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Efficacy of Cinnamon, Spirulina and Chlorella Utilization in Broiler Diets

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ABSTRACT:
The existing experiment was carried out to study the impact of Cinnamon powder (CP), Spirulina platensis and Chlorella utilization in broiler diets on broiler productivity, carcass features and serum biochemical parameters of broilers. In addition, immune status and antioxidant enzymes were estimated. 180 1-day-age, unsexed chicks (Ross-308) will be acquired from local commerce sources and will be allocated randomly into 4 equal groups 45 birds in each in 3 replicates (15 chicks/replicate). Control group was fed basal diets without any treatment, G2 was fed diets treated with 1g of Cinnamon powde/kg diet, G3 was fed diets treated with 5g of Spirulina powder/kg diet, and G4 was fed a diet treated with 5g Chlorella powder/kg diet. The finding displayed that the Spirulina platensis treated group documented significant ($P<0.05$) improved body weight and weight gain (3073g, 3025.10g) than the untreated group (2733.60g, 2683.40g). During the trial period, the good FCR was documented in G3 (Spirulina), followed by G2 (Cinnamon), while the worst was recorded in the control group. Additionally, the finding demonstrated a significant rise in the albumin in the 2nd group supplemented with Cinnamon (0.86 g/dL). Triglyceride proved a significant reduction in all treatments in comparison to the untreated group. Alanine aminotransferase (ALT) demonstrated a significant decline in the 2nd group supplemented with Cinnamon (13.55 IU/L) relative to the control group (17.23 IU/L). The existing study's outcomes illustrated that the third group of broilers receiving a diet containing 5g/kg of Spirulina powder.

KEYWORDS: Growth performance, carcass traits, broilers, phytogenic, microalgae.

1. Introduction

Phytogenic feed additives known as Phytobiotics are substances produced from plants supplied to diets to enhance performance in animals and poultry. Common herbs and spices utilized as phytogenic feed additives in the poultry industry include oregano, thyme, chile, pepper, cinnamon, anise, and rosemary. Approximately 70–80% of the animal diet production sectors use botanicals, in the feeding of poultry and pigs [1]. These additives seem to offer an extensive range of beneficial activities. According to [2, 3, 4, 5] they possess antibacterial, antiviral, antifungal, antiparasitic, antioxygenic, and insecticidal activity. Cinnamon (Cinnamomum zeylanicum), a historically significant and widely utilized medicinal herb, can be incorporated into poultry feed in the shape of dried meal or extract of essential oil. Cinnamon is a phytogenic feed additive (PFA) permitted for use in poultry feed production by the US Food and Drug Administration (FDA). Since 2000, bioactive chemicals, such as phenolic substances and cinnamaldehyde have been used in broilers nutrition as supplements to boost metabolism, immunity status, overall health status, antioxidant state, productivity, carcass characteristics and meat quality. Microalgae are microscopic unicellular organisms that yield an extensive variety of compounds, including proteins, lipids, carbohydrates, minerals and vitamins for human consumption and animal feed [6] . These are natural substance components with significant nutritional value, employed in poultry feed to enhance meat color and nutritional quality as a partial substitution for traditional protein. Furthermore, they have been associated with enhancements in health status and well-being [7, 8]. Chlorella is a green algae it is thought to be one of the most important algae because it contains a great source of nutrients like (proteins, lipids, fiber, carbohydrates, vitamins, and minerals) in addition to quick growth and simple to grow [9]. Chlorella has

great impacts, like growth promotor, immune boosting, antioxidant activation, and tissue repair [10]. Spirulina is a microalgae that developed in freshwater; it has several compounds such as phycocyanin [11], carotenoids, iron and vitamins, antioxidants, phenolic chemicals, alkaloids, flavonoids, glycosides, tannins, steroids, and saponins [12]. Moreover, Spirulina is a native feed additive utilized for centuries as a nutritional source. It possesses a high protein, essential fatty acids, chlorophyll and a superior concentration of vitamins A, C, E, and B-complex vitamins. Spirulina is also abundant in iron, magnesium, phosphorus, calcium, potassium, and sodium [13].

2. Material and methods

2.1. Ethical approval

This study methodology and all animal experiments were formulated following the criteria for Animal Experimentation. They obtained approval from the Institutional Review Board, Medical Ethics Committee, Faculty of Veterinary Medicine, New Valley University, Egypt (02-1-6-2023-2). The existing study was performed at the Research Center of the Teaching Veterinary Hospital, Department of Nutrition and Clinical Nutrition, Faculty of Veterinary Medicine, New Valley University. The experiment lasted 42 days, from December 29 to February 2, 2024.

2.2. Birds and housing

180 one-day-old, unsexed broilers (Ross-308) will be acquired from local commercial sources and will be allocated randomly into 4 equal groups each of 45 chicks in three replicates (15 chicks/replicate). G1 was fed basal diets without any treatment (control), the G2 was fed diets treated with 1g of Cinnamon powder/kg diet, the G3 was fed diets treated with 5g of Spirulina powder/kg diet, and the G4 was fed a diet treated with 5g Chlorella powder/kg diet. All birds will be nearly equal in initial body weight at the beginning of the experiment.

Table 1: Composition and chemical analysis of the experimental diets (starter and finisher diets).

Items		
Starter	Finisher	
Ingredients (%)		
Yellow Corn	56.85	61.25
Soybean meal	34.30	32.80
Soybean oil	0.70	2.50
Corn gluten (62% CP)	4.50	0.00
Di-Calcium phosphate	0.20	0.25
Limestone	2.20	2.00
Vit-min Premix*	0.30	0.30
NaCl	0.30	0.30
DL-Methionine	0.17	0.20
L-Lysine	0.28	0.25
Choline Chloride 60%	0.20	0.15
Total	100	100
Calculated analysis** (%)		
CP	23.11	20.07
ME Kcal/kg diet	2913	3107
Ca	1.00	0.97
P (Available)	0.46	0.45
Lysine	1.40	1.29
M+C	0.92	0.82
CF	3.62	3.57
Linoleic acid	1.38	1.47

* Growth Vitamin and Mineral premix Each 2.5 kg consists of: Vit A 12000, 000 IU; Vit D3, 2000, 000 IU; Vit. E. 10g; Vit k3 2 g; Vit B1, 1000 mg; Vit B2, 49g; Vit B6, 105 g; Vit B12, 10 mg; Pantothenic acid, 10 g; Niacin, 20 g, Folic acid, 1000 mg; Biotin, 50 g; Choline Chloride, 500 mg, Fe, 30 g; Mn, 40 g; Cu, 3 g; Co, 200 mg; Si, 100 mg and Zn, 45 g. ** Calculated according to NRC (1994). *** Determined according to AOAC (2006).

2.3. Experimental Diets

They were given standard broiler diets according to [14]. Feed and water were ad libitum. From 0 to 6 weeks of age, every group of broiler chicks was fed pellets. Data (Table 1) demonstrates the composition and layout of the commercial broiler diet. Cinnamon powder was purchased from Biochem Egypt Limited, Hadayk El Ahram, Giza, Egypt, while Spirulina and Chlorella were

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obtained from the Agriculture Research Center in Doki, Giza, Egypt.

2.4. Growth performance

The live body weight (LBW) of chicks was recorded individually at starting of the research and subsequently on a weekly basis during the experimental duration. Measurements were taken in the morning prior to providing feed and water. The total individual LBW was calculated and divided by the number of chicks to determine the average LBW. The weekly body weight increase (BWG) of chicks was determined by subtracting the live body weight (LBW) at the week's starting from the LBW at the week's end. The total BWG for each group was calculated and divided by the number of chicks to detect the average BWG. The diets were administered consistently in the morning, and the daily feed consumption for each replicate was determined by calculating the difference between the weight of the offered feed and the residual feed, subsequently divided by the number of birds in that subgroup to derive the average feed consumption per bird per day, which was then aggregated weekly. The mean feed intake per bird for the experimental duration of 42 days was determined for each group. Feed use was quantified by the feed conversion ratio (FCR). The feed conversion ratio was computed weekly as grams of feed intake divided by grams of body weight gain.

2.5. Carcass traits

At the conclusion of the research, 3 birds were randomly selected from each group (one from each replication), weighed, and euthanized following an overnight fast to ensure full death. The weight of the dressed carcasses (the weight of slaughtered birds after the removal of feathers, head, and feet, but containing all edible offal) was documented. Dressed carcass weight = weight of eviscerated carcass + giblets (liver without gall bladder, heart and skinned empty gizzard). The dressing % was computed as (Dressed carcass weight/weight of the live bird) X100 [15].

2.6. Blood chemistry

At the conclusion of the trial, 3 randomly chosen birds from each group (one from each replication) were euthanized following an overnight fast. 3 blood samples were obtained from each of the 3 slaughtered birds in each group using non-heparinized tubes. The serum was isolated via centrifugation at 3000 rpm for 10 minutes and thereafter kept at -20°C until further examination. The identified biochemical parameters encompass total protein (TP), albumin (ALB), aspartate aminotransferase (AST), alanine aminotransferase (ALT), creatinine, urea levels, total cholesterol (TC), high-density lipoprotein (HDL), cholesterol, triglyceride (TG), MDA, catalase enzyme and superoxide dismutase (SOD). The measurements were acquired using diagnostic instruments supplied by Bio Diagnostic Co. in Giza, Egypt.

2.7. Statistical analysis

The mean ± standard error was used to present the results. Utilizing SPSS 16.0 statistical software [16] , all data were subjected to a one-way analysis of variance (ANOVA) and subsequently a least significant variation (LSD) test.

3. Results

3.1. Growth parameters

The influence of Cinnamon, Spirulina, and Chlorella on BWG, FI and FCR during the experimental period and the all research period are explained (Table 2). The finding demonstrated that the Spirulina platensis treated group illustrated significantly increased body weight and weight gain (3073g, 3025.10g) than the untreated group (2733.60g, 2683.40g). During the research period, the best feed conversion ratio was documented in third group (Spirulina), followed by the second group (Cinnamon), while the worst was documented in the control one.

3.2. Carcass measurements

The influence of using diets treated with Cinnamon, Spirulina, and Chlorella on carcass characters parameters such

Table 2: Growth performance of broiler chicks as affected by dietary treatments at 6 weeks of age

Items	Treatments			
	Control	Cinnamon	Spirulina	Chlorella
Body weight (g)				
1 wk	191.50±2.69	195.50±5.45	201.50±2.59	192.50±4.17
3 wk	926.5±33.00 ^{b}	950±29.15^{b}	1070.50±39.91^{a}	917±23.71^{b}
6 wk	2733.60±118.40 b	2862±102.11^{b}	3073±109.86^{a}	2852±119.05^{b}
Body weight gain (g / day)				
1-3 wk	876.40 ± 32.20^{b}	900.50 ±28.61^{b}	1022.60 ±38.87^{a}	869.20 ± 22.52^{b}
3-6 wk	1807 ± 87.81^{c}	1912.50 ±74.42^{b}	2002.50 ± 70.90^{a}	1935 ±95.96^{ab}
1-6 wk	2683.40 ± 117.60^{ab}	2813 ± 101.61^{b}	3025.10 ± 108.80^{a}	2804.20 ± 117.85^{b}
Feed intake (g / day)				
1-3 wk	1049 ± 110.06^{a}	977±15.07^{ab}	955±14.06^{b}	959±13.11^{b}
3-6 wk	3561 ± 28.16^{a}	3307±32.11^{b}	3325±27.21^{ab}	3340±30.11^{ab}
1-6 wk	4610 ±50.11^{a}	4284±50.16^{b}	4280±55.06^{b}	4299±52.06^{ab}
Feed conversion ratio (g /g)				
1-3 wk	1.21±0.05^{a}	1.09±0.03^{b}	0.95±0.04^{c}	1.11±0.03^{ab}
3-6 wk	2.02±0.11^{a}	1.75±0.07^{ab}	1.68±0.06^{b}	1.77±0.09^{ab}
1-6 wk	1.75±0.08^{a}	1.54±0.06^{bc}	1.43±0.05^{c}	1.56±0.07^{abc}

Means in the same raw with no superscript letters after them or with a common superscript letter following them are not significantly different (P<0.05).

as eviscerated carcass, hot carcass and dressed carcass percentages, absolute & relative % of internal organs are illustrated in (Table 3). The finding demonstrated no significant variation (P>0.05) in the pre-slaughter weight of all treated groups relative to the control. Furthermore, there was a significant elevation (P<0.05) in the hot carcass % in the 2nd and 4th groups supplemented with Cinnamon (91.21) and Chlorella (93.35) respectively. Moreover, there was a significant elevation (P<0.05) in the eviscerated carcass % in the fourth group supplemented with chlorella (82.14) than the control (76.28), furthermore, there was a significant rise in the dressed carcass% in the 4th group supplemented with Chlorella (85.74) than the control (80.07). The liver % displayed a significant elevation (P<0.05) in the 2nd group fortify with Cinnamon (2.84) compared to the control (2.39). The heart % was significantly augmented (P<0.05) in the 4th group treated with Chlorella (0.55) compared to the control (0.41), but the gizzard % displayed no significant changes (P>0.05) between groups supplemented with Cinnamon, Spirulina, and Chlorella.

3.3. Immunity

The effect of using diets supplemented with cinnamon, spirulina, and chlorella on the immune organs weight

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Table 3: Carcass traits of broiler chicks as affected by dietary treatments at 6 weeks of age.

Items	Treatments			
	Control	Cinnamon	Spirulina	Chlorella
Pre-slaughter Wt. (g)	2851.67±205.80	2985±212.27	2951.67±130.94	2720±75.06
Hot carcass %	81.55±4.75^{b}	91.21±1.07^{a}	86.92±0.90^{ab}	93.35±1.90^{a}
Eviscerated carcass %	76.28±0.51^{b}	76.65±0.42^{b}	74.22±1.57^{b}	82.14±2.81^{a}
Liver %	2.39±0.07^{b}	2.84±0.05^{a}	2.26±0.04^{b}	2.27±0.06^{b}
Gizzard %	0.94±0.04^{ab}	0.92±0.05^{ab}	0.90±0.02^{ab}	1.00±0.02^{a}
Heart %	0.41±0.04^{b}	0.51±0.03^{ab}	0.45±0.04^{ab}	0.55±0.02^{a}
Giblets %	0.95±0.04	0.92±0.05	0.90±0.02	1.00±0.02
Dressing %	80.07±0.46^{b}	81.20±0.23^{ab}	77.88±1.50^{b}	85.74±5.29^{a}

Means in the same raw with no superscript letters after them or with a common superscript letter following them are not significantly different (P<0.05).

Table 4: Immune organs of broiler chicks as affected by dietary treatments at 6 weeks of age.

Items	Treatments			
	Control	Cinnamon	Spirulina	Chlorella
Spleen %	0.10±0.05^{ab}	0.09±0.02^{ab}	0.10±0.04^{ab}	0.11±0.02^{a}
Thymus %	0.34±0.11^{a}	0.31±0.09^{bc}	0.31±0.07^{bc}	0.34±0.01^{a}
Bursa of Fabricius %	0.10±0.03^{bc}	0..09±0.05^{bc}	0.12±0.07^{a}	0.11±0.06^{ab}

Means in the same raw with no superscript letters after them or with a common superscript letter following them are not significantly different (P<0.05).

are illustrated in (Table 4). our result demonstrated a variation in immune organ weight and spleen percentage displayed no significant variations (P>0.05) along with groups respects the control. Whereas thymus % displayed a significant reduction (P<0.05) in the 2nd and 3rd groups (0.31%, 0.31%) but the 4th group showed no significant differences. The Bursa of Fabricius % displayed a significant increase (P<0.05) in G3 supplemented with Spirulina (0.12%) as opposed to the control.

Table 5: Biochemical parameters of broiler chicks as affected by dietary treatments at 6 weeks of age.

Items	Treatments			
	Control	Cinnamon	Spirulina	Chlorella
TP (g/dL)	3.11±0.31	4.22±1.38	3.04±0.28	2.93±0.24
ALB (g/dL)	0.55±0.09^{b}	0.86±0.07^{a}	0.74±0.03^{ab}	0.60±0.06^{b}
GLOB (g/dL)	2.56±0.23	3.36±1.33	2.29±0.29	2.34±0.23
A/G (%)	21.20±1.46^{b}	29.82±0.92^{a}	29.58±1.23^{a}	25.92±3.09^{ab}
AST (IU/L)	158.93±5.72^{a}	128.80±0.64^{b}	136.20±4.78^{b}	123.57±2.80^{b}
ALT (IU/L)	17.23±1.19^{a}	13.55±0.84^{b}	15.25±0.84^{ab}	16.25±0.6^{ab}

Means in the same raw with no superscript letters after them or with a common superscript letter following them TP: total protein; Alb: albumin GLOB: globulin; A/G: albumin/ globulin ratio. AST: aspartate aminotransferase and ALT: alanine aminotransferase.

Table 6: Lipid profile of broiler chicks as affected by dietary treatments at 6 weeks of age.

Items	Treatments			
	Control	Cinnamon	Spirulina	Chlorella
TP (g/dL)	3.11±0.31	4.22±1.38	3.04±0.28	2.93±0.24
ALB (g/dL)	0.55±0.09^{b}	0.86±0.07^{a}	0.74±0.03^{ab}	0.60±0.06^{b}
GLOB (g/dL)	2.56±0.23	3.36±1.33	2.29±0.29	2.34±0.23
A/G (%)	21.20±1.46^{b}	29.82±0.92^{a}	29.58±1.23^{a}	25.92±3.09^{ab}
AST (IU/L)	158.93±5.72^{a}	128.80±0.64^{b}	136.20±4.78^{b}	123.57±2.80^{b}
ALT (IU/L)	17.23±1.19^{a}	13.55±0.84^{b}	15.25±0.84^{ab}	16.25±0.6^{ab}

Means in the same raw with no superscript letters after them or with a common superscript letter following them are not significantly different (P<0.05). TC: total cholesterol; TG: triglycerides; HDL: high-density lipoprotein; LDL: low-density lipoprotein.

3.4. Biochemical parameters

The impact of using diets supplemented with Cinnamon, Spirulina, and Chlorella on serum biochemical parameters such as total serum protein, globulin, albumin, AST and ALT are displayed in (Table 5). The results illustrated non-significant variation (P>0.05) in total protein among treatments. There was a significant rise in the albumin in 2nd group supplemented with Cinnamon (0.86 g/dL), and globulin displayed no significant variation (P>0.05) among treated groups. The existing data provided a significant drop (P>0.05) in (AST) and the fourth group supplemented with Spirulina presented decreased levels (123.57IU/L) compared to the control (158.93IU/L). Moreover, (ALT) confirmed a significant decline (P>0.05) and the 2nd group supplemented with Cinnamon presented decreased levels (13.55 IU/L) compared to the control (17.23 IU/L).

3.5. Lipid profile

The effect of using diets supplemented with Cinnamon, Spirulina, and Chlorella on cholesterol, triglycerides, HDL, LDL and are exhibited in (Table 6). The outcome displayed a significant difference (P<0.05) in TC and TG and the 3rd group that was supplemented with Spirulina revealed the lowest triglyceride level (70.33 mg/dL). HDL and LDL displayed no significant variation (P<0.05) among treatments.

Table 7: Antioxidant activity of broiler chicks as affected by dietary treatments at 6 weeks of age.

Items	Treatments			
	Control	Cinnamon	Spirulina	Chlorella
MDA (nmol/mL)	13.10±2.14[a]	7.81±0.75[b]	6.97±0.09[b]	7.70±0.15[b]
SOD (U/ml)	41.33±0.88[b]	60.29±2.94[a]	63.15±1.86[a]	57.23±4.16[a]
CAT (mg/dl)	27±2.08[c]	45.13±2.31[a]	50.67±1.00[a]	42.23±1.30[ab]

Means in the same raw with no superscript letters after them or with a common superscript letter following them are not significantly different (P<0.05). MDA: malondialdehyde; SOD: superoxide dismutase; CAT: catalase enzyme

3.6. Antioxidant activity

The effect of using diets supplemented with Cinnamon, Spirulina and Chlorella on antioxidative status including Malondialdehyde (MDA), catalase enzyme and superoxide dismutase are tabulated in (Table 7). The finding demonstrated that malondialdehyde (MAD) displayed a significant decrease (P<0.05) in all treatments and the 3rd group supplemented with spirulina revealed a decreased level (6.97 nmol/mL), while superoxide dismutase (SOD) and catalase enzyme (CAT) displayed a significant boost (P<0.05) in all treatments and the 3rd group augment with Spirulina revealed the increased level (63.15 U/ml, 50.67 mg/dl).

4. Discussion

At the conclusion of the trial, the Spirulina platensis supplemented group displayed significantly enhanced BW and BWG (3073g, 3025.10g) respectively than that documented by the control group (2733.60g, 2683.40 g). Adding of Spirulina platensis at the dose of 5g/kg diet to broiler diets improved live body weight and body weight gain relative to control. These findings match the results displayed by [17] discovered that supplementing chick diets with Spirulina platensis at a rate of 1 kg/ton feed enhanced growth performance. [18] found that adding 0.3 or 0.5 g of Spirulina platensis powder considerably enhanced broiler's mean LBW and WG (p<0.001). [19] Demonstrated that the administration of Spirulina platensis to broiler feed at doses of 0.7 or 0.9g/kg feed greatly increased the animal's live weight and weight gain. [20] Showed that when control chickens were fed 15% Spirulina, their body weight increased (P < 0.001) and feed conversion ratio (P < 0.001) boosted. On the other hand, [21] examined the effect of dietary Spirulina platensis (5 or 10 g/kg feed) on the chickens productivity, the findings displayed that body weight gain (at 21 and 42 days), did not change between the various treated groups compared with the control one. [22] Showed that broiler females' body weight, feed consumption and livability did not differ considerably with in groups (P>0.05) when 10% S. platensis was introduced to the diet. Furthermore, there was a significant reduction (P <0.05) in FCR in the 3rd group (0.95) from 0 – 3wk treated with 5g Spirulina respectively relative to control (1.21). At the grower period from 3-6wk, FCR was also improved in the 3rd group (1.68) than the control group (2.02). During the finishing period, the best feed conversion ratio was recorded in the 4th group supplemented with 5g Spirulina (1.43), whereas the worst FCR was displayed in the first group (1.75) fed on a control diet. During the whole experimental period, the good feed conversion ratio was documented in the Spirulina group followed by the Cinnamon group while the worst feed conversion ratio was documented in the control group. These discoveries are aligned with those recorded by [23] who discovered that adding 2g of Spirulina / kg of feed enhanced the feed conversion ratio in birds and yielded the greatest results. These outcomes are also proven by [24] who found that adding Spirulina platensis to broiler diets dramatically enhanced the feed conversion ratio relative to the control. [25] Demonstrated that feeding broiler chickens with 30 and 50 mg of Spirulina /kg of grain decreased the feed conversion ratio. Contrariwise, [26] observed that the feed conversion ratio of chicks fed diets treated with 1% Spirulina was considerably (P < 0.05) higher. [21] Recorded that there was no variation in the feed conversion ratio among the different treatment groups for broiler hens given a diet supplied with Spirulina platensis at a rate of

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5 or 10 g/kg feed. Our findings displayed that there was no significant variation in the pre-slaughter weight of all tested groups relative to the control. Additionally, there was a significant elevation in the hot carcass % in the second and fourth groups treated with Cinnamon (91.21) and Chlorella (93.35) respectively compared to the control (81.55), while the Spirulina group (86.92) displayed no significant relative to the control (81.55). The same findings were obtained by [27] who established that the administration of Spirulina had no significant influence on broiler carcass features. Also, [28] reported that Spirulina had no impact on carcass yield. [29] revealed that the dietary additions of Chlorella vulgaris have no significant variations in carcass %. Conversely, [30] recorded that the dietary treatments included Cinnamon and Garlic powder had no discernible impacts on carcass features in broilers. Furthermore, there was a significant improvement in the eviscerated carcass % in the fourth group supplemented with chlorella (82.14) than the control (76.28), while other treatments supplemented with Cinnamon (76.65) and Spirulina (74.22) were not significant relative to the control (76.28). These data aligned with those recorded by [31] who illustrated that the weight of the eviscerated carcass in heat-stressed broilers increased in treatments that received (0.2, 0.4 g/Kg) Chlorella extract ($P<0.05$). [29] demonstrated no discernible variation in the percentage of the carcass when Spirulina platensis algae were added to the diet at 0.0, 2.0, 4.0, or 6.0 g/kg dry in the SP group. [32] cleared that adding dietary Cinnamon at the levels of 2%, 4%, 6%, or 8% Cinnamon powder/kg feed did not significantly influence any of the evaluated carcass characteristics or growth performance indices. Conversely, [33] displayed that the introduction of dietary Chlorella vulgaris in broiler feed did not significantly alter any of the carcass metrics. Our data displayed a significant elevation in the dressed carcass% in the fourth group supplemented with chlorella (85.74) while other treatments supplemented with cinnamon (81.20) and spirulina (77.88) were not significant relative to the control (80.07). [34] revealed that the maximum dressing percentage of 74.46% was due to the inclusion of 10% Chlorella vulgaris. On the other hand [35] found that the carcass dressing percentage varied according to the cumulative amount of C. vulgaris consumed. [24] exhibited that with the adding of Spirulina to the broiler, the dressing percentages at 0.2 or 0.3 g Spirulina /kg enhanced. [23] observed that the carcass percentage of broiler chicks increased by 4.9% when fed a ration treated with 2 g of Spirulina per kg. The liver % displayed a significant elevation in the second group supplemented with cinnamon (2.84) relative to the control (2.39). Conversely, [36] demonstrated that adding cinnamon powder (CP) at a level of (0.25% - 0.50% - 0.75% - 1.0%) decreased the liver weight percentage ($P>0.05$) because of a decrease in certain enzyme production. [37] demonstrated that adding 1, 3, or 5% of Cinnamon meal to broiler chick diets had no discernible influence on the relative weight of liver percentage. The heart % was significantly improved in the G4 fortify with Chlorella) 0.55(relative to the control) 0.41(. Gizzard % showed no significant differences among treatments supplemented with Cinnamon, Spirulina, and Chlorella. The same results were obtained by [37] who determined that adding 1, 3, or 5% of Cinnamon to broiler chick meals had no discernible impact on the percentage of the gizzard. The Spleen percentage displayed no significant variation between groups relative to the control. The thymus % displayed a significant reduction in the G2 and G3 but the G4 displayed non-significant differences relative to the untreated group. Bursa percentage displayed a significant raise in the third group supplemented with Spirulina relative to the control The total protein showed no significant difference among treatments. The same result was obtained by [30] demonstrated that adding 4 g/kg of Cinnamon to broiler diets did not affect the animals' blood protein levels. [29] found that, as compared to other

groups, broiler diets containing varied amounts of Spirulina platensis (SP) or Chlorella vulgaris (CV) at the doses of (2.0, 4.0, 6.0) g/kg did not differ in terms of total protein across all groups. On the other hand [38] discovered that the groups treated with Cinnamon at a concentrate of 150 and 250 mg/kg diet had significantly higher plasma total protein in their diets for rabbits.[39] demonstrated that the groups given with 500 or 1000 mg/kg of Cinnamon meal had a significantly higher total protein content.[40] displayed that adding Spirulina platensis at doses of (0.25 - 0.5 - 0.75 - 1 g/kg feed) to broiler chicks increased blood levels of total proteins. The result also displayed that there was a significant elevation in the albumin in the 2nd group supplemented with Cinnamon (0.86), while other treatments displayed no significant differences. The same findings were obtained by [38] discovered that the groups treated with Cinnamon at the dosages of (150 - 250 mg/kg diet) in the rabbit diet had significantly higher plasma albumin levels. On the other hand [39] showed that when comparing the albumin concentrations of the two treated groups treated with 500 or 1000 Cinnamon mg /kg to the control one, the variations were not significant (P>0.05). [30] demonstrated that adding 4 g/kg of Cinnamon to broiler chickens did not influence the concentration of serum albumin. [29] observed that when broiler diets containing different amounts of Spirulina platensis (SP) or Chlorella vulgaris (CV) at the levels of (2.0, 4.0, 6.0) g/kg had no variation in serum albumin across all groups. While globulin demonstrated no significant differences among treatments. Conversely, [38] discovered that the groups treated with cinnamon at levels of (150 - 250 mg/kg diet) in the rabbit diet had significantly higher plasma globulin levels. [39] displayed that there was a significant improvement in globulin in the groups supplemented with 500&1000 mg/kg of cinnamon powder (CNP). [41] determined that giving growing hens under heat stress Spirulina (0.5 - 1 g/kg feed) and vitamin E (75 mg/kg diet) lowered the detrimental influences of heat stress on blood parameters like globulin. The Cholesterol displayed a significant elevation in the third group treated with Spirulina relative to the control, while other treatments second and fourth supplemented with Cinnamon and Chlorella displayed no significant differences relative to the control. The same results were obtained by [36] showed that supplementing Cinnamon to broiler chicks' feed at doses of (0.25%, 0.50%, 0.75%, and 1.0%) had no discernible impacts (P>0.05) on cholesterol levels.[42] showed that adding Chlorella by-product (CBP) to the laying hens' feed at the doses of (25, 50, or 75 g/kg) did not affect their total cholesterol levels during the 8-week feeding period.[43] determined that the amount of Chlorella meal added to diets during 35 days at levels of (25 – 50 - 75 g/kg feed) did not change total cholesterol levels. Conversely,[38] discovered that rabbits given a diet containing 250 mg of Cinnamon per kg had improvements in their cholesterol levels. [44] demonstrated that adding Cinnamon at doses of 250 – 500 – 1000 - 2000 mg/kg diet had no discernible impact on cholesterol levels.[24] found that adding a small amount of Spirulina to the diet (0.02 or 0.03%) reduced blood cholesterol. [45] displayed that supplementing Spirulina to a diet at the level of (0, 0.5, 1, and 1.5%) significantly reduced serum cholesterol, particularly when additional Spirulina was added. Malondialdehyde (MDA) displayed a significant reduction in all treatments relative to the control. The same findings obtained by [40] concluded that (MDA) in broiler chickens decreased linearly when Spirulina platensis supplements were given at the levels of (0.25 - 0.5 - 0.75 - 1 g/kg diet). This reduction may have been induced by the powerful antioxidant activity of Spirulina platensis. [46] discovered that the blood malondialdehyde concentrations of birds fed 20 $g\,kg^{-1}$ Chlorella by-product (CBP) were lower. Conversely, [45] demonstrated that additional Spirulina supplementation

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(0, 0.5, 1, and 1.5%) increased antioxidant enzyme activity in the heat-stressed group. SOD and catalase enzyme displayed a significant boost in all treatments relative to the control. The same findings obtained by [40] displayed that the administration of Spirulina platensis phycocyanin (0.25 - 0.5 - 0.7 - 1 g/kg diet) boosted the activities of antioxidant categories (catalase, SOD and TAC) in a linear state. [47] demonstrated that adding 2 g/kg of Clove and Cinnamon powders considerably raised the catalase activity, but not 1 g/kg or 3 g/kg. [48] displayed that larger superoxide dismutase action ($P < 0.001$) and improved catalase action ($p < 0.003$) were observed in the treatment groups of rabbits treated with (200 - 300 - 400 - 500) mg of Chlorella meal per kg of body weight together with commercial rabbit feed day by day. Conversely, [1] demonstrated that dietary regimens containing 2 levels of garlic (0 - 1.5%) and 3 concentrations of Cinnamon powder (0 - 0.4 - 0.8%) did not affect the activity of SOD enzymes. [29] Found that there are no variations in SOD across all groups when diets containing varying amounts and kinds of algae such as Spirulina platensis (SP) at the concentrations of (0.0, 2.0, 4.0, 6.0) g/kg dried of SP group and Chlorella vulgaris (CV) at the level of 2.0, 4.0, 6.0 g chlorella /kg of dried CV group, separately for 42 d.

Conclusion

The recent study's results illustrated that administration of Cinnamon, Spirulina and Chlorella in chicks diets significantly enhanced productivity, carcass characteristics, antioxidant activity and immune response, with the most favorable outcomes observed in the third group of broilers receiving a diet containing 5g/kg of Spirulina powder.

Conflict of interest

The authors proclaim no conflict of interest

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