Archives of Razi Institute, Vol. 78, No. 2 (2023) 659-666

DOI: 10.22092/ARI.2022.359478.2430

Original Article

Effect of Adding *Cordyceps sinensis* Extract and Probiotic to the Diet on Productive Performance of Broiler

Khalid Shihab, S[1 *], Hkmat Nafea, H[2]

1. Directorate of Agriculture of Anbar Province, Ministry of Agriculture, Republic of Iraq, Baghdad, Iraq
2. Department of Animal Recourse, College of Agriculture, University of Anbar, Baghdad, Iraq

Received 23 July 2022; Accepted 13 August 2022
Corresponding Author: salam.khaled2014@gmail.com

Abstract

Following a substantial increase in poultry breeding, the demand for their meat has risen. Poultry meat is one of the primary sources of protein in human nutrition, which contributes to food security. However, implementing intensive breeding programs and exposing birds to multiple stressors have led to the overuse of antibiotics and worse poultry health. This study was carried out at the poultry farm of the Animal Production Department, College of Agriculture, University of Anbar, Ramadi, Iraq from 28/10/2021 to 8/12/2021 (42 days), to show the effect of the addition of *Cordyceps sinensis* extract and a probiotic to the diet of broilers on their productive performance. For this purpose, 210 one-day-old unsexed chicks of strain (Ross 308) were used with an average weight of 40 g. They were randomly divided into seven groups of treatments, and each treatment had three replicates (10 chicks per replicate). The treatments included T1, which was the control group without any addition to the diet, T2 and T3 with the addition of *C. sinensis* extract at a level of 300 and 600 mg/kg feed, respectively, T4 and T5 with the addition of a probiotic at the level of 3 and 6 g/kg feed, respectively, T6 with the addition of *C. sinensis* extract at a level of 300 mg/kg feed + the probiotic at a level of 3 g/kg feed, T7 with the addition of *C. sinensis* extract at a level of 600 mg/kg feed + the probiotic at a level of 3 g/kg fodder and 6 g/kg feed. The results showed a significant superiority ($P \leq 0.05$) in favor of the T6 and T7 treatments, which included the mixture of *C. sinensis* extract and the probiotic, in terms of the average body weight at the sixth week, over the rest of the treatments except for the T3 treatment which included the addition of *C. sinensis* extract at a level of 600 mg/kg feed. Regarding weight increase, the T3 treatment, which included the addition of *C. sinensis* extract at a level of 600 mg/kg feed, was significantly superior ($P \leq 0.05$) to the T4 treatment, which included the addition of the booster at a level of 3 g/kg feed. Regarding the feed consumption rate, it was observed that all the added treatments significantly decreased it ($P \leq 0.05$), compared to the control T1 and the cumulative feed conversion factor (0-6 weeks). It was noticed that the treatments of the mixture T6 and T7 led to a significant ($P \leq 0.05$) improvement, compared to the other experimental treatments. It is concluded from this that the addition that *C. sinensis* extract and the probiotic improved the productive performance of broilers without any adverse effects.

Keywords: Broiler, Cordyceps, Performance productive, Probiotic

1. Introduction

After the significant expansion in poultry breeding, the demand for their meat has doubled. Poultry meat is a major source of protein for humans, which helps ensure food security. However, intensive breeding programs and overcrowding have caused birds to be exposed to several stressors, such as bruises, lack of oxygen, pollution from droppings, moisture problems, and disease. This has led to the overuse of antibiotics, which can cause health problems (1). The European Union has been directed since 2006 to ban antibiotics as growth stimulants (2).

Researchers and poultry farmers have tended to use unconventional and available natural alternatives that can enhance the vital and physiological functions of poultry and can be added to feed to reduce disease, stimulate growth, and preserve the environment. Among them is *Cordyceps sinensis*, whose components act as prebiotics.

As for probiotics, they are substances that are used in poultry diets as manufactured products consisting of beneficial microorganisms isolated from the intestinal flora of the gastrointestinal tract of chickens (3). The addition of probiotics to the diet of newly hatched chicks will contribute to the transfer of these microorganisms. It is beneficial to chicks (4) as it accelerates the occurrence of microbial balance 14 days after its administration, which contributes to strengthening immune responses (5).

The primary immune response against a wide range of antigens is using antibodies and immune cells, where the components of the probiotic work to remove dead cells after tissue damage by phagocytosis (6). Therefore, this will improve the health status and product performance and also raise the rate of body weight of the broiler.

2. Materials and Methods

2.1. Experiment Design

This experiment was conducted on the poultry farm of the Animal Production Department, College of Agriculture, University of Anbar, Ramadi, Iraq from 28/10/2021 to 8/12/2021 (42 days). In total, 210 unsexed one-day-old chicks of the Ross 308 strain were used in the experiment. The chicks weighed 40 g and were randomly divided into seven treatment groups with three replicates per treatment, and each replicate contained 10 chicks.

The treatment groups included the T1, which was considered as a control group without any addition to the diet, T2 and T3 with the addition of *C. sinensis* extract at a level of 300 and 600 mg/kg feed, respectively, and T4 and T5 with the addition of a probiotic at the level of 3 and 6 g/kg feed, respectively, T6 with the addition of *C. sinensis* extract at a level of 300 mg/kg feed + the probiotic at a level of 3 g/kg feed, and T7 with the addition of *C. sinensis* extract at a level of 600 mg/kg feed + the probiotic at a level of 3 g/kg fodder and 6 g/kg feed.

2.2. Diets

Three types of diet were provided during the experiment, including the first diet (starter), the second diet (grower), and the third diet (finisher) provided within the age ranges of 1-11 days, 12-21 days, and from the age of 22 days old until the end of the experiment (42 days), respectively. The diets were formed based on the Ross company guide for the year 2014 and according to the chemical composition of the diets as stated in the N.R.C. (1994) and summarized in table 1.

2.3. Additive Treatments

Extract of *C. sinensis* was used as an additive to the diet; it was purchased from the Amazon site and was produced by Samsara Herbs Lindon Utah (U.S.A.) from brown crystalline powder. Moreover, the probiotic (BIO-SAC WS) was purchased from a Portuguese company, Zoopan. It should be mentioned that the probiotic is in the form of a white powder**.**

2.4. Growth Performance

Live body weight, weight gain, feed consumption rate, and feed conversion factor were measured as reported by Al-Zubaidi (7), (8).

2.5. Statistical Analyses

Replicate means served as the experimental unit for statistical analysis. Data were analyzed using the general linear model procedure in SAS software (SAS Institute 2002). Orthogonal comparisons were used to determine the linear and quadratic effects of the increasing levels of the fibroblast-populated collagen matrix. Mean values were compared using Tukey's test when probability values were significant (P<0.05).

Table 1. Ingredients and nutrient composition of experimental diets

Item	Starter (1-11 d)	Grower (12-21)	Finisher (22-42 d)
Corn	35	38	44
Wheat	22.55	24.15	19.14
Soybean meal (44% CP)	33	28	25
Protein concentrate (40% C.P.)*	5	5	5
Palm oil	2	3	5
Dicalcium phosphate	0.6	0.4	0.3
Limestone	1.5	1.2	1.2
DL-Methionine	0.2	0.15	0.2
Lysine	0.05	0	0.06
Sodium chloride	0.1	0.1	0.1
Total	100%	100%	100%
****Calculated composition, %**			
ME, kcal/kg	2967	3085	3237
Protein %	23.4	21.4	19.9
Lysine %	1.37	1.19	1.15
methionine % + cysteine	1.08	0.98	0.99
Fiber %	2.8	2.8	2.6
Calcium %	1.07	0.90	0.86
Non-phytic phosphorus	0.47	0.43	0.40
lipid	4.5	5.6	7.7

* Protein concentrate for poultry feed Brocorn-5 special W produced by WAFI B.V. ALBLASSERDAM HOLLAND Crude Protein 40%, Crude Fat 5%, Crude Fiber 2.20%, Moisture 7.13%, Ash 28.32, Calcium 4.50%, Phosphorous 2.65%, Available Phosphorous 4.68%, Lysine 3.85%, Methionine 3.70%, Methionine + Cysteine 4.12 %, tryptophan 0.42%, threonine 1.70%, metabolizable energy 2107, selenium 2.30% and copper 4%

** The chemical composition values were calculated according to N.R.C. (1994)

3. Results and Discussion

Live body weight is one of the most important economic characteristics that broiler breeders aim to improve, as it expresses the amount of the production yield of his project. table 2 tabulates the effects of the addition of *C. sinensis* extract and the probiotic to the diet on the average live body weight of broilers. The results showed no significant differences among the different treatments in terms of the average live body weight during the first three weeks of the experiment. However, T2, T4, and T6 treatments had a significant superiority in terms of the average live body weight ($P \leq 0.05$) in the fourth week, compared to T1, T5, and T7 treatments, while they did not differ significantly from T3 treatment. Moreover, in the fifth week of the experiment, all treatments were significantly ($P \leq 0.05$) superior to T1 and T2 treatments. In the sixth week of the experiment, a significant superiority ($P \leq 0.05$) was observed in T6 and T7 treatments, compared to T1, T2, T4, and T5 treatments, with 2348.6 and 2332.3 g, respectively; however, it did not differ significantly from T3 treatment with 2316.6 g.

The superiority of T6 and T7 treatments may be attributable to the role of *C. sinensis* in conjunction with the probiotic. The fungus provides indigestible nutrients, such as polysaccharides, and thereby facilitates the fermentation processes that occur in the intestines and plays a covalent role in boosting immunity and intestinal health (9). Moreover, it may be due to the role of the probiotic in enhancing thymus function (10).

These results were in line with those of a study performed by Han, Qu (11), which showed that the increase in body weight rate came from the use of *C. sinensis*. This fungus acts as a precursor as it is effective in the process of competitive exclusion which increases the number of beneficial bacteria at the expense of harmful bacteria in the intestines of chickens. It works

(the polysaccharides) as the *C. sinensis* blocks the receptor sites on the surface of harmful bacteria, preventing them from sticking to the receptors of the cells lining the digestive canal, and thereby reflecting positively on improving the growth of broilers.

Results of the present study were also consistent with those of a study conducted by Zeng, Li (10), who noticed that adding the probiotic (10^{10}) to the broiler diet led to a significant improvement ($P \leq 0.05$) in their average body weights. However, these results differed from those of a study carried out by Willis, Wall (12), who added *C. sinensis* at levels of 5% and 10% to the diet. They found that the reason for the decrease in the average body weight is due to the physical and chemical composition of the mushrooms, the concentration of the mushrooms, or the level used in the experiment.

Table 3 shows the effect of the addition of *C. sinensis* extract and the probiotic to the diet on the rate of weekly weight gain of broilers. The results showed that there were no significant differences among the different treatments of the experiment during the first three weeks. However, significant differences appeared among the treatments in the fourth week of the experiment; accordingly, T6 treatment significantly ($P \leq 0.05$) outperformed the other treatments, and in the fifth week, all treatments were significantly ($P \leq 0.05$) superior to the control T1 treatment. Moreover, in the sixth week, significant superiority ($P \leq 0.05$) appeared in each of the T1, T4, T5, T6, and T7 treatments, compared to T2 and T3 treatments.

Regarding the cumulative weight gain rate for the weeks of the experiment (0-6 weeks), the results showed that there were significant differences among the experimental treatments. Accordingly, T3, T4, T6, and T7 treatments significantly outperformed ($P \leq 0.05$) the control T1 treatment, while they did not differ significantly from T2 and T5 treatments. These results were in line with those of the research performed by An, Lee (13), (14), which indicated that *C. sinensis* extract leads to a significant increase in the rate of weight gain, in comparison to the control treatment. Moreover, the improvement of growth performance and moral superiority in the rate of weight gain is attributed to Cordycepin, ergosterol, and polysaccharides, the active substances in *C. sinensis* that play a vital role in improving the gut environment by raising the level of immunity, antioxidants, and antimicrobial activities. They also promote the growth of beneficial bacteria in the digestive system of broilers (15). The results also agreed with those of a study performed by Biswas, Dev (16) which indicated that the use of the probiotic contributes to a significant increase in the rate of weight gain for broilers, compared to the control treatment, by increasing the number of beneficial bacteria in the gut (17).

These results differed from those of a study performed by Gao, Wang (17), which indicated that the probiotic might not increase the rate of weight gain of broilers, in comparison with a synergistic mixture that includes probiotics with alternative nutritional supplements to antibiotics.

Table 2. The effect of adding Cordyceps sinensis extract and the probiotic on the average live body weight (gm) of broilers

Week		1	2	3	4	5	6
TREATMENTS	T1	116.97±3.93	312.10±11.31	627.53±17.20	1014.13±13.54b	1433.33±23.92b	2155.67±18.77b
	T2	115.03±0.90	319.10±10.00	633.97±5.56	1039.57±21.39a	1617.67±53.64a	2279.33±81.07b
	T3	110.77±2.94	309.97±6.50	625.20±11.43	1035.90±43.96ab	1620.00±28.04a	2316.67±37.26ab
	T4	116.37±1.84	317.83±0.93	634.77±22.01	1046.03±10.71a	1580.67±20.83a	2287.00±42.78b
	T5	113.43±2.10	314.50±7.04	622.37±26.78	1028.97±26.83b	1576.00±12.29a	2279.00±50.52b
	T6	112.10±4.72	308.80±5.14	601.30±8.03	1070.40±37.39a	1622.67±69.18a	2348.67±54.96a
	T7	112.50±5.60	306.80±11.64	606.27±19.27	1019.07±9.14b	1602.33±44.95a	2332.33±50.52a
Sg		NS	NS	NS	*	*	*

The values represent the mean ± standard error

NS: not significant at the level of significance ($P \leq 0.05$)

*: There is a significant difference between the experimental treatments

a, b, and c: the different letters within the same row indicate the presence of significant differences between the treatments at the level of significance ($P \leq 0.05$)

Experimental treatments: T1 control (without addition), T2 (Cordyceps level 300 mg/kg feed), T3 (Cordyceps level 600 mg/kg feed), T4 (probiotic level 3g/kg feed), T5 (probiotic level 6g/kg feed), T6 (Cordyceps 300 mg + probiotic 3 g / kg feed), T7 (Cordyceps 600 mg + probiotic 6 g / kg feed)

Table 3. The effect of adding Cordyceps sinensis and the probiotic on the rate of weekly weight gain (gm) for broilers

Week		1	2	3	4	5	6	0-6
TREATMENTS	T1	76.97±3.93	195.13±9.23	315.43±8.22	386.60±30.18b	419.20±15.15b	722.33±42.22a	2115.67±18.77b
	T2	75.03±0.90	204.07±9.11	314.87±10.12	405.60±23.76b	578.10±45.70a	661.67±27.91b	2239.33±81.07ab
	T3	70.77±2.94	199.20±3.60	315.23±7.89	410.70±39.35b	584.10±36.96a	696.67±12.60b	2276.67±37.26a
	T4	76.37±1.84	201.47±1.32	316.93±22.42	411.27±12.02b	534.63±31.53a	706.33±27.71a	2247.00±42.78a
	T5	73.43±2.10	201.07±7.41	307.87±21.46	406.60±50.50b	547.03±24.94a	703.00±60.80a	2239.00±50.52ab
	T6	72.10±4.72	196.70±0.46	292.50±6.00	469.10±29.96a	552.27±41.74a	726.00±73.51a	2308.67±54.96a
	T7	72.50±5.60	194.30±6.06	299.47±7.77	412.80±17.91b	583.27±42.16a	730.00±52.54a	2292.33±50.52a
Sg		NS	NS	NS	*	*	*	*

The values represent the mean ± standard error
NS: not significant at the level of significance ($P \leq 0.05$)
*: There is a significant difference between the experimental treatments
a, b, and c: the different letters within the same row indicate the presence of significant differences between the treatments at the level of significance ($P \leq 0.05$)
Experimental treatments: T1 control (without addition), T2 (Cordyceps level 300 mg/kg feed), T3 (Cordyceps level 600 mg/kg feed), T4 (probiotic level 3g/kg feed), T5 (probiotic level 6g/kg feed), T6 (Cordyceps 300 mg + probiotic 3 g / kg feed), T7 (Cordyceps 600 mg + probiotic 6 g / kg feed)

The characteristic of feed consumption is one of the important product characteristics and a significant economic indicator in calculating the production cost of the project. This is especially important since nutrition constitutes more than two-thirds of the total cost of broilers. During the weeks of the experiment, the results summarized in table 4 show that there were no statistically significant differences among the groups in the first four weeks of the experiment, while in the fifth week, the results showed a significant improvement ($P \leq 0.05$) in the T2, T3, T4, T5, T6, and T7 treatments, compared to the T1 control treatment. However, in the sixth week, the result of the T1 control treatment underwent a significant improvement ($P \leq 0.05$), compared to the T2, T3, T4, T5, T6, and T7 treatments, which underwent a significant decrease ($P \leq 0.05$).

The results of the cumulative feed consumption rate for the experimental weeks (0-6 weeks) showed no significant differences ($P \leq 0.05$) among the T1, T2, T3, T4, T5, T6, and T7 treatments.

The results of the statistical analysis were in line with those of a study performed by An, Lee (13), who found no significant difference ($P \leq 0.05$) in the feed consumption rate for Ross 308 broilers after the addition of 0.5% of *C. sinensis* with probiotic to their diet.

Results of this study differed from those of a study carried out by Biswas, Dev (16), which indicated that the treatment containing the probiotic at a level of 10^8 CFU/g feed improved the performance of feed intake for the birds in the first three weeks of rearing, compared to the control treatment.

The character of the feed conversion factor is one of the most important economic indicators of the efficiency and ability of birds to convert feed into live weight, as it depends on the amount of the consumed feed and the weight gain rate. Table 5 summarizes the effect of the addition of *C. sinensis* extract and the probiotic on the food conversion factor of broilers during the weeks of the experiment.

The results showed no significant differences in the first and second weeks of the experiment. In the third week, the results indicated a significant deterioration ($P \leq 0.05$) in T5, T6, and T7 treatments, compared to T1, T3, and T4 treatments, and it did not differ significantly from the T2 treatment. As for the fourth week, the results had a significant deterioration ($P \leq 0.05$) in all treatments, compared to the T6 treatment.

Regarding the fifth week, the results showed a significant deterioration ($P \leq 0.05$) in T1, T4, and T5 treatments, compared to the T3 treatment, and it did not differ significantly from T2, T6, and T7 treatments. In

the sixth week, the results showed a significant improvement ($P\leq0.05$) for the T7 treatment, compared to the T1 control treatment as it did not differ significantly from T2, T3, T4, T5, and T6 treatments. However, in the cumulative average of the experimental weeks (0-6 weeks), the results showed a significant improvement ($P\leq0.05$) in T6 and T7 treatments, compared to the other experimental treatments. Results of the T1 control group did not differ significantly from those of the T2, T3, T4, and T5 treatments, which is the best result in terms of this trait.

The improvement in feed consumption and the efficiency of food conversion may be attributed to the joint and individual roles of *C. sinensis* and the probiotic. The fungus, which acts as a prebiotic, includes polysaccharides that are among the most important nutrients for beneficial bacteria in the intestine. Therefore, it provides a healthy environment for the intestine and has a positive effect on the digestion of birds; hence, it may be responsible for the observed results. As for the probiotic, it is a beneficial bacteria that was added to the ration, which increased its numbers and reduced the harmfulness of pathogenic bacteria, which led to an increase in the level of bird health (11, 18).

The results of the statistical analysis that are summarized in table 5 and include the efficiency of feed conversion are in line with what was found by Han, Qu (11). They noticed a significant improvement ($P\leq0.05$) in the feed conversion efficiency of Ross 308 broilers when *C. sinensis* were added at levels of 1 and 2 g/kg feed. Furthermore, these results were consistent with those of a study conducted by Hsieh, Lin (18) who found a significant improvement ($P\leq0.05$) when adding 1% of *C. sinensis* to the diet of Ross 308 broiler broilers as it enhances the feed conversion efficiency in the herd. Besides, these results agreed with those of a study performed by Nopparatmaitree, Plaimast (19) who noticed a significant improvement ($P\leq0.05$) when adding probiotic 2 kg/ton of feed to the diet of Ross 308 broilers, as it enhanced the feed conversion efficiency of the experimental birds.

Table 4. The effect of adding Cordyceps sinensis extract and the probiotic on feed intake (gm) for broilers

Week		1	2	3	4	5	6	Total
TREATMENTS	T1	91.67±3.33	224.67±3.18	363.17±7.99	593.33±3.33	780.73±37.16b	1258.13±4.04a	3311.70±33.17
	T2	96.67±4.41	218.67±4.98	379.00±14.57	595.00±5.00	942.93±24.51a	1064.47±25.22b	3296.73±38.23
	T3	96.67±6.01	221.17±7.10	374.00±7.00	595.00±2.89	916.90±11.60a	1147.20±16.54b	3350.93±26.09
	T4	98.33±1.67	224.00±3.21	372.33±13.28	590.00±7.64	939.83±31.24a	1113.93±30.42b	3338.43±54.29
	T5	93.33±6.01	221.67±2.60	375.33±12.35	596.67±3.33	936.50±4.12a	1095.20±42.12b	3318.70±35.28
	T6	93.33±1.67	223.17±2.74	354.83±42.20	585.00±5.00	921.80±37.19a	1145.47±21.97b	3323.60±16.87
	T7	96.67±6.01	225.50±2.60	384.00±12.22	596.67±3.33	934.70±42.30a	1082.53±59.85b	3320.07±91.41
Sg		NS	NS	NS	NS	*	*	N.S.

The values represent the mean ± standard error

NS: not significant at the level of significance ($P\leq0.05$)

:*There is a significant difference between the experimental treatments

a, b, and c: the different letters within the same row indicate the presence of significant differences between the treatments at the level of significance ($P\leq0.05$)

Experimental treatments: T1 control (without addition), T2 (Cordyceps level 300 mg/kg feed), T3 (Cordyceps level 600 mg/kg feed), T4 (probiotic level 3g/kg feed), T5 (probiotic level 6g/kg feed), T6 (Cordyceps 300 mg + probiotic 3 g / kg feed), T7 (Cordyceps 600 mg + probiotic 6 g / kg feed)

Table 5. The effect of adding Cordyceps sinensis extract and the probiotic on the efficiency of F.C.R. (gm) for broilers

Week		1	2	3	4	5	6	0-6
TREATMENTS	T1	1.20±0.10	1.16±0.04	1.15±0.01b	1.56±0.14a	1.86±0.03a	1.76±0.10a	1.56±0.03a
	T2	1.29±0.08	1.07±0.05	1.21±0.08ab	1.47±0.08a	1.66±0.15ab	1.61±0.03ab	1.48±0.05ab
	T3	1.36±0.04	1.11±0.04	1.19±0.03b	1.48±0.16a	1.58±0.10b	1.65±0.03ab	1.47±0.02ab
	T4	1.29±0.02	1.11±0.02	1.20±0.13b	1.44±0.03a	1.76±0.04a	1.58±0.04ab	1.48±0.01ab
	T5	1.27±0.05	1.11±0.03	1.23±0.12a	1.51±0.18a	1.72±0.08a	1.57±0.07ab	1.48±0.02ab
	T6	1.31±0.07	1.14±0.01	1.22±0.16a	1.26±0.08b	1.68±0.07ab	1.60±0.12ab	1.44±0.04b
	T7	1.34±0.08	1.16±0.05	1.29±0.07a	1.45±0.07a	1.63±0.18ab	1.49±0.03b	1.45±0.05b
Sg		NS	NS	*	*	*	*	*

The values represent the mean ± standard error
NS: not significant at the level of significance ($P \leq 0.05$)
*: There is a significant difference between the experimental treatments
a, b, and c: the different letters within the same row indicate the presence of significant differences between the treatments at the level of significance ($P \leq 0.05$)
Experimental treatments: T1 control (without addition), T2 (Cordyceps level 300 mg/kg feed), T3 (Cordyceps level 600 mg/kg feed), T4 (probiotic level 3g/kg feed), T5 (probiotic level 6g/kg feed), T6 (Cordyceps 300 mg + probiotic 3 g / kg feed), T7 (Cordyceps 600 mg + probiotic 6 g / kg feed)

There was a significant improvement in the productive performance of each body weight, feed consumption rate, and feed conversion factor when adding *C. sinensis* extract and the probiotic to the broiler diet. Treatment T7, which included the addition of 600 mg/kg feed of *C. sinensis* extract and 6 g/kg probiotic feed led to the best productive performance of broilers during the rearing period.

Authors' Contribution

Study concept and design: S. K. S.
Acquisition of data: H. H. N.
Analysis and interpretation of data: S. K. S.
Drafting of the manuscript: S. K. S.
Critical revision of the manuscript for important intellectual content: S. K. S.
Statistical analysis: H. H. N.
Administrative, technical, and material support: H. H. N.

Ethics

This study was approved by the ethics committee of the Ministry of Agriculture, Republic of Iraq, Baghdad, Iraq.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. Derakhshan Z, Mokhtari M, Babaei F, Malek Ahmadi R, Ehrampoush MH, Faramarzian M. Removal methods of antibiotic compounds from aqueous environments–a review. J Environ Health Sustain Dev. 2016;1(1):43-62.
2. Gambi L, Crippa C, Lucchi A, De Cesare A, Parisi A, Manfreda G, et al. Research note: The resistome of commensal Escherichia coli isolated from broiler carcasses "produced without the use of antibiotics"(a). Poult Sci. 2022;101(4):101770.
3. Awad WA, Ghareeb K, Abdel-Raheem S, Bohm J. Effects of dietary inclusion of probiotic and synbiotic on growth performance, organ weights, and intestinal histomorphology of broiler chickens. Poult Sci. 2009;88(1):49-56.
4. Chen X, Zhang Y, Ma W, Zhu Y, Wu X, Wang Z. Effects of Cordyceps militaris polysaccharide on egg production, egg quality and Caecal microbiota of layer hens. Worlds Poult Sci J. 2020;10(1):41-51.
5. Jia L, Zhang X, Li X, Schilling W, David Peebles E, Kiess AS, et al. Bacitracin, Bacillus subtilis, and Eimeria spp. challenge exacerbates woody breast incidence and severity in broilers. Poult Sci. 2022;101(1):101512.
6. Shehata AA, Yalcin S, Latorre JD, Basiouni S, Attia YA, Abd El-Wahab A, et al. Probiotics, Prebiotics, and Phytogenic Substances for Optimizing Gut Health in Poultry. Microorganisms. 2022;10(2).
7. Al-Zubaidi SSA. Poultry Management. 1st ed. College of Agriculture, University of Basra. 1986.

8. Al-Fayad HA-A, Nagy SA-H. Poultry products technology. Baghdad, Iraq: Directorate of Higher Education Printing Press; 1989.
9. Deng B, Wang ZP, Tao WJ, Li WF, Wang C, Wang MQ, et al. Effects of polysaccharides from mycelia of Cordyceps sinensis on growth performance, immunity and antioxidant indicators of the white shrimp Litopenaeus vannamei. 2015;21(2):173-9.
10. Zeng X, Li Q, Yang C, Yu Y, Fu Z, Wang H, et al. Effects of Clostridium butyricum- and Bacillus spp.-Based Potential Probiotics on the Growth Performance, Intestinal Morphology, Immune Responses, and Caecal Microbiota in Broilers. Antibiotics (Basel). 2021;10(6).
11. Han JC, Qu HX, Wang JG, Yan YF, Zhang JL, Yang L, et al. Effects of fermentation products of Cordyceps militaris on growth performance and bone mineralization of broiler chicks. J Appl Anim Res. 2015;43(2):236-41.
12. Willis W, Wall D, Isikhuemhen O, Jackson J, Ibrahim S, Hurley S, et al. Effect of level and type of mushroom on performance, blood parameters and natural coccidiosis infection in floor-reared broilers. Open Mycol J. 2013;7(1).
13. An JW, Lee JH, Oh HJ, Kim YJ, Chang SY, Go YB, et al. Effect of Cordyceps militaris with probiotics supplement on growth performance, meat quality characteristics, storage characteristics and cordycepin content of the breast meat in broilers. Korean J Agric Sci. 2021;48(3):423-32.
14. Boontiam W, Wachirapakorn C, Wattanachai S. Growth performance and hematological changes in growing pigs treated with Cordyceps militaris spent mushroom substrate. Vet World. 2019;13(4):768-73.
15. Chen J, Guo Y, Lu Y, He Z, Zhu Y, Liu S, et al. Effects of Acremonium terricola Culture on the Growth, Slaughter Yield, Immune Organ, Serum Biochemical Indexes, and Antioxidant Indexes of Geese. Animals (Basel). 2022;12(9).
16. Biswas A, Dev K, Tyagi PK, Mandal A. The effect of multi-strain probiotics as feed additives on performance, immunity, expression of nutrient transporter genes and gut morphometry in broiler chickens. Anim Biosci. 2022;35(1):64-74.
17. Gao J, Wang R, Liu J, Wang W, Chen Y, Cai W. Effects of novel microecologics combined with traditional Chinese medicine and probiotics on growth performance and health of broilers. Poult Sci. 2022;101(2):101412.
18. Hsieh YC, Lin WC, Chuang WY, Chen MH, Chang SC, Lee TT. Effects of mushroom waster medium and stalk residues on the growth performance and oxidative status in broilers. Anim Biosci. 2021;34(2):265-75.
19. Nopparatmaitree M, Plaimast H, Soisuwan K. Dietary of probiotics and organic acids supplementation on productive performances, intestinal morphology, carcass characteristics, and meat quality of broiler chickens. Technology. 2022;18(2):695-708.