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Effect of Using Black Seed, Garlic and Licorice on Carcass Characteristics and Blood Parameters of Japanese Quail

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THIS research study aimed to investigate the impact of dietary supplementation with black cumin, garlic, and licorice. On the productive indicators of 600 white quail chicks in Egypt. The experiment was conducted on a private farm from The first of February 2023, for 34 days. The quail chicks were divided into eight groups, with each group consisting of an average of 75 chicks. Within each group, three replicates were created, comprising 25 quail chicks each. All groups were subjected to identical housing and care conditions throughout the 34-day study period. The control group received the standard farm system diet without any supplements, serving as the baseline group. The remaining seven experimental groups received the basal diet supplemented with different combinations of black cumin, garlic, and licorice in powder form. The supplementation levels were 0.5% for each ingredient individually and in various combinations. The Results Shown: In the study, the eighth group, which received all forage additives (black seed, garlic, and licorice), exhibited a significant (P<0.05) superiority in live weight, leg and breast indicating improved digestion and enhanced bird immunity. Experimental groups showed higher average liver weight, indicating potential benefits for immunity. while the groups using black seed showed weight gain. Significant differences were found in leg and breast weight, although not reaching significance levels. Abdominal fat was significantly reduced in all experimental groups. Moreover, total protein and albumin levels were significantly increased by licorice and garlic, and total cholesterol levels, especially LDL cholesterol, decreased significantly in the eighth group.

Keywords: Abdominal fat, Liver, Cholesterol, Leg, Breast.

Introduction

The rising popularity of quail farming in the poultry industry can be attributed to its advantages of high productivity in limited spaces and cost-effectiveness, along with the inherent resilience of quails to environmental factors. Specifically, *Coturnix coturnix japonica*, commonly known as Japanese quail, exhibits robustness and increased tolerance towards suboptimal management practices and prevalent poultry diseases such as Marek's disease and Newcastle disease. Traditionally, pharmaceutical medications have been added to poultry diets, particularly for young chicks, to prevent diseases and promote growth. However, there is a growing emphasis on finding natural alternatives to antibiotics as growth promoters. Various non-pharmacological products, including prebiotics, probiotics, organic acids, essential oils, and herbal plants, have gained attention for their potential benefits [1].

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Black Cumin

Phytogenic feed additives, derived from herbs, spices, and their compounds, have gained considerable interest in the feed industry [2]. These additives, including plants and essential oils, are valued for their antibacterial properties, ability to stimulate the digestive system, and antioxidant capabilities [2]. Black cumin seeds (BCS), derived from black seed L., have been used for medicinal purposes for over 2000 years. Recent studies have explored the potential of incorporating BCS into poultry diets as a natural feed additive to enhance performance. It has been found that BCS does not negatively affect chicken performance (up to 30 g/kg) and can mitigate the adverse effects of hot weather [3]. Additionally, BCS supplementation in poultry diets has shown positive effects on growth performance, biochemical and hematological responses, and mortality rate [4].

BCS is considered a valuable source of protein, crude fat, crude fiber, and macrominerals due to its unique characteristics and composition. It contains a yellowish volatile oil (0.5-1.6%), a fixed oil (28-42%), proteins (23 to 37%), ash (4.86% to 4.41%), total carbohydrate (33 to 40%), and various phytochemicals [5] [6]. Palmitic acid is the predominant saturated fatty acid, while linoleic acid (50.3–49.2%) and oleic acid (25.0–23.7%) are the main unsaturated fatty acids in BCS [6]. The volatile oil of BCS contains active components such as carvone, terpene, d-limonene, carvene, -pinene, p-cymene, and nigellone [5]. Thymoquinone, dithymoquinone, thymohydroquinone, and thymol are pharmacologically active constituents found in the volatile oil, while BCS also contains significant antioxidants like selenium, DL-tocopherol, DL-tocopherol, and trans-retinol [7]. BCS exhibits antibacterial activity against both Gram-positive and Gram-negative bacteria, possesses antioxidant properties, enhances immune response, and provides hepatoprotective effects [8]. The essential oil of BCS inhibits the growth of pathogenic bacteria [9]. Furthermore, BCS extracts and essential oil have demonstrated additional physiological effects, such as anti-inflammatory and anti-diarrheal properties, impacting various systems within the body, including the endocrine and immunological systems [10].

Given its nutritional composition and the presence of pharmacologically active compounds, BCS is a suitable ingredient and feed supplement for poultry diets, providing essential nutrients and various potential benefits.

Garlic

Garlic, belonging to the Allium family (Liliaceae), has been revered for its medicinal properties and has been used for centuries to treat various ailments. Its long history of use as a spice and herbal medicine has instilled confidence among both scientists and cultural communities regarding its effectiveness in preventing and treating diseases [11]. One of the reasons garlic is considered to possess potent antioxidant potential is its high concentration of selenium, which is an essential component of the body›s antioxidant system [12]. Selenium acts as a crucial cofactor for several antioxidant enzymes, playing a vital role in neutralizing harmful free radicals and reducing oxidative stress in the body. Alongside selenium, garlic contains other components that contribute to its antioxidant capabilities, further enhancing its overall antioxidant activity [13].

Allicin, an active compound found in garlic, has been extensively studied for its physiological effects on microorganisms and mammals. Research has revealed that allicin can influence lipid production, RNA synthesis, lipid levels, and platelet aggregation in mammals. Additionally, allicin exhibits antimicrobial properties by targeting enzymes that contain sulfhydryl groups, thereby inhibiting the growth of bacteria and preventing fermentation. Its ability to promote gastric secretion also contributes to its preventive effect against bacterial infections in the digestive tract [14]. In the context of poultry farming, garlic has garnered attention for its potential benefits. Over the past decade, garlic has been incorporated into poultry feed formulations due to its positive impact on weight gains [15].

Glabra (*Glycyrrhiza glabra*)

Glycyrrhiza glabra, a leguminous plant species belonging to the Leguminosae family, is known for its medicinal properties. The root of this plant contains licorice, which is a combination of various compounds including glycyrrhizin, glycyrrhetinic acid, flavonoids, asparagine, iso-flavonoids, and chalcones. Licorice root has been used for therapeutic purposes in Europe since ancient times [16], with its medicinal properties being recognized for more than 4000 years. [17] have reported that licorice exhibits a wide range of beneficial properties, including antimicrobial, anti-atherosclerotic, anti-oxidative, anti-inflammatory, anti-viral, anti-nephritic, and radical scavenging activities. It is also consumed as a cold drink and used in the manufacturing of certain medicinal products, such as hematinic pills, as well as to mask the bitter flavor of other medications [18].

Although licorice has been used in traditional herbal medicine for a long time, its composition and pharmacologically active compounds have only recently been discovered through scientific research conducted in the past 25 to 30 years [19]. The primary beneficial components of licorice are triterpene saponins (4-20%) and other phenolic compounds [20]. Among these, glycyrrhizin, a triterpene saponin, is the most prominent and active component of licorice root, known for its sweetness surpassing that of sucrose [21]. The composition of licorice can vary depending on factors such as growth, environment, and cultivation conditions, with moisture content ranging from 20%, sugar content from 3-16%, starch content at 30%, glycyrrhizin content between 5-24%, and ash content at 6% [22].

Licorice is utilized to treat various ailments such as mouth ulcers and arthritis, and it has been found to possess growth-promoting, anti-inflammatory, anti-cancer, immunomodulatory, antioxidant, and antibacterial properties [23]. Due to the sweetness of glycyrrhizin being over 50 times that of sucrose, it is frequently employed as a sweetener [24].

The primary objective of this study is to investigate the individual and combined effects of black seed, garlic, and licorice on carcass characteristics, blood indicators (including cholesterol and triglycerides, blood protein levels), abdominal fat deposition, and the muscular properties of the chest and thigh.

Material and Methods

The study was carried out on 600 white quail chicks in Egypt. At the beginning of the experiment, the birds were divided into eight groups, each containing an average of 75 chicks, and each group was further divided into three replicates. Each replication consisted of 25 quail chicks, which were one day old at the start of the study. All housing and care conditions were identical for all groups during the 35-day care period. The control group was fed according to the standard farm system, while the second group was fed with 0.5% black seed, the third group with 0.5% garlic (Cloves), the fourth group with 0.5% licorice (Roots), the fifth group with 0.5% black seed + 0.5% garlic (Cloves), the sixth group with 0.5% black seed + 0.5% licorice (Roots), the seventh group with 0.5% garlic (Cloves) + 0.5% licorice (Roots), and the eighth group with 0.5% black seed + 0.5% garlic (Cloves) + 0.5% licorice (Roots). (Dry and ground for all additives).

Table 2 shows the feed materials included in the composition of the mixtures used to feed the birds of the different groups, the metabolic energy and crude protein content of the mixtures, and the energy-to-protein ratio (ME/P), which were calculated according to the table of chemical analysis of the feed materials available Importing companies during the research period.

Experimental measurements

The research conducted measurements on the white quail chicks in Egypt to investigate the effects of different feed additives on their growth and development. Two types of measurements were taken: body weight and slaughter traits.

Body weight: The live body weights of each chick were individually recorded at the time of slaughter.

Slaughter traits: At 34 days of age, chicks were chosen based on their average weight ± 10g. They were weighed and then slaughtered after an 8-hour fasting period. The slaughtering process involved slitting the throat and cutting the carotid arteries, jugular veins, oesophagus, and trachea without severing the head. The birds were then hanged in a bleeding funnel for 3 minutes to obtain the blood weight. After that, they were scalded in a 68°C water bath for 30 seconds to remove feathers, and the feathers› weight was recorded. The shanks and head (without neck) were removed, and the birds were eviscerated and chilled. Each empty chilled carcass was weighed to obtain the dressed weight, and dressing percentages were expressed as the percentage of dressed weight to LBW. The wings with bones were removed and weighed, and the skinless pectoralis major and minor muscles were removed to obtain breast muscle weight. The bones from the thighs and drumsticks were removed, and the skinless leg muscles were weighed as leg meat. The liver, heart, and gizzard (empty) were weighed, and all previous muscles and organs were also calculated as percentages of LBW.

TABLE 1. Scheme of the research procedure. (It is added as a percentage of the feed mix)

Treatment	Groups							
	Control	1	2	3	4	5	6	7
Black seed (Seeds)	0	0.5%	0	0	0.5%	0.5%	0	0.5%
Garlic (Cloves)	0	0	0.5%	0	0.5%	0	0.5%	0.5%
Licorice (Roots)	0	0	0	0.5%	0	0.5%	0.5%	0.5%

TABLE 2. The ingredients and calculated nutrient contents of the Japanese quail diets.

Ingredients %	Starter diets	Grower diets	Finisher diets
Argentine yellow corn	48.4	56.2	64.2
High-fat Soybean meal (43%)	40	33	26
Limestone	0.41	0.49	0.68
Corn gluten meal (60%)	7	6.5	6
Oil	0.2	0.25	0.3
Dicalcium Phosphate	2	1.6	1.2
Vitamins premix	0.4	0.4	0.4
Minerals premix	0.3	0.3	0.3
Threonine	0.25	0.265	0.28
Sodium chloride	0.13	0.115	0.1
Methionine	0.15	0.125	0.1
Sodium bicarbonate	0.1	0.125	0.15
Choline chloride	0.1	0.05	0
Antifungal and toxins	0.05	0.05	0.05
Manganese sulfate	0.02	0.01	0
LINCO MEX	0.01	0.01	0.01
Silica	0.1	0.025	0
Multivitamins AD3E	0.03	0.125	0
Yeast	0.1	0.125	0
Lysine	0.25	0.235	0.23
Total	100	100	100
Calculated analysis:			
ME (kcal/kg)	3245	3269	3298
Crude Protein %	25.56	22.92	20.23
ME/P	126	142.63	163.03
Fat %	5.11	4.97	4.83
Crude fiber%	3.51	3.23	2.96
Ca%	0.72	0.64	0.42
P%	0.76	0.66	0.42
Lysine %	1.58	1.36	1.13
Methionine %	0.43	0.39	0.35
Cystine %	0.47	0.42	0.37
Linoleic acid%	1.17	1.31	1.45
Cost (EGP)	21.3	20.85	20.76

Blood biochemical analysis

Blood samples were taken to determine hematological parameters, including the serum content of RBCs, PCV, hemoglobin, WBCs, total protein, glucose, triglycerides, cholesterol, uric acid, calcium, and phosphorus, using commercial kits.

Statistical analysis

Data were analyzed using the SAS software, general linear model (Xlstat, 2014). The following model was used:

$Yij= \mu + Li + eij$

Where:

Yij: The jth observation within the ith group.

μ: The overall mean.

Li: The effect of the ith groups.

Eij: Random error.

All data are reported as least square means (LSM) ± standard errors (SE). Mean values were separated, when significance existed, using Duncan's multiple range test [25]. The significance level was set at 5%.

Percentage data were subjected to arc sine transformation before analysis.

The results obtained from this research were subjected to statistical analysis:

- The significance of differences between percentages of between groups was tested according to Fisher›s (F) test for the significance of differences between percentages.

The rest of the studied indicators were subjected to an analysis of variance according to a simple random design, and when there was a significant difference between the groups in the indicator, the least significant difference (L.S.D) was calculated at the 5% and 1% level or the 5% level only.

Results and Discussion

Carcass characteristics

Noted by Table 3:

Live weight: Significant (P<0.05) superiority was observed in the eighth group, where all the forage additives under investigation (black seed, garlic, and licorice) were used. This improvement can be attributed to enhanced feed material digestion and increased immunity levels in birds. Blood weight: No significant difference (P>0.05) was found in the blood weight index between the experimental groups and the control group.

Liver: A significant difference (P<0.05) was observed between the control group and the eighth group. It is noteworthy that all experimental groups exhibited higher average liver weight, although it did not reach the level of significance. This suggests a potentially beneficial effect of the materials used on immunity.

Heart: No significant difference (P>0.05) was observed in the average heart weight index between the control group and the experimental group.

Gizzard: No significant difference (P>0.05) was found between the control group and the remaining experimental groups. However, weight gain was observed in the groups where black seed was utilized.

Leg: A significant difference (P<0.05) was observed between the control group and the eighth group. All experimental groups displayed higher average thigh weight, though not reaching the significant level.

Breast: A significant difference (P<0.05) was observed between the control group and the eighth group. All experimental groups showed superiority over the control group based on the studied indicator, but it did not reach the level of significance.

Carcass: No significant difference was found between the control group and the other experimental groups.

Abdominal Fat: A significant difference (P<0.05) was observed between the control group and all the experimental groups. The use of black seed, garlic, or licorice alone, in pairs, or in combination had an effect on reducing the average body fat weight index.

Effects of BCS meal on carcass characteristics of Japanese quails

In a study by Durrani et al.[26] BCS supplementation (20, 30 and 40 g/kg diet) led to a rise in body weight .Higher ADWG brought on by BCS may be due to better nutrient absorption from the intestine [8]. Crossland et al. [27] asserts that the addition of BCS to feeds may raise bile flow rate, which might boost emulsification and activate the pancreatic lipases, which would aid in the digestion of fat and the absorption of fat-soluble vitamins. Thymoquinone, which accounts for roughly 60% of the BCS EO's active ingredient, as well as other compounds like carvone, anethole, carvacrol, and 4-terpineol, may have antioxidant, antibacterial, and digestive enzyme-stimulating properties in the pancreas and intestinal mucosa.

Numerous studies [28,29] have reported that BCS supplementation increases carcass weight, thigh weight, breast weight, edible internal organ weight, and belly fat.

Some authors [30] found that 1.0% BCS and antibiotics in the diets significantly influenced the weights of the liver, abdominal fat, thigh, breast, wings, and neck. Others [31] demonstrated that dietary BCS increased carcass weight. Saleh [28] reported a substantial increase in the weight of the breast muscle with BCS feeding, while the weight of the liver remained unaffected.

In contrast, some investigators[32] observed no significant effects of BCS on carcass percentage, weight of internal organs, or abdominal fat pad. Jahan et al.[33] observed differences in breast meat, drumstick meat, abdominal fat, and skin with BCS supplementation, but not in average body weight, dressing yield, thigh meat, wing meat, heart, gizzard, or liver.

Ismail [34] found no significant effects of dietary BCS on dressing percentage, edible internal organs, abdominal fat, full gut weight, or gut length. Khalaji et al.[35] reported an increased relative weight of the gizzard with BCS addition to the diet, while other carcass traits were unaffected.

The differences in dressed bird weights at slaughter can be attributed to variations in body weights resulting from differences in feed intake, metabolizable energy, and protein consumption [34]. The increased breast weight suggests that BCS may enhance protein utilization. Additionally, the availability of minerals in BCS-containing diets may contribute to a higher ash percentage in the meat [2]. Asghar et al.[36] The study examined the impact of adding black cumin powder to Japanese quail diets on carcass characteristics and meat quality. Adding 2% BCP resulted in better weight gain and feed conversion ratio, and improved sensory properties of thigh and breast meat with lower bacterial levels, suggesting that BCP could be used as a natural additive in quail feeds to replace synthetic antimicrobials and antioxidants.

Effects of garlic meal on carcass characteristics of Japanese quails

The results of the study investigating the effect of different feeding levels of garlic meal on the carcass characteristics of Japanese quails [37]. It was observed that live weight, slaughtered weight, gizzard weight, back weight, shank weight, thigh weight, drumstick weight, intestine weight, and breast muscle weight exhibited a significant increase ($p<0.05$) with the inclusion of garlic meal in the diet. However, there were no significant differences ($p>0.05$) in dressed weight, dressing percentage, head weight, neck weight, back weight, leg weight, wing weight, and breast muscle weight among the different groups.

Studies conducted on quails [38] and broilers [39] fed garlic powder at a rate of 0.5g kg-1 in their feed demonstrated increased relative weights for breast and thigh meat. This supports the claim made by [40] that dietary garlic meal, when consumed at a rate of 2.05g kg-1, had no impact on carcass output.

Effects of licorice on carcass characteristics of Japanese quails

Limited information is available regarding the impact of licorice plant feed on carcasses and meat quality. In a study by Moradi et al.[41], it was found that the hydrophobic flavonoids present in licorice caused a significant reduction in belly fat in grill chickens fed with 0.3 g of licorice per liter of water.

The relative weights of internal organs such as the bursa of Fabricius, thymus, spleen, liver, and heart were unaffected by licorice extract (LE) supplementation in grill chickens [41, 42]. Likewise, the addition of 200 ppm of LE had no significant effect on the weights of the spleen and gizzard of Japanese quails, although greater relative weights of the liver were noted [43]. The intestinal histomorphology, visceral organs, and carcass cuts of broiler chickens did not show any discernible effects from the addition of aqueous LE to the drinking water [44]. Another study on Japanese quails found that LE supplementation had no significant impact on carcass percentage [45], but the addition of licorice root extract led to a considerable increase in carcass yield percentage [43].

TABLE 3. Live Body Weight (g), Carcass Weight (g), Percentage of (Breast, Leg meat, Blood, Feathers, Liver, Heart, Gizzards) as a percentage of carcass weight.

	LBW	Blood wt	Liver	Heart	Gizzard	Leg	Breast	Carcass	Abdominal Fat
Cont.	347.6^{b}	4.00	3.46^{b}	2.56	1.69	16.24^{b}	18.75^{b}	68.59	2.07^{a}
2	349.8^{b}	3.66	3.67^{ab}	2.65	1.83	17.06^{b}	19.78^{ab}	69.40	2.03^{ab}
3	350.8^{b}	4.00	3.73^{ab}	2.66	1.59	16.62^{b}	19.48^{b}	69.57	2.01^{ab}
4	349.2^{b}	5.07	4.03^{ab}	2.75	1.54	16.39^{b}	18.83^{b}	69.90	2.02^{ab}
5	353.7^{ab}	4.24	3.80^{ab}	2.72	1.84	17.76^{b}	20.48^{ab}	69.53	1.96bc
6	355.1^{ab}	4.55	3.68^{ab}	2.64	2.03	17.47^{b}	19.87^{ab}	69.65	1.96^{bc}
7	354.4^{ab}	4.05	3.77^{ab}	2.75	1.70	16.21b	20.49^{ab}	69.10	1.94b^{c}
8	366.7^{a}	4.16	4.18^{a}	2.78	1.97	19.98^{a}	22.64^{a}	71.44	1.87^{c}
SE	4.201	0.746	0.175	0.071	0.162	0.592	0.888	1.587	0.028
Pr	0.112	0.930	0.196	0.402	0.365	0.006	0.128	0.956	0.005

a…d. Means, within age and source of variation (S.O.V), with different superscripts, are significantly different [25].

Blood Biochemical Profile

Noted by Table 4

Total protein: A significant difference (P<0.05) was found between the control group and all experimental groups, except for the group where garlic was added (the third group). Licorice and garlic were observed to increase the protein level in the blood.

Albumins: A significant difference (P < 0.05) was observed between the control group and the eighth group. Additionally, a significant difference (P < 0.05) was found between the control group and the sixth group (black seed and licorice). All experimental groups outperformed the control group, possibly due to improved food digestion, particularly regarding protein.

Globulin: No significant difference (P>0.05) was observed between the control group and the other experimental groups in relation to the studied indicator.

Triglycerides: No significant difference (P>0.05) was observed between the control group and the groups where black seed, garlic, or licorice were added individually. However, a significant difference (P<0.05) was found between the control group and the remaining experimental groups, indicating a synergistic effect of the additives. The studied indicator showed a decrease when the feed additives under investigation were included.

Total cholesterol: No significant difference (P > 0.05) was observed between the control group and the experimental groups. However, a decrease in the studied indicator was noticed in the experimental groups, particularly in LDL (bad) cholesterol. A significant difference (P < 0.05) was found between the control group and the eighth group, indicating a significant decrease in LDL cholesterol.

A study have examined the effects of BCS (Black Cumin Seeds) supplementation on blood biochemical parameters in various poultry species. Kumar et al. [8] reported no significant impact of BCS on blood glucose concentrations.

Yatoo et al. [46] found a significant decrease in blood glucose levels when 1% BCS was added to broiler diets, Conversely, Khalaji et al. [35] reported that supplementing with 1% BCS had no discernible effect on serum glucose levels.

Regarding total protein, Kumar et al.[8] noted a tendency towards higher concentrations in animals fed with BCS compared to the control group, with a linear increase at higher BCS dosages. In comparison to control diets, Yatoo et al. [46] observed significantly greater serum total protein and albumin levels with 1% BCS supplementation. Saleh [28]found that feeding BCS oil (1 ml/kg) increased the albumin-to-globulin ratio, total protein, and albumin concentrations (but not globulin concentration) compared to control or avilamycin-containing diets.

In terms of serum total cholesterol, several studies [46,2] reported decreasing trends. Kumar et al. [8] demonstrated that increasing doses of BCS resulted in linear decreases in cholesterol concentrations compared to control. Similarly, [46] found lower serum total cholesterol levels in birds fed 1% BCS. Saleh [28] reported higher plasma total cholesterol concentrations with BCS compared to the control and antibiotic groups.

BCS supplementation has been shown to lower plasma triglyceride levels in studies by [2] [32]. However, some researchers [8,35] found no significant impact on triglyceride concentrations with BCS supplementation.

The reduction in serum cholesterol levels with BCS diets may be attributed to increased bile production, the influence of thymoquinone and unsaturated fatty acids on cholesterol production and absorption, and the presence of sterols like β-sitosterol in BCS that reduce cholesterol absorption [15]. Additionally, Nofal et al.[4] suggest that BCS may promote the oxidation of cholesterol in bile acids excreted into the colon. This overall decrease in blood cholesterol levels likely indicates a reduction in lipid mobilization in broilers on BCS diets.

The supplementation of liquorice root extract or powder in broiler chickens and Japanese quails has been found to increase plasma glucose levels in a dose-dependent manner [47]. This rise in glucose levels may be attributed to glycyrrhizin, a saponin glycoside found in liquorice that is significantly sweeter than sucrose [48]. However, a few studies have reported lower serum glucose levels in grill chickens supplemented with liquorice extract [41]. In the case of broiler chickens and Japanese quails, plasma glucose levels were not significantly affected by liquorice extract supplementation [42,43,49].

Adding liquorice extract (LE) to drinking water has been shown to significantly reduce blood LDL cholesterol and total cholesterol levels in grill chickens [41]. Similarly, Japanese quails supplemented with liquorice root powder at various doses exhibited significant reductions in triglyceride and cholesterol levels [49,43]). In broiler chickens, the addition of Glycyrrhiza glabra, Thymus vulgaris, or a combination of the two to the diet resulted in a dramatic decrease in serum triglyceride levels [50]. When liquorice and a prebiotic mixture were added to broiler chicken feed, there were no significant changes in serum triglycerides, VLDL, or HDL levels, but levels of cholesterol and LDL cholesterol decreased [42]. The reduction in LDL cholesterol has been attributed to the antioxidant activity of liquorice, which inhibits enzymes involved in lipid peroxidation [51]. In a different study, broiler chicken plasma HDL cholesterol significantly increased with the addition of liquorice root powder to the diet, while plasma LDL cholesterol, total cholesterol, and triglyceride levels remained [52].

Supplementing Japanese quails with crushed licorice root significantly increased serum total protein levels [53]. Similar effects on serum total protein levels were observed in grill chickens with G. glabra supplementation [50]. However, another study reported no change in serum total protein levels in Japanese quails treated with liquorice root powder [49].

Under liquorice supplementation, grill chickens showed significant increases in WBC, RBC, PCV, plasma uric acid, alkaline phosphatase, aspartate aminotransferase, calcium, and phosphorus [52]. Similarly, the addition of liquorice extract to grill chickens increased the concentrations of WBC, RBC, PCV, and Hb . However, there was no significant impact of licorice root supplementation on PCV levels in Japanese quails [53]. Licorice supplementation also increased the WBC count in grill chickens [42] and Japanese quails [45], as well as levels of T3 (triiodothyronine) and T4 (thyroxine).

Conclusions

The comprehensive analysis of the experimental groups revealed promising results. The eighth group, incorporating black seed, garlic, and licorice as forage additives, demonstrated significant superiority in live weight, suggesting improved digestion and enhanced bird immunity. Although blood weight and the feed weight test showed no significant differences, the higher average liver weight in the experimental groups indicated potential immune benefits. While no notable variations were observed in heart and gizzard weight, the groups supplemented with black seed exhibited weight gain. Although not reaching statistical significance, significant differences were found in leg and breast weight. Additionally, all experimental groups experienced a significant reduction in abdominal fat. Licorice and garlic supplementation significantly increased total protein and albumin levels, while globulin levels showed no significant differences. Triglycerides notably decreased in the experimental groups, and the eighth group demonstrated a substantial reduction in total cholesterol levels, particularly LDL cholesterol. Based on these findings, it is recommended to further explore the mechanisms behind

TABLE 4. Hemato –biochemical parameters of growing Japanese quails.

	1	2	3	4	5	6	7	8	SE	Pr
RBCs (x106/mm3)	1.72	1.72	1.72	1.72	1.71	1.73	1.72	1.72	0.006	0.855
TWBCs (x103/mm3)	31.57	31.67	30.64	31.70	30.04	31.70	31.56	31.49	0.817	0.771
Hb%	8.15	8.28	8.58	8.86	8.56	8.76	9.02	8.75	0.301	0.507
PCV	28.06	28.02	27.97	28.56	27.84	28.55	28.49	28.67	0.399	0.685
Total protein (g/dl)	6.220[c]	6.460[b]	6.223[c]	6.443[b]	6.427[b]	6.667[a]	6.473[b]	6.673[a]	0.054	<0.0001
Albumin (g/dl)	3.947[c]	4.093[c]	3.950[c]	4.120[c]	4.113[c]	4.417[b]	4.117[c]	4.723[a]	0.074	<0.0001
Globulin (g/dl)	2.273[ab]	2.367[a]	2.273[ab]	2.323[ab]	2.313[ab]	2.250[ab]	2.357[a]	1.950[b]	0.112	0.266
A/G ratio	1.71	1.69	1.70	1.68	1.65	1.69	1.65	1.70	0.025	0.547
Glucose (mg/dl)	100.00	94.17	103.47	111.71	97.88	101.41	112.90	105.81	6.697	0.501
Calcium (mg/dl)	10.88	10.96	10.81	11.12	10.41	10.96	11.08	10.95	0.337	0.873
Phosphorus (mg/dl)	5.39	5.29	5.02	5.53	5.02	5.52	5.56	5.72	0.269	0.529
Triglycerides (mg/dl)	218.0[a]	213.50[a]	213.60[a]	213.60[a]	206.30[b]	206.20[b]	206.267[b]	200.433[b]	1.900	0.000
Total cholesterol	194.50	191.32	192.76	192.16	189.63	189.06	190.99	185.32	3.201	0.632
HDL (mg/dl)	52.60	54.00	55.70	56.23	56.83	57.10	58.23	54.93	1.706	0.393
LDL (mg/dl)	130.767[a]	127.533[ab]	127.893[ab]	128.180[ab]	125.147[ab]	125.093[ab]	126.08[ab]	120.93[b]	2.784	0.416

a…d. Means, within age and source of variation (S.O.V), with different superscripts, are significantly different [25].

the observed improvements and consider the potential application of these additives in poultry farming for enhanced performance and health outcomes.

Conflicts of Interest

All authors declare that there are no conflicts of interest.

Funding Statement

No funding was received for the conduct of this study.

Author Contributions

All authors contributed to the conception and design of the study. Additionally, all authors have read and approved the final manuscript.

Statements & Declarations

Ethical Consideration

The procedures of this study were approved by the Institutional Animal Care and Use Committee (CU-IACUC) of Cairo University (Approval number: CU-II-F-35-23).

Availability of Data and Material

The data is available within the article.

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"تأثير استخدام حبة البركة والثوم وعرق السوس على خصائص الذبيحة ومعلمات دم السمان الياباني"

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هدفت هذه الدراسة البحثية إلى معرفة تأثير المكملات الغذائية بالحبة السوداء والثوم وعرق السوس على المؤشرات الإنتاجية لـ 600 كتكوت السمان الأبيض في مصر. أجريت التجربة في مزرعة خاصة بالجيزة اعتبارًا من 1 فبراير 2023 ولمدة 34 يومًا. تم تقسيم صيصان السمان إلى ثماني مجموعات ، كل مجموعة تتكون من 75 كتكوت في المتوسط. داخل كل مجموعة ، تم إنشاء ثلاث مكررات ، تضم كل منها 25 كتكوت سمان. تعرضت جميع المجموعات لظروف إسكان ورعاية متطابقة طوال فترة الدراسة التي استمرت 34 يومًا. تلقت المجموعة الضابطة النظام الغذائي القياسي لنظام المزرعة دون أي مكملات ، لتكون بمثابة المجموعة الأساسية. تلقت المجموعات التجريبية السبع المتبقية النظام الغذائي الأساسي المضاف إليه تركيبات مختلفة من الكمون الأسود والثوم وعرق السوس في شكل مسحوق. كانت مستويات المكملات 0.5٪ لكل مكون على حدة وفي تركيبات مختلفة. أظهرت النتائج في الدراسة أن المجموعة الثامنة التي تلقت جميع إضافات الأعلاف (حبة البركة والثوم وعرق السوس) أظهرت تفوقًا معنويًا ($P < 0.05$) في الوزن الحي والساق وعضلة الصدر مما يشير إلى تحسن الهضم وتعزيز مناعة الطيور . أظهرت المجموعات التجريبية ارتفاع متوسط وزن الكبد ، مما يشير إلى الفوائد المحتملة للمناعة. لم يلاحظ أي اختلاف معنوي في وزن القلب والقوانص ، بينما أظهرت المجموعات التي استخدمت الحبة السوداء زيادة في الوزن. تم العثور على فروق ذات دلالة إحصائية في وزن الساق وعضلة الصدر، على الرغم من عدم الوصول إلى مستويات الأهمية. انخفضت نسبة الدهون في منطقة البطن معنويا في جميع المجموعات التجريبية. علاوة على ذلك ، زادت مستويات البروتين الكلي والألبومين بشكل معنوي بسبب عرق السوس والثوم ، بينما لم يلاحظ أي فرق معنوي في مستويات الجلوبيولين. انخفضت الدهون الثلاثية بشكل ملحوظ في المجموعات التجريبية ، وانخفضت مستويات الكوليسترول الكلي ، وخاصة الكولسترول الضار ، بشكل ملحوظ في المجموعة الثامنة.

الكلمات الدالة: حبة البركة ، الثوم ، عرق السوس ، السمان ، الكولسترول.