are the chief transporters of cholesterol from its site of synthesis, i.e., the liver to the body tissues and they consequently decrease cholesterol and triglycerides available for tissue metabolism, lipogenesis in liver and fat accumulation in carcasses (Alvarenga et al. 2011). In the present investigation, LDL levels in the groups supplemented with chia seed were similar to those reported by (Abdelhady et al. 2018 and Alagawany et al., 2020).

5. Conclusions

In conclusion, it could be recommended that, supplemented diet with chia seeds up to the level of 600g /ton of feed caused to improve productive performance traits and physiological response of Japanese quails.

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