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Evaluating the dietary effects of elderberry (*Sambucus ebulus*) on production performance, carcass characteristics, biochemical parameters and blood antioxidant status, immune system, and meat sensory and taste traits, and its fatty acid profile in broiler chickens

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Introduction: Elderberry (*Sambucus ebulus*) as a valuable antioxidant, immune stimulant, anti-influenza and antibiotic alternative and a strong antiviral supplement, and in parallel reducing a variety of metabolic and non-metabolic diseases, can have a good prospect in poultry nutrition. It has been proven that *Sambucus ebulus* fruit extract can increase cytokine production by monocytes, and subsequently the expression of IL-6, IL-8 and TNF is revealed, and the immune system in the host body is modulated and improved. Administration of this extract of this plant through drinking water showed positive and promising results in the improvement and treatment of H9N2 avian influenza. Therefore, the present study was planned to evaluate the dietary effects of elderberry (*Sambucus ebulus*) on production performance, carcass characteristics, biochemical parameters and blood antioxidant status, immune system, and meat sensory and taste traits, and its fatty acid profile in broiler chickens.

Material and method: Biological experiments were conducted in a completely randomized design using elderberry (*Sambucus ebulus*) fruit powder (SE) consisting of three treatments of 0, 1.5 and 2%, each treatment consisting of 5 replications and 10 birds per replication, and a total of 150 Ross 308 broiler chickens. Assay diets based on corn and soybean meal were formulated during three periods: starter (1-11 d), grower (12-21 d) and finisher (22-42 d). During the three rearing periods of starter, grower, finisher and the entire period, feed intake (FI) and body weight (BW) were measured, respectively, and FCR was also calculated. At the end of the period, after four hours of starvation, two birds with the average weight of their experimental unit from each replicate were randomly selected and slaughtered and, by separating the carcasses, the following were weighed and measured: live weight, defeather body, eviscerated carcass, breast, thigh, gizzard, crop, liver, heart, pancreas, spleen, bursa of Fabricius weight and abdominal fat, respectively, with a scale with an accuracy of 0.001. In addition, at the end of the period, blood samples were taken from the wing vein of three birds from each replicate using sterile 5 cc syringes, and biochemical blood parameters were measured. To evaluate immunological parameters, sheep red blood cells (SRBC) were injected at a 5% dilution into the pectoral muscle area of the birds on days 28 and 36 of rearing in a volume of 0.2 cc. Seven days after SRBC injection (days 35 and 42), samples were taken from the wing vein of the same injected birds with sterile syringes with a volume of 3 cc to evaluate the level of antibodies against SRBC using the hemagglutination method for Newcastle disease (NDV) and influenza (AIV) titers. In order to evaluate the fatty acid profile of meat, sampling was performed from the whole breast of the bird and meat health indices including omega 6 to omega 3 ratio, atherogenic index (AI), thrombogenic index (TI), hypocholesterolemic index (HI), and hypocholesterolemic to hypercholesterolemic ratio were calculated. For the sensory and taste attributes item including the evaluation of aroma, flavor, odor, tenderness, color and overall desirability of breast meat, one sample was taken from each replicate and the samples were cooked without spices. Then, it was evaluated by six panels (food testers) (by scoring from 1 to 10). All data obtained were collected in Excel software and the results were analyzed with statistical software (SAS 9.3). Comparisons of treatment means were reported with Duncan's multiple range test. Quadratic, linear, nonlinear and orthogonal equations were reported and finding the turning point of quadratic equations was achieved with the "Solver" extension of Excel software. For traits related to breast fatty acids, statistical analysis was not performed and only the raw laboratory data report was published and the calculation of indices was presented.

Results and discussion: The performance results showed that only in the finisher period (22-42 d), the feed conversion ratio (FCR) increased at the level of 2% ($P<0.05$) and for other periods and even the entire period, there was no negative effect on performance after SE feeding ($P<0.05$). Carcass traits for live body weight and defeather body weight in the control treatment were significantly higher in the SE-fed groups ($P<0.05$). Also, for these two mentioned traits, the contrast effects of the control group compared with the combined effect of the SE-fed groups were significantly different ($P<0.05$). Eviscerated carcass, heart and pancreas weights in the control treatment were significant compared with the combined effect of the SE-fed groups ($P<0.05$). However, no significant difference was observed in carcass relative weight between the experimental treatments ($P<0.05$). Results of blood parameters for glucose, cholesterol, atherogenic index, triglyceride, phosphorus, Fe, calcium, liver enzymes and total antioxidant capacity were significantly different in line with the improvement of chicken health after SE feeding ($P<0.01$). For immunological traits Antibody Titr (35day-SRBC test), the treatment containing 1.5% SE and the control treatment had significantly higher values than the 2% SE treatment ($P<0.05$). Meat color was observed to increase in the treatments fed with SE compared with the control treatment ($P<0.05$). Overall, the results indicated that SE feeding in broiler chickens with the least negative effect on performance has a positive role on the biochemical health parameters of blood and immunity of broilers and in parallel affected meat color and the potential of supplementing this antioxidant source in nutrition has a promising perspective for health.

Key words: Antioxidant, Atherogenic index, Broiler chickens, Elderberry, Health, Meat color.

Introduction

Growing demand for food and feed, if not addressed, will pose great risks to humanity (Seidavi *et al.* 2023ab; Abd El-Hack *et al.* 2020; Madhulika *et al.* 2025). The poultry industry, especially the poultry nutrition sector, can play an important role in the food and agricultural cycle and help reduce the aforementioned crises, given its potential and strategic role in food security (Ahmad *et al.* 2022; Hosseintabar-Ghasemabad *et al.* 2024ab). Plants that are high in nutrients, bioactive compounds, and high in growth potential, resistant to various environmental stresses, have ecological compatibility, and can be produced and available with minimal risk, and in the form of enrichment and additive products, can accelerate and facilitate the achievement of important goals in the poultry industry (Janmohammadi *et al.* 2023). The use of natural dietary antioxidant sources has always been considered in nutritional applications in poultry nutrition as a healthy, acceptable solution and in line with reducing the use of antibiotics and chemical growth promoters (Korver 2012; Philips *et al.* 2023). An antioxidant is defined as "a substance that exists in low concentrations against an oxidizable substrate and can significantly delay or prevent the oxidation of that substrate" (Matés *et al.* 1999). Therefore, in order to protect the body against free radical damage and prevent and treat various metabolic and non-metabolic diseases, the use of antioxidant sources can be a low-risk and nutritionally sound strategy. On the other hand, the poultry industry is always faced with a variety of known and unknown pathogens and has the necessary physiological and environmental background for the development of disease. Therefore, healthy nutrition and supplementation of diets with natural products play an important role in maintaining health and preventing disease (Mocanu and Amariei 2022). In addition, the sensitivity of modern commercial poultry to high growth and the relative weakness of this group of animals to stress and tension have necessitated conditions in which stress control and natural growth with natural antioxidant supplements are of particular interest in applied poultry research (Philips *et al.* 2023; Hosseintabar-Ghasemabad *et al.* 2024ac). On the other hand, the growth, spread, and negative effects of various diseases are always faster than finding treatment solutions for them, therefore, strengthening immunity with antioxidant sources for prevention can serve as the first line of defense against various diseases in poultry (Mocanu and Amariei 2022; Hosseintabar-Ghasemabad *et al.* 2024bc). According to scientific documentation, the *Caprifoliaceae* family has 20 genera and more than 300 plant species with rich nutritional and antioxidant properties, and all plants of this family are of interest in scientific research. The most important genera of this family include *Sambucus* (80 species), *Viburunum* (150 species), *Lonicera* (150 species) and *Linnacea* (12 species) (Zargari 1997). The species Sumbucus ebulus, known as SE, is considered one of the most valuable species of this family, and a review of the scientific literature indicates its valuable nutritional and antioxidant properties based on its active constituents (Ebadi and Hisoriev 2011). Flavonoids, steroids, tannins, glycosides, cardiac glycosides, caffeic acid derivatives, ebulitins, ebulin-1 and volatiles substancesare among the most important phytochemical compounds reported in this plant (Saeedi 2010). Additional scientific studies indicate the presence of a unique compound ebulosid (7-oxo-8-deoxyvaleroside) with the molecular formula $C_{21}H_{32}O_{10}$ in the leaves and fruits of the plant (Saravi and Shokrzadeh 2009). In addition, 15 amino acids, ten organic acids, 36 sugar acids and alcohols, 25 mono-, di- and trisaccharides, 13 fatty acids (saturated and unsaturated) and their esters and 38 phenolic compounds have been reported in the plant, indicating the potential of this source in terms of the diversity of constituent compounds (Tasinov *et al.* 2021). Active compounds such as anthocyanins, proanthocyanidins, resveratrol and hydroxycinnamic acids have been reported as the most important anti-inflammatory and stress-reducing antioxidants in blackcurrant fruits (Tasinov *et al.* 2021). The use of SE as an antioxidant-rich fruit can be considered a constructive proposal for supplementation in human and animal nutrition programs (Pascariu and Israel-Roming 2022). Flavonoids present in SE have shown good potential in the prevention of influenza pathogenesis (by competitive inhibition of the virus and through endocytosis), which is a potential advantage for poultry (Akram *et al.* 2018; Mocanu *et al.* 2022). It has been proven that SE fruit extract can increase cytokine production by monocytes, and subsequently the expression of IL-6, IL-8 and TNF is revealed, and the immune system in the host body is modulated and improved (Kinoshita *et al.* 2012; Mocanu *et al.* 2022). Administration of this extract of this plant through drinking water showed positive and promising results in the improvement and treatment of H9N2 avian influenza (Karimi *et al.* 2014). Therefore, SE as a valuable antioxidant, immune stimulant, anti-influenza and antibiotic alternative and a strong antiviral supplement, and in parallel reducing a variety of metabolic and non-metabolic diseases, can have a good prospect in poultry nutrition (Shokrzadeh and Saravi 2010; Merecz-Sadowska *et al.* 2024; Durakova *et al.* 2025). Therefore, the aim of the present study is to evaluate the antioxidant potential of SE fruit in a functional diet for broiler chickens, and also to investigate the items and parameters related to performance, animal health, and the products obtained in the present study.

Materials and Methods

In compliance with the guidelines for the welfare of laboratory animals by the Ethics Committee of Islamic Azad University, Rasht-Gilan Branch, the biological experiments of this study began in 2024 with the ethics code IR.IAU.RASHT.REC.1402.021.

In this study, 150 Ross308 broiler chickens with similar average weight (41±1.0 g) were considered in a completely randomized design including three treatments, five replications and 10 birds per replication. The test ingredient of this study was dried fruit powder of *Sambucus ebulus*, which was supplied by Darvash Giah Khazar medicinal herbs complex company (Ltf) (Iran-Gilan-Rasht). The treatments also included three levels of 0, 1.5 and 2% SE. 42 days of rearing were planned in three periods: starter (1-11 d), grower (12-21 d) and finisher (22-42 d) at the Maaf Research and Development (R&D) farm of Sepid Makian Company (Somaesara-Gilan-Iran). Temperature, light and vaccination management were based on the recommendations of the breeder reference and in accordance with the accompanying guide catalog. The cage dimensions were (1.2m×1.5m×2m) and *ad libitum* access to food and water was considered throughout the period. The assay diets were formulated using Amino Feed 5.0 software from Evonik based on corn and soybean meal according to Table (1). Apparent metabolizable energy corrected to zero nitrogen balance (AME_n) values for the test ingredient of the study were calculated based on the equation proposed by the World Poultry Science Association (WPSA) according to Formula (1).

Formula (1): AME_n (kcal/kg DM) = 15.51 (Crude protein) + 34.31 (Ether extract) + 16.51 (Strach) + 13.01 (Sugar)

The values of Crude protein, Ether extract, Strach and Sugar were measured in Viromed Laboratory (Rasht-Gilan-Iran) according to the Institute of Standards and Industrial Research of Iran (ISIR) method 10703-1, 10700, In House and 8986-2 respectively. Also, phytosterol and tocopherol compounds were evaluated according to the standard method 9760 at Tekno Azma Research and Laboratory Institute (Tehran-Iran) and all items were reported in Table (2).

Table 1- Ingredients and nutrients composition of the assay diets

Items	Starter (1-11 d)			Grower (12-21 d)			Finisher (22-42 d)		
Ingredients (%)	**T_1**	**T_2**	**T_3**	**T_1**	**T_2**	**T_3**	**T_1**	**T_2**	**T_3**
Corn	53.54	51.61	50.99	61.78	59.94	59.33	67.59	67.75	65.13
Soybean meal 44%	40.95	40.85	40.82	33.23	33.12	33.08	27.35	27.23	27.20
Elderberry (SE[1])	0.00	1.50	2.00	0.00	1.50	2.00	0.00	1.50	2.00
Vegetable oil	1.53	2.04	2.20	1.39	1.87	2.03	1.91	2.39	2.55
Methionine	0.35	0.36	0.36	0.28	0.28	0.28	0.22	0.23	0.23
Lysine hydrochloride	0.21	0.20	0.19	0.21	0.20	0.19	0.20	0.19	0.19
Threonine	0.11	0.12	0.12	0.09	0.09	0.10	0.07	0.08	0.08
Valine	0.04	0.04	0.04	0.02	0.03	0.03	0.01	0.01	0.01
Choline chloride	0.01	0.05	0.05	0.07	0.06	0.06	0.07	0.07	0.07
Monocalcium phosphate	1.11	1.11	1.11	0.90	0.91	0.91	0.69	0.69	0.69
Calcium carbonate	1.19	1.17	1.16	1.06	1.04	1.03	0.92	0.90	0.89
Sodium bicarbonate	0.24	0.25	0.25	0.27	0.26	0.26	0.27	0.27	0.27
Sodium chloride	0.21	0.20	0.20	0.19	0.20	0.20	0.19	0.19	0.20
Vit and Min Premix[2]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Phytase	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
Calculated nutrient composition (%)									
ME (kcal/kg)[3]	2853	2853	2853	2937	2937	2937	3040	3040	3040
Crude protein	22.91	22.85	22.83	19.98	19.92	19.90	17.70	17.64	17.62

Lysine	1.26	1.26	1.26	1.09	1.09	1.09	0.96	0.96	0.96
Met + Cys[4]	0.94	0.94	0.94	0.81	0.81	0.81	0.71	0.71	0.71
Threonine	0.83	0.83	0.83	0.72	0.72	0.72	0.63	0.63	0.63
Tryptophan	0.25	0.25	0.25	0.21	0.21	0.21	0.18	0.18	0.18
Arginine	1.40	1.39	1.39	1.20	1.19	1.18	1.04	1.03	1.03
Isoleucine	0.86	0.86	0.86	0.74	0.74	0.74	0.65	0.65	0.65
Valine	0.97	0.97	0.97	0.84	0.84	0.84	0.74	0.74	0.74
Calcium	0.95	0.95	0.95	0.84	0.84	0.84	0.73	0.73	0.73
Av. Phosphorus[5]	0.48	0.48	0.48	0.42	0.42	0.42	0.37	0.37	0.37
Sodium	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Potassium	1.01	1.02	1.03	0.88	0.89	0.90	0.78	0.79	0.79
Chlorine	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
DCAB (mEq/kg)	269	272	273	235	239	240	209	212	213
Choline (g/kg)	1.47	1.69	1.69	1.59	1.59	1.59	1.48	1.48	1.48
Ether extract	4.19	4.83	5.04	4.24	4.85	5.06	4.87	5.48	5.68
Linoleic acid	1.99	2.31	2.41	2.02	2.32	2.42	2.34	2.64	2.74
NDF	9.65	9.95	10.06	9.70	10.02	10.13	9.70	10.02	10.12
ADF	4.19	4.50	4.60	3.97	4.28	4.38	3.79	4.09	4.20
Crude fiber	3.10	3.29	3.35	2.94	3.13	3.19	2.81	2.99	3.06
Ash	6.17	6.23	6.25	5.44	5.49	5.51	4.77	4.83	4.85
Starch	34.20	33.15	32.82	39.38	38.39	38.06	43.03	42.04	41.70

Experimental treatments: T_1: 0% Elderberry level or control group, T_2: 1.5% Elderberry level and T_3: 2% Elderberry level.
[1] SE: *Sambucus ebulus* (Dried fruit powder)
[2]The values of vitamins and minerals per kg of the assay diet: Vitamin A, 9000 IU; vitamin D_3, 3000 IU; vitamin E, 18 IU; vitamin K_3, 3 mg; vitamin B_1, 1.8 mg; vitamin B_2, 6 mg; vitamin B_6, 3 mg; vitamin B_{12}, 0.012 mg; vitamin B_3, 30 mg; vitamin B_9, 1 mg; vitamin H_3, 0.24mg; vitamin B_5, 10 mg; 500 mg; Choline,100 mg; Mn, 100 mg; Zinc, 80 mg; Iron, 10 mg; Cu, 1 mg.
[3]ME: Metabolizable Energy
[4]Methionine + Cysteine
[5]Av. phosphorus: Available Phosphorus

Table 2- Analysis of some chemical, tocopherol, and phytosterol compounds for *Sambucus ebulus*

Items	Values
Crude protein (g/kg)	86.60
Ether extract (g/kg)	141.70
Starch (g/kg)	187.30
Sugar (g/kg)	117.00
Total Sterols (mg/kg)	3879.62
Alpha-Tocopherol (ppm)	41.33
Gamma-Tocopherol (ppm)	36.81
Delta-Tocopherol (ppm)	0.87
Total Tocopherol (ppm)	79.01
Campesterol (%)	0.66
Cholesterol (%)	0.10
Stigma Sterol (%)	0.26
Beta-Sitosterol (%)	78.98
Delta-5-Avena Sterol (%)	17.75
Delta-7-Stigma Sterol (%)	0.07
Delta-7-Stigma Stanol (%)	0.39
Other Sterols (%)	1.79
Moisture and Volatile Matter (%)	8.80
Total Styrene (mg/kg)	0.05

Sampling, measurement and calculation of items and performance and clinical parameters

During the three rearing periods of starter, grower, finisher and the entire period, feed intake (FI) and body weight (BW) were measured, respectively, and FCR was also calculated. At the end of the period, after four hours of starvation, two birds with the average weight of their experimental unit from each replicate were randomly selected and slaughtered and, by separating the carcasses, the following were weighed and measured: live weight, defeather body, eviscerated carcass, breast, thigh, gizzard, crop, liver, heart, pancreas, spleen, bursa of Fabricius weight and abdominal fat, respectively, with a scale with an accuracy of 0.001.

In addition, at the end of the period, blood samples were taken from the wing vein of three birds from each replicate using sterile 5 cc syringes, and biochemical blood parameters were measured. According to the recommendations of the reference laboratory, the samples were prepared for testing under cool conditions and centrifuged (3000 rpm) in commercial kits from Pars Azmoon Company (made in Iran). Colorimetric method was used to measure glucose, triglycerides, total cholesterol, HDL, LDL, total protein, albumin, uric acid, calcium, iron, total antioxidant capacity and malondialdehyde (MDA). The atherogenic index (LDL to HDL ratio) was calculated as a health index (Hosseintabar 2015; Hosseintabar *et al.* 2015; Baghban-Kanani *et al.* 2018; Baghban-Kanani *et al.* 2019a; Baghban-Kanani *et al.* 2019a; Tufarelli *et al.* 2021; Tufarelli *et al.* 2022; Feshanghchi *et al.* 2022; Selim *et al.* 2022; Baghban-Kanani *et al.* 2023; Kianfar *et al.* 2023; Janmohammadi *et al.* 2023). Enzymatic method was used to measure the liver enzymes aspartate aminotransferase (AST) and alanine aminotransferase (ALT). Photometric method was also used to measure phosphorus (P) (Mohamed *et al.* 2024).

To evaluate immunological parameters, sheep red blood cells (SRBC) were injected at a 5% dilution into the pectoral muscle area of the birds on days 28 and 36 of rearing in a volume of 0.2 cc (Seidavi *et al.* 2014). Seven days after SRBC injection (days 35 and 42), samples were taken from the wing vein of the same injected birds with sterile syringes with a volume of 3 cc to evaluate the level of antibodies against SRBC using the hemagglutination method for Newcastle disease (NDV) and influenza (AIV) titers (Shabani *et al.* 2015; Omidi *et al.* 2021; Amirdahri *et al.* 2023).

In order to evaluate the fatty acid profile of meat, sampling was performed from the whole breast of the bird based on the method reported by Zaker Esteghamati *et al.* (2021) and Belali *et al.* (2021) and meat health indices including omega 6 to omega 3 ratio, atherogenic index (AI), thrombogenic index (TI), hypocholesterolemic index (HI), and hypocholesterolemic to hypercholesterolemic ratio were calculated based on formulas (2, 3, 4, and 5) (Attia *et al.* 2022). It should be noted that for this item, only one sampling was performed from each treatment and the technical limitations of the laboratory activities were the reason for the sampling limitation.

Formula (2):	AI= (4 × C14:0) + C16:0/(ΣMUFA + ΣPUFA – ω-6 + ΣPUFA – ω-3)
Formula (3):	TI = (C14:0 + C16:0 + C18:0)/0.5 × ΣMUFA + 0.5 × Σ (ω-6) + 3 × Σ(ω-3) + Σ(ω-3)/Σ(ω-6)
Formula (4):	HI = (C18:1 + C18:2 + C18:3 + C20:3 + C20:4 + C20:5 + C22:4 + C22:6)/(C14:0 + C16)
Formula (5):	Hypocholesterolemic/Hypercholesterolemic index = [(C18:1 ω-9 + C18:1 ω-7 + C18:2 ω-6 + C18:3 ω-6 + C18:3 ω-3 + C20:3 ω-6 + C20:4 ω-6 + C20:5 ω-3 + C22:4 ω-6 + C22:5 ω-3 + C22:6 ω-3)/(C14:0 + C16:0)]

For the sensory and taste attributes item including the evaluation of aroma, flavor, odor, tenderness, color and overall desirability of breast meat, one sample was taken from each replicate and the samples were cooked without spices. Then, it was evaluated by six panels (food testers) (by scoring from 1 to 10) (Azizi *et al.* 2021). Measurements of blood, immune and meat biochemical parameters were performed in the Viromed laboratory (Rasht-Gilan-Iran).

All data obtained were collected in Excel software and the results were analyzed with statistical software (SAS 9.3). Comparisons of treatment means were reported with Duncan's multiple range test. Quadratic, linear, nonlinear and orthogonal equations were reported and finding the turning point of quadratic equations was achieved with the "Solver" extension of Excel software. For traits related to breast fatty acids, statistical analysis was not performed and only the raw laboratory data report was published and the calculation of indices was presented.

Results

The results of the starter period performance (1-11 d) in Table (3) showed that there was no significant difference in feed intake, body weight and FCR of the different experimental groups. Also, the orthogonal, linear and quadratic models were not significant for these traits.

Table 3- Performance results of treatments in broiler chickens (1-11 d)

Treatments	Feed Intake (g)	Body Weight (g)	FCR (g/g)
T_1: (0% SE)	472.00	437.80	1.07
T_2: (1.5% SE)	469.80	433.80	1.08
T_3: (2% SE)	481.80	448.60	1.07
SEM	8.19	7.95	0.006
P-value	0.560	0.42	0.76
Control Vs. SE	0.71	0.73	0.89
Linear	0.41	0.35	0.63
Quadratic	0.49	0.35	0.58

SE: *Sambucus ebulus*

The performance results of the grower period (12-21 d) in Table (4) showed that there was no significant difference in feed intake, body weight and FCR between the control group and the groups fed with different levels of SE. Also, the effects of contrast, linear and quadratic equations between treatments were not significant.

Table 4- Performance results of treatments in broiler chickens (12-21 d)

Treatments	Feed Intake (g)	Body Weight (g)	FCR (g/g)
T_1: (0% SE)	570.90	402.20	1.42
T_2: (1.5% SE)	562.20	392.40	1.43
T_3: (2% SE)	578.40	408.00	1.41
SEM	10.86	10.26	0.02
P-value	0.58	0.56	0.85
Control Vs. SE	0.96	0.87	0.78
Linear	0.63	0.69	0.99
Quadratic	0.36	0.33	0.58

SE: *Sambucus ebulus*

The performance results of the finisher period (22-42 d) in Table (5) showed that there was a significant difference for FCR in the experimental group, such that the 2% group had a higher FCR than the control treatments and 1.5% SE ($P<0.05$). Also, significant linear equation effects ($y = 0.0221x + 1.7506$ with $R2=0.36$) were obtained for the FCR trait.

Table 5- Performance results of treatments in broiler chickens (22-42 d)

Treatments	Feed Intake (g)	Body Weight (g)	FCR (g/g)
T_1: (0% SE)	2882.80	1640.60	1.75^b
T_2: (1.5% SE)	2738.40	1566.20	1.75^b
T_3: (2% SE)	2805.40	1541.70	1.82^a
SEM	54.51	40.46	0.01
P-value	0.21	0.23	0.03
Control Vs. SE	0.12	0.10	0.28
Linear	0.33	0.10	0.03
Quadratic	0.13	0.62	0.10

Means with the same letter for each column are not significantly different
SE: *Sambucus ebulus*

The performance results for the entire period (1-42 d) in Table (6) showed that there was no significant difference for performance traits in the tested groups. Also, the effects of contrast, linear and quadratic equations between treatments were not significant.

Table 6- Performance results of treatments in broiler chickens (1-42 d)

Treatments	Feed Intake (g)	Body Weight (g)	FCR (g/g)
T_1: (0% SE)	3925.70	2480.70	1.58
T_2: (1.5% SE)	3770.40	2392.40	1.57
T_3: (2% SE)	3865.60	2398.30	1.61
SEM	68.046	51.53	0.01
P-value	0.30	0.42	0.18
Control Vs. SE	0.22	0.20	0.44
Linear	0.54	0.28	0.13
Quadratic	0.15	0.47	0.26

SE: *Sambucus ebulus*

The results of carcass weights in Table (7) showed that among the carcass traits, a significant difference was observed for live body weight and defeather body weight (P<0.05), so that for both mentioned traits, the control treatment was significantly higher than each of the groups fed with SE (P<0.05). Also, for these two mentioned traits, the contrast effects of the control group compared with the combined effect of the groups fed with SE were significantly different (P<0.05). In addition, for the parameters eviscerated carcass, heart and pancreas weight, the performance of the control treatment was also significant compared with the combined effect of the groups fed with SE (P<0.05). The linear and quadratic equations that were significant for the mentioned traits were also as follows:

Live body weight=-87.231x + 2547.8	R^2= 0.94
Defeather body weight=-84.769x + 2174.2	R^2= 0.95
Pancreas weight=-0.5015x + 6.1185	R^2= 0.98
Heart weight=$1.8x^2$ - 4.22x + 12.16	Min= 1.17

Table 7- Results of carcass weight traits of treatments in broiler chickens

Treatments	Live body (g)	Defeather body (g)	Eviscerated carcass (g)	Breast (g)	Thigh (g)	Abdominal fat (g)	Gizzard (g)	Heart (g)	Crop (g)	Liver (g)
T_1: (0% SE)	2554.00[a]	2180.00[a]	1904.00	688.00	506.00	23.30	37.64	12.16	9.88	52.04
T_2: (1.5% SE)	2392.00[b]	2024.00[b]	1762.00	666.00	480.00	20.00	39.38	9.88	7.74	46.68
T_3: (2% SE)	2392.00[b]	2022.00[b]	1770.00	654.00	494.00	22.30	38.42	10.92	7.62	46.46
SEM	45.10	35.73	45.49	23.84	18.367	2.66	2.61	0.61	1.62	2.17
P-value	0.03	0.01	0.08	0.60	0.61	0.66	0.89	0.06	0.55	0.16
Control Vs. SE	0.01	0.004	0.02	0.35	0.41	0.51	0.70	0.03	0.29	0.06
Linear	0.02	0.009	0.05	0.33	0.65	0.79	0.83	0.18	0.34	0.09
Quadratic	0.16	0.10	0.20	0.86	0.39	0.39	0.68	0.04	0.62	0.35

SE: *Sambucus ebulus*

The results of carcass relative weight in Table (8) showed that there was no significant difference between the experimental treatments for any of the traits (P<0.05). Also, the orthogonal model of the control treatment was not significant compared with the groups fed with SE and the linear and quadratic models.

Table 8- Results of relative weight percentage of carcass traits of treatments in broiler chickens

Treatments	Defeather body (%)	Eviscerated carcass (%)	Breast (%)	Thigh (%)	Abdominal fat (%)	Gizzard (%)	Heart (%)	Crop (%)	Liver (%)
T_1: (0% SE)	85.37	74.49	26.88	19.78	0.90	1.46	0.47	0.38	2.04
T_2: (1.5% SE)	84.65	73.66	27.86	20.06	0.83	1.64	0.41	0.32	1.95
T_3: (2% SE)	84.53	74.00	27.35	20.65	0.93	1.60	0.45	0.31	1.94
SEM	0.61	0.86	0.69	0.48	0.10	0.09	0.02	0.06	0.09
P-value	0.59	0.79	0.61	0.45	0.80	0.42	0.27	0.70	0.70
Control Vs. SE	0.31	0.54	0.40	0.35	0.88	0.20	0.22	0.41	0.41
Linear	0.35	0.69	0.63	0.23	0.85	0.34	0.57	0.46	0.46
Quadratic	0.69	0.59	0.39	0.79	0.53	0.36	0.13	0.70	0.73

SE: *Sambucus ebulus*

The results of blood parameters showed that in all blood traits mentioned in Table (9) except uric acid, blood albumin and total blood protein, there was a significant difference between the tested treatments (P<0.01). Also, in all traits (except uric acid, blood albumin and total blood protein) a significant difference was observed between the control group compared with the contrast of SE effects (zero group compared with two levels of 1.5 and 2 percent SE). For all traits except (except uric acid, blood albumin and total blood protein) significant linear equations were observed.

For the parameters glucose, cholesterol, atherogenic index, triglycerides, ALT and MDA, a significant difference was observed between the control treatment compared with each of the SE treatments (1.5 and 2 percent) and the performance of the control treatment was significantly higher than the other treatments (P<0.01). For HDL, iron and TAC parameters, a significant difference was observed between the control treatment compared with each of the SE treatments (1.5 and 2 percent) (P<0.01), and the performance of the treatments containing SE was significantly higher than the control treatment. With increasing SE levels, a significant downward trend was observed in the performance of each of the LDL and AST parameters, so that the control treatment showed higher and significant values compared with the two treatments containing SE (1.5 and 2 percent) and also the 1.5 percent treatment compared with 2 percent (P<0.01). The highest to lowest blood phosphorus levels were for the 1.5 percent treatment, the 2 percent SE treatment and the control treatment, respectively, so that the 1.5 percent treatment showed a significant difference compared with the two treatments of 2 percent SE and the control, while the 2 percent treatment also had a significant difference from the control treatment (P<0.01). With increasing SE levels, a significant upward trend was observed in blood calcium, so that the control treatment showed significantly lower performance compared with the two treatments containing SE (1.5 and 2%) and also the 1.5% treatment compared with 2% (P<0.01).

Table 9- Results of blood biochemical parameters of treatments in broiler chickens

Items	Treatments			SEM	P-value	Control Vs. SE	Linear			Quadratic
	T_1	T_2	T_3				P value	Equal	R^2	
Glucose (mg/dl)	186.20^a	171.80^b	170.00^b	1.69	0.0001	0.0001	0.0001	y = -8.44x + 185.80	0.98	0.0102
Cholesterol (mg/dl)	183.40^a	156.00^b	159.00^b	1.64	0.0001	0.0001	0.0001	y = -13.6x + 182.00	0.88	0.0001
HDL (mg/dl)	37.16^b	46.90^a	47.60^a	0.74	0.0001	0.0001	0.0001	y = 5.514x + 37.40	0.96	0.0003
LDL (mg/dl)	102.34^a	94.88^b	90.80^c	0.87	0.0001	0.0001	0.0001	y = -5.58x + 102.50	0.98	0.14

Atherogenic Index	2.76^{a}	2.02^{b}	1.91^{b}	0.05	0.0001	0.0001	0.0001	y = -0.443x + 2.74	0.98	0.0010
Triglycerides (mg/dl)	77.40^{a}	71.50^{b}	73.44^{b}	0.77	0.0005	0.0002	0.0035	y = -2.43x + 76.90	0.71	0.0014
Uric Acid (mg/dl)	5.74	5.78	5.89	0.09	0.52	0.40	0.27	-	-	0.80
Albumin (g/dl)	2.12	2.14	2.13	0.01	0.68	0.40	0.49	-	-	0.60
Total Protein (g/dl)	4.38	4.36	4.38	0.01	0.47	0.44	0.84	-	-	0.23
Phosphorus (mg/dl)	3.82^{c}	4.77^{a}	4.30^{b}	0.04	0.0001	0.0001	0.0001	y = 0.331x + 3.91	0.53	0.0001
Fe (µg/dl)	131.80^{b}	140.40^{a}	139.60^{a}	1.31	0.0010	0.0003	0.0012	y = 4.32x + 132.2	0.89	0.01
Ca (mg/dl)	10.63^{c}	11.11^{b}	11.62^{a}	0.02	0.0001	0.0001	0.0001	y = 0.45x + 10.59	0.91	0.64
ALT (u/l)	14.20^{a}	9.26^{b}	8.50^{b}	0.43	0.0001	0.0001	0.0001	y = -2.95x + 14.09	0.98	0.0020
AST (u/l)	360.40^{a}	306.60^{b}	293.00^{c}	2.87	0.0001	0.0001	0.0001	y = -34.2x + 359.90	0.99	0.0001
MDA (nmol/ml)	20.04^{a}	18.70^{b}	18.04^{b}	0.34	0.0044	0.0018	0.0014	y = -0.97x + 20.06	0.99	0.43
TAC (nmol/ml)	707.20^{b}	847.40^{a}	828.40^{a}	10.98	0.0001	0.0001	0.0001	y = 68.18x + 714.7	0.87	0.0001

Means with the same letter for each row are not significantly different.

SE: *Sambucus ebulus;* T_1: (0% SE); T_2: (1.5% SE); T_3: (2% SE)

The results of immunological traits in Table (10) showed that the type of treatment had a significant effect on the performance of Antibody Titr (35day- SRBC test) ($P<0.05$). So that the treatment containing 1.5% SE and the control treatment had a higher and more significant Antibody Titr (35day- SRBC test) value than the 2% SE treatment. The linear equation for the significant parameter Antibody Titr (35day- SRBC test) was as follows:

Antibody Titr (35 day- SRBC test): $y= -0.4923x + 2.5$ $R^2= 0.18$

Also, comparing the contrast effects of the control treatment compared with the groups fed with SE and the linear equation ($y = -0.5015x + 6.1185$ with a coefficient of determination of 0.98) for pancreas weight was significant ($P<0.05$).

Table 10- Results of immunological parameters of treatments in broiler chickens

Treatments	Antibody Titr (35 day-SRBC test)	Antibody Titr (42day-SRBC test)	Pancreas weight (g)	Relative weight of the pancreas (%)	Spleen weight (g)	Relative weight of the spleen (%)	Fabricius weight (g)	Relative weight of the Fabricius (%)
T_1: (0% SE)	2.20^{a}	5.00	6.10	0.24	3.16	0.12	2.00	0.07
T_2: (1.5% SE)	3.00^{a}	5.60	5.44	0.23	2.46	0.10	1.76	0.07
T_3: (2% SE)	0.60^{b}	4.00	5.06	0.21	3.02	0.13	1.76	0.07
SEM	0.40	0.76	0.30	0.01	0.26	0.01	0.26	0.01
P-value	0.004	0.36	0.09	0.33	0.17	0.27	0.76	0.94
Control Vs. SE	0.43	0.83	0.04	0.22	0.21	0.49	0.47	0.74
Linear	0.01	0.37	0.03	0.14	0.71	0.87	0.53	0.77
Quadratic	0.008	0.26	0.71	0.91	0.07	0.11	0.71	0.86

SE: *Sambucus ebulus*

The results of the taste and sensory attributes of meat in Table (11) showed that only meat color was affected by the experimental treatments, so that a significant difference was observed between the meat color of the treatments containing SE (1.5 and 2 percent) compared with the control treatment (P<0.05). Also, the results of the contrast effects of the control group compared with the treatments containing SE, the linear equation (y = 0.6462x + 7.0462 and the coefficient of determination 0.94) for the meat color attribute was significant (P<0.05).

Table 11- Results of sensory and taste characteristics of breast meat of treatments in broiler chickens

Treatments	Meat perfume	Meat taste	Meat smell	Meat crispy	Meat color	Desirability and acceptance of meat
T_1: (0% SE)	7.00	7.60	7.40	7.20	7.00^b	7.60
T_2: (1.5% SE)	7.60	8.00	8.20	7.60	8.20^a	7.40
T_3: (2% SE)	7.60	7.20	8.00	8.60	8.20^a	8.20
SEM	0.32	0.25	0.36	0.34	0.35	0.29
P-value	0.35	0.13	0.30	0.03	0.05	0.17
Control Vs. SE	0.16	0.99	0.14	0.05	0.01	0.58
Linear	0.21	0.29	0.26	0.01	0.03	0.17
Quadratic	0.46	0.08	0.28	0.49	0.19	0.19

Means with the same letter for each row are not significantly different.

SE: *Sambucus ebulus*

The fatty acid profile of broiler breast meat is reported in Table (12) and the calculation and health-related indices were reported for each treatment, and statistical analysis and Duncan comparisons were not performed. Evaluation of indices for judging the health of meat products in the future perspective of healthy nutrition can be one of the important goals of applied research in the poultry industry.

Table 12- Results of fatty acid profile of breast meat of treatments in broiler chickens

Items	Treatments		
	T_1: (0% SE)	T_2: (1.5% SE)	T_3: (2% SE)
Caprylic acid (C8:0)	0.01	0.04	0.05
Capric acid (C10:0)	0.01	0.04	0.05
Lauric acid (C12:0)	0.06	0.31	0.47
Myristic acid (C14:0)	0.56	0.69	0.67
Pentadecanoic acid (C15:0)	0.07	0.10	0.10
Palmitic acid (C16:0)	23.86	26.17	23.98
Margaric acid (C17:0)	0.12	0.14	0.12
Stearic acid (C18:0)	7.47	7.63	6.58
Arachidic acid (C20:0)	0.26	0.24	0.16
Behenic acid (C22:0)	0.34	0.50	0.32
Total SFA	32.76	35.86	32.50
Myristoleic acid (C14:1)	0.12	0.11	0.11
Palmitoleic acid (C16:1)	4.16	4.20	4.20
Elaidic acid (C18:1t)	0.13	0.12	0.13
Oleic acid (C18:1c)	33.87	31.01	33.77
Gondoic acid (C20:1)	0.09	0.09	0.02
Erucic acid (C22:1)	0.02	0.02	-
Total MUFA	72.35	66.65	72.02
Linoleic acid (C18:2c)	25.22	24.21	25.31
Linolelaidic acid (C18:2c)	25.22	24.21	25.31
Cis-11,14-Eicosadienoic acid (C20:2)	0.25	0.35	0.27
Arachidonic acid (C20:4)	0.07	0.13	0.04

Cervonic acid (22:6)	0.18	0.14	0.20
Total PUFA, n-6	50.94	49.04	51.13
Dihomo-γ-linolenic acid (C20:3)	1.13	1.82	1.53
Linolenic acid (18:3)	1.85	1.80	1.80
Total PUFA, n-3	2.98	3.62	3.33
Total PUFA, n-6/Total PUFA, n-3	17.09	13.54	15.35
Other	0.13	0.11	0.11
UFA	123.42	115.80	123.26
UFA/SFA	3.76	3.22	3.79
Atherogenic index (AI)	2.43	2.97	2.86
Thrombogenic index (TI)	4648.95	4632.97	4533.98
Hypocholesterolemia index (HI)	2.55	2.20	2.54
Hypocholesterolemic / Hypercholesterolemic	5.05	4.31	5.00

PUFA: polyunsaturated fatty acids, MUFA: monounsaturated fatty acids, UFA: unsaturated fatty acids, SFA: Saturated fatty acids fatty acids

Discussion

A review of the scientific literature and the latest documentation presented in the research showed that the studied species was rich in bioactive compounds, especially the profile of tocopherols and phytosterols. Bubulica *et al.* (2012) confirmed the presence of sterol side compounds including beta-sitosterol, campesterol, stigmasterol, sitosterol in SE fruit. Tasinov *et al.* (2012) reported the highest sterol as beta-Sitosterol (40.43%). In the present study, the analysis of a laboratory sample in Table (2) showed that beta-sitosterol had the highest amount (78.98%), which was in agreement with other researches. Other compounds in SE include anthocyanins and flavonoids (potent antioxidants), phenolic acids (immunostimulatory and antimicrobial), tocopherols (immune-enhancing), and terpenoids (anti-inflammatory effects) that have been shown to have beneficial effects on the health of the consuming host (Chakravarti *et al.* 2012; Cvetanović 2020). The researchers of this study did not obtain any new achievements on the nutritional use of SE in poultry nutrition, especially in the broiler animal model, and most studies were conducted in other animal models and focused on the pharmacological properties of this antioxidant source. However, in order to better discuss and understand the results, the latest research findings and generalization of its results to poultry nutrition will be used. The effectiveness of SE extract in feeding carp (Cyprinus carpio) resulted in improved FCR and weight at 1 and 5% levels (Hosseini Shekarabi *et al.* 2021; Binaii *et al.* 2022). The results on the fish animal model were not consistent with the results of this study and it seems that the differences in the type of animal and the level of consumption were the reasons for these differences.

The reduction in blood sugar as well as the reduction in cholesterol, triglyceride, LDL, atherogenic index, ALT, AST and MDA and the parallel increase in HDL, Phosphorus, Fe, Ca and TAC after feeding SE in broilers indicate the high potential of this dietary source as a health-promoting dietary supplement in poultry nutrition.

Consumption of SE fruit infusion for one month in 21 volunteers aged 20 to 59 years resulted in a decrease in triglycerides (14.92%), cholesterol (15.04%), LDL (24.67%) in human blood, and an improvement in the HDL to LDL ratio of 42.77%. In parallel, the antioxidant status of the volunteers' blood was significantly improved, and overall, the preventive role of this dietary source against lipid metabolism disorders and the reduction of oxidative stress and diabetes was promising (Ivanova *et al.* 2014). The results presented in the aforementioned study were consistent with the present study. It seems that the decrease in serum levels of CRP, IL-1β, leptin, and adiponectin after consumption of SE fruit extract led to an increase in immune modulatory activity and lipid metabolism. Given that macrophages are the source of various proinflammatory cytokines, chemokines and act in a paracrine and endocrine manner, therefore, in low-grade inflammation and obesity, activation and release of chemokines by attracting macrophages and creating an inflammatory process through nutrition leads to complications such as diabetes and atherosclerosis. Released cytokines and chemokines such as TNFα, IL-6, IL-1β and NO as iNOS can activate signaling pathways by Jun N-terminal kinase (JNK) and Inhibitor of β-kinase and subsequently stimulate proinflammatory genes (Nguyen *et al.* 2007). Therefore, SE consumption can be very effective in reducing this process and contributing to the health of its consumers (Olefsky and Glass 2010). Despite the beneficial effects of SE consumption on health, the use of this source in dietary programs is limited due to the complexity of active compounds and low palatability (Jiménez *et al.* 2015; Eyupoglu *et al.* 2024). The most abundant anthocyanins of SE, including cyanidin-3-O-galactoside and cyanidin-3-sambobioside, play an important role in immune modulation and prevention against various diseases, and enhance anti-oxidative and anti-inflammatory properties under conditions of physiological stress (Kiselova-Kaneva *et al.* 2023).

SE fruit contains structural proteins (lectins) that bind sugars together with the activity of ribosome-inactivating proteins (RIPs). RIPs are enzymes that can inhibit protein synthesis by stopping the elongation of polypeptide chains. Evidence suggests that this potential plays an important role in plant defense against predators and viruses, nitrogen storage, and immunogenic properties. The evaluation of the toxicity of ebulin and the immunotoxin properties of this plant to prevent adverse effects is one of the reasons for its use at low levels in nutritional studies. Lectins are proteins that bind sugars, and RIPs are enzymes that hydrolyze the N-glycosidic bond, resulting in the attachment of adenine (4234) to the ribose phosphate backbone of 28S rRNA. RIPs are of two types in SE depending on their structure. Type 1 RIPs are single-chain (A chain) and have only enzymatic activity. Type 2 RIPs have two- and four-chain proteins A and B, in which the A chain is an enzyme and the B chain contains a lectin. In the alpha ebulitins, type 1 RIP is found, and in ebulin, beta and gamma RIP forms are found, in both cases the potential for enhancing immunity and the properties of promoting their antiviral role are important. It seems that improving the immune system by consuming this source in chickens with such a mechanism is not far-fetched. Tasinov *et al.* (2021) also announced in a review report examining the phytochemical compounds and in SE fruit that there is a potential for immune stimulation, anti-inflammatory, anti-stress, hematopoietic and antiviral properties in this edible source. In complementary studies, consumption of fruit aqueous extract (FAE) has been considered to modulate immunity and enhance anti-inflammatory activities by reducing endoplasmic reticulum (ER) stress under lipopolysaccharide (LPS) stimulation conditions (Fathi *et al.* 2015; Tasinov *et al.* 2021).

Phytochemicals in SE fruit such as anthocyanins, proanthocyanidins and hydroxycinnamic acids can play an effective role in creating the aforementioned condition and helping to reduce stress and modulate immunity (Seymenska *et al.* 2023; Floares *et al.* 2025). In fact, transcriptional stimulation for immune stimulation, without causing stress, will occur with the help of COX2, Ccl2, TNFα, IL-6 and iNOS enzymes in the ER system with the consumption of this plant fruit (Tasinov *et al.* 2020ab; Eyupoglu *et al.* 2024). SE extract suppresses the transcription of pro-inflammatory genes such as IL-1β, IL-6, TNFα, Ccl2, Icam-1, Fabp4, COX2, iNOS, Noxo1, IL-1ra, Sirt-1 induced by lipoprotein saccharide (LPS) and reduces their protein levels, and subsequently, by targeting ER stress, it provides an anti-inflammatory background and helps to reduce inflammation in pathological conditions and stress (Tasinov *et al.* 2020ab and 2021; Floares *et al.* 2025). On the other hand, research shows that protein synthesis, endoplasmic reticulum (ER) plays an important role in nutrient absorption and has a positive effect on activating protein synthesis in stress and disease conditions (Ozcan *et al.* 2004; Tasinov *et al.* 2021). Following increased ER stress, inflammation by iNOS can be increased and this enzyme can be considered a therapeutic target as a factor in reducing inflammation and ER stress (Zhang and Kaufman 2008; Anthony and Wek 2012). In general, in the state of ER stress and inflammation and pathological conditions, compounds such as resveratrol (Li *et al.* 2011; Sun *et al.* 2020), epigallocatechin-gallate (Karthikeyan *et al.* 2017), and proanthocyanidins present in the SE plant play an effective role in contributing to host health. Given that SE fruits are rich in polyphenols, anthocyanins and stilbenes, the fight against ER stress and inflammation is carried out with good efficiency, and the preventive role of SE against many viral and infectious diseases and based on the aforementioned mechanisms is not far-fetched and the health of the consumer will be guaranteed.

The anthocyanins of SE fruits also have high antioxidant activity and protect macrophages against cytotoxicity caused by oxidative stress and produced tert-Butyl hydroperoxide (Todorova *et al.* 2019). In fact, macrophages fed lipopolysaccharides and ethanol can stimulate transcription and suppress glutamate-cysteine ligase, glutathione peroxidase and nuclear factor kappa B (NFκB) (Tasinov *et al.* 2020ab). In addition, ethyl acetate in SE fruits has cytoprotective and anti-inflammatory activities, reducing ethanol-induced cell death and increasing pro-inflammatory gene transcription in macrophages (Zahmanov *et al.* 2015; Tasinov *et al.* 2021). In a study, methanolic and n-hexane extracts of SE fruits were able to inhibit the pro-inflammatory enzyme cyclooxygenase (COX), thereby contributing to anti-inflammatory effects. In addition, the analgesic effects of SE extract were mediated by the release of endogenous glucocorticoids and steroids, through interaction with adrenergic receptors in the serotonergic system derived from L-arginine, by affecting the nitric oxide (NO) pathway and interacting with the tachykinin pathway, helping to reduce the effects of pain and enhance the immune system (Ahmadiani *et al.* 1998; Shokrzadeh and Saravi 2010). Other studies have also shown the anti-Helicobacter pylori activity of SE to reduce the pain of gastric ulcers and reduce the use of antibiotics and contribute to the health of the digestive system, which were very promising results (Yesilada *et al.* 1999; Eyupoglu *et al.* 2024ab).

The set of mechanisms presented in human research and other laboratory animal models indicate that SE fruit, in addition to have a number of valuable active compounds, has good potential for supplementation in poultry diets. All the events after consuming this valuable food source, including immune modulation, helping with digestive system health, stress reduction, reduced antibiotic consumption, antiviral properties, preventive properties against infectious diseases, enhanced anti-inflammatory properties, and enhanced antioxidant properties, are not far from expected for the broiler animal model and can meet the expectations of the poultry industry for this source as a valuable herbal supplement

Conclusion

Nutritional evaluation of SE fruit consumption in broiler chickens showed that consumption of this source as a dietary supplement at low levels can affect animal health without negatively affecting production performance and by improving the lipid and antioxidant profile of the blood and reducing glucose and liver enzymes, it leads the biochemical status of the bird's blood towards health and in parallel strengthens the antibody titer of the chicken. The color of the meat also increased after feeding this source, which can be considered in future research along with other effective findings for poultry meat products. Considering that SE plant has high germination power and good distribution in many poor clay soils in plain areas and the supply of its fruit is economically justified in many countries; therefore, the exploitation of the antioxidant properties of this source in poultry nutrition as an effective phytogenic herbal supplement that contributes to animal health can offer a promising position in the future perspective of poultry nutrition.

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ارزیابی اثرات تغذیه ای آقطی (*Sambucus ebulus*) بر عملکرد تولیدی، ویژگی‌های لاشه، پارامترهای بیوشیمیایی و وضعیت آنتی‌اکسیدانی خون، سیستم ایمنی، ویژگی‌های حسی و چشایی گوشت و پروفیل اسیدهای چرب آن در جوجه‌های گوشتی

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چکیده

زمینه مطالعاتی: مطالعه حاضر به منظور ارزیابی اثرات غذایی آقطی (*Sambucus ebulus*) بر عملکرد تولیدی، ویژگی‌های لاشه، پارامترهای بیوشیمیایی و وضعیت آنتی‌اکسیدانی خون، سیستم ایمنی، ویژگی‌های حسی و چشایی گوشت و پروفیل اسیدهای چرب آن در جوجه‌های گوشتی برنامه‌ریزی شده بود. **روش کار**: آزمایش‌های بیولوژیکی در قالب طرح کاملاً تصادفی با استفاده از پودر میوه آقطی (*Sambucus ebulus*) (SE) شامل سه تیمار ۰، ۱/۵ و ۲ درصد، هر تیمار شامل ۵ تکرار و ۱۰ پرنده در هر تکرار و در مجموع ۱۵۰ قطعه جوجه گوشتی راس ۳۰۸ انجام شد. جیره‌های آزمایشی بر پایه ذرت و کنجاله سویا در سه دوره آغازین (۱-۱۱ روزگی)، رشد (۱۲-۲۱ روزگی) و پایانی (۲۲-۴۲ روزگی) فرموله شدند. **نتایج**: نتایج عملکرد نشان داد که فقط در دوره پایانی (۲۲-۴۲ روزگی)، ضریب تبدیل غذایی (FCR) در سطح ۲٪ افزایش یافت (P<0/05) و برای سایر دوره‌ها و کل دوره، هیچ تأثیر منفی بر عملکرد پس از تغذیه SE وجود نداشت(P<0/05) . صفات لاشه برای وزن زنده و وزن بدن پرکنده در تیمار شاهد در گروه‌های تغذیه شده با SE به طور معنی‌داری بیشتر بود (P<0/05). همچنین، برای این دو صفت ذکر شده، اثرات متضاد گروه شاهد در مقایسه با اثر ترکیبی گروه‌های تغذیه شده با SE تفاوت معنی‌داری داشت (P<0/05). وزن لاشه بدون احشاء، قلب و پانکراس در تیمار شاهد در مقایسه با اثر ترکیبی گروه‌های تغذیه شده با SE معنی‌دار بود (P<0/05). نتایج پارامترهای خونی برای گلوکز، کلسترول، شاخص آتروژنیک، تری‌گلیسیرید، فسفر، آهن، کلسیم، آنزیم‌های کبدی و ظرفیت آنتی‌اکسیدانی کل پس از تغذیه باSE، تفاوت معنی‌داری داشتند (P<0/01) . برای صفات ایمونولوژیکی تیتر آنتی‌بادی (آزمایش SRBC ۳۵ روزگی) ، تیمار حاوی ۱/۵٪ SE و تیمار شاهد مقادیر معنی‌داری بالاتر از تیمار ۲٪ SE داشتند (P<0/05). رنگ گوشت در تیمارهای تغذیه شده با SE در مقایسه با تیمار شاهد افزایش یافت (P<0/05).

واژگان کلیدی: آنتی‌اکسیدان، شاخص آتروژنیک، جوجه‌های گوشتی، آقطی، سلامت، رنگ گوشت