

Article

Effect of adding *Cynara scolymus* L. (artichoke) extract to water or diet on the productive performance of broilers.

Ammar Taleb Dhiab and Ali Jabbar Ali

Prof. Dept. Animal Production, Agriculture of College, University of Diyala, Iraq.

*Correspondence: Ammaraltememy@uodiyala.edu.iq, ali.jabbarali1988@gmail.com

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Abstract: The experiment was carried out in the poultry field of the Department of Animal Production/College of Agriculture/the University of Diyala from 4/9/2021 to 10/14/2021 to study the effect of adding *Cynara scolymus* L. (artichoke) extract to the diet of broilers. It was used as an antioxidant to show its effect on birds' productive, physiological and immune performance. In this experiment, 225 unsexed Ross 308 hybrid broiler chicks were used (one day age), with an initial weight of 44.36 g/chick. These chicks were randomly distributed from the first day of receiving them to five experimental treatments with three replicates for each treatment (15 birds/repeat). The experimental treatments were: T1 = (control treatment) provided a standard diet free of additives, T2 = Standard ration plus 75 mg/L artichoke extract, T3 = a standard diet supplemented with 150 mg/L artichoke extract, T4 = Standard ration to which 2 g/kg of artichoke extract is added, and T5 = Standard ration to which 3 g/kg of artichoke extract is added. The experiment results indicated a significant effect on product traits when adding different artichoke leaf extract powder levels to Ross 308 broiler water and diet (1-42 days). Generally, treatment T3 was significantly ($P<0.05$) superior in the fourth week in recording the highest average live body weight of 3170.90 g, and treatment T4 was significantly ($P<0.05$) in the fourth week and recorded the highest rate of weight gain. Also, treatment T1 in the first week recorded the highest rate of feed consumption, treatment T2 in the first week recorded the highest efficiency of food conversion, and treatment T3 significantly ($P<0.05$) and recorded the highest rate of productive evidence.

Keywords: broiler, artichoke leaf extract, productive traits

Introduction

The poultry industry has developed rapidly and tangibly in recent years and has become built on modern scientific foundations due to the rapid development in all areas of animal production. The importance of poultry lies in the fact that it produces materials of high nutritional value, such as eggs and meat, which are among the primary sources of animal protein in the human diet. Therefore, poultry projects are critical due to increasing product demand. Diet is essential as poultry feed composition greatly influences its development, well-being, and quality. So, the search for feed additives that simultaneously provide better performance, low-cost usage, and ensure animal welfare and product safety is a priority for the poultry industry^{1, 2}. Iraq's total production of broiler meat for the private sector was estimated at 2,148 thousand tons for the year 2020, and it

increased by 8.38 thousand tons of the total production of Iraq for the year 2019 as it was 4.109 thousand tons and increased by 35.5%³.

It was found that there was a negative correlation coefficient between body weight and the immune response of broilers, which forced broiler producers to adequately use medicines and medical drugs during the breeding period to reduce disease infections. The use of medicinal plants as additives to feed or water plays a fundamental and vital role in animal production and health through its work in killing germs and improving body immunity⁴.

Moreover, medicinal plants also act as antioxidants in reducing oxidative damage at the level of cells and biomolecules caused by free radicals, which contribute to increased oxidative stress, causing many diseases. For this reason, the protective effects of antioxidants have received significant attention in recent years. They work by inhibiting the enzymes involved in oxidation, preventing free radicals and chelating metals, and stimulating the antioxidant enzyme systems, thus reducing the damage caused by forming free radicals^{4, 5, 6}. Because many medicinal plants are known for producing active compounds, interest in them has increased due to their great importance in the pharmaceutical industry. These plants are distinguished by their antioxidant property. Based on the preceding, there is a trend towards commercial feed additives of plant origin, including some medicinal plants that are included in plant feed additives as they are plant extracts that have an antibacterial and inhibitory effect on the growth of pathogenic microorganisms because they contain natural compounds and antibiotics that reduce or eliminate pathogenic bacteria. They are considered alternatives to antibiotics to maintain excellent poultry production, and they are cheaper and loaded with many minerals, vitamins, and phytochemicals such as alkaloids, saponins, flavonoids, and phenols⁷. In addition to their anti-microbial properties, it was found that some of them possess antioxidant properties, improve digestion, the animal's palatability for feed, and many other productivity indicators. Usually, this has made them one of the modern strategies for feed additives because their use offers more benefits than common commercial antibiotics. Adding it is safer regarding its effect on humans and animals and does not cause side effects to the body⁸. The artichoke is among the medicinal plants whose extract has been used as an antioxidant and a growth stimulator for broilers. This plant is essential in improving the poultry industry because it is one of the feed additives with positive effects on improving animal production and the quality of meat products⁹.

Several studies showed that artichoke extract has beneficial effects, such as ridding the body of metabolic waste and free radicals and reducing blood urea, LDL cholesterol, and triglycerides in broilers¹⁰. In addition, it improves productive and immune performance, lowers cholesterol levels in local Egyptian chicken eggs, improves oxidative stability and meat quality in Japanese quail¹¹, and enhances body immunity in broilers¹².

Materials and Research Methods

Experiment date

The experiment was carried out in the poultry field of the Department of Animal Production/College of Agriculture/the University of Diyala for the period from 4/9/2021 to 14/10/2021 to study the effect of adding artichoke extract to the broiler diet as an antioxidant and study its effect on the productive, physiological and immune performance of birds.

Experience design

In the experiment, 225 unsexed Ross 308 broiler hybrid chicks were used at the age of one day. The chicks were randomly distributed from the first day of receiving them to five experimental treatments with three replications for each treatment (15 birds/repeat), and the experimental treatments were as follows:

T1 = (control treatment) standard diet without addition.

T2 = Standard diet supplemented with artichoke extract at 75 mg/L of water.

T3 = Standard diet supplemented with artichoke extract at 150 mg/liter.

T4 = standard diet supplemented with artichoke extract at 2 g/kg of feed.

T5 = Standard diet supplemented with artichoke extract at 3 g / kg of feed.

Source and specifications of artichoke leaf extract.

The artichoke leaf powder was obtained from the company that produced it (Prescribed for Life) in America (French origin). The weight of the product is 1 kg, and this product is a fine powder with a dark brown color, kept at room temperature and away from moisture.

Preparing experiment diets

The birds were fed a starter diet from 1-14 days, a growth diet from 15-28 days, and a final diet from 29-42 days, as in Table 1. The extract of artichoke leaves was also added to the diets by mixing them manually with a small amount of feed. Then, the quantity was increased with good mixing until it reached the required homogeneity to maintain the additives' effectiveness.

Feedstuffs (%)	Starter Ration (1-14 days)	Grow Ration (15-28 days)	Final Ration (29-42 days)
YELLOW CORN	52	55	57.5
SOYBEAN MEAL*	41	36	33
PREMIX**	2.5	2.5	2.5
SUN FLOWER OIL	3	4.5	5
DICALCIUM PHOSPHATE	1.5	1	1
LIMESTONE	0	1	1
Total	100	100	100
Calculated Chemical Analysis			
CRUDE PROTEIN (%)	23.16	21.25	20.1
ENERGY REPRESENTED KILO-CALORIES/KG	2983	3095	3168
METHIONINE (%)	0.56	0.58	0.52
METHIONINE AND CYSTEINE (%)	0.94	0.92	0.86
LYSINE (%)	1.39	1.40	1.19
CALCIUM (%)	0.87	0.87	0.8

AVAILABLE PHOSPHOROUS (%)	0.44	0.49	0.38
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* The soybean meal of Argentine origin contained 44% crude protein and 2230 kcal/kg of energy. * Ingredients of premix 2.5 AH produced by WAFI International Company, containing protein 29.50%, energy 1817 kcal/kg, lysine 11.70%, methionine 10.40%, methionine + cysteine 10.46%, available phosphorous 12.90%, sodium 5.30%, and calcium 6.40% With an array of vitamins and minerals. * According to the chemical composition analysis of the feed materials contained in the reports of the U.S.²⁸.

Table 1. Components and chemical analysis of the diets used in the experiment.

Productive traits

live body weight (gm)

Chicks were weighed at the age of one day, and the average was extracted. As well as weekly during the experiment period. An electronic balance type Banaroma was used, and the following equation referred to by¹³ was applied to determine a live bird's average weight within a single repeater.

$$\text{Average bird weight (gm)} = \frac{\text{Sum of bird weights in repeater}}{\text{The total number of birds in the repeater}}$$

Weight Gain (gm)

The achieved weekly weight gain was calculated according to the following equation¹³: weight gain (gm) = live body weight at the end of the week - body weight at the beginning of the week.

feed consumed (gm/bird)

The feed consumed was calculated by weighing the remaining feed at the end of the week. Also, it was subtracted from the amount of feed provided at the beginning of the week for the repeater by using the equation referred to by¹⁴.

Feed consumption (gm/bird/week) = the feed provided at the beginning of the week (gm) - the remaining feed at the end of the week (gm).

Food conversion efficiency (gm of feed/gm of weight gain)

The feed conversion efficiency of birds was calculated weekly, as shown in the equation referred to by¹⁴.

$$\text{Feed Conversion Efficiency} = \frac{\text{Average weight of feed consumed (gm) during a week}}{\text{Average weight gain (gm) during the same week}}$$

Index Product

Good breeding and efficient management depend on several factors: average live body weight when marketing, mortality rate, feed conversion efficiency, and breeding duration. Therefore, good performance has the highest weight of birds when marketing, lower mortality during a shorter time, and high food conversion efficiency to reach high production efficiency. To express the good productive performance of the broiler herd, a scale was used that includes all the previous factors, giving a low or good grade to the broiler herd depending on the value of the Production Index (P.I.) as in the equation mentioned by¹⁵.

$$\text{Index Product} = \frac{\text{Average body weight (kg)} \times \text{vital percentage}}{\text{Number of breeding days} \times \text{feed conversion efficiency}} \times 100$$

Note that the percentage of vitality = 100 - the percentage of fatalities.

Statistical Analysis

Statistical analysis was carried out using Complete Randomized Design (C.R.D.), and arithmetic means were compared using Tukey's test¹⁶ at the significance level of 0.05. The ready-made statistical analysis program²⁹ was used to analyze the data.

Results

Productive Traits

Average live body weight (gm).

Table (2) shows a significant effect when adding different levels of artichoke leaf extract powder to Ross 308 broiler diet or water for 1-42 days on average live body weight. The treatment T3 was significantly superior at ($P < 0.05$) in the fourth week and recorded the highest average live body weight of 1467.53 gm compared to treatments T2, T4, and T5 in the same week except for the control treatment, which recorded the lowest average live body weight of 1306.53 gm. In the fifth and sixth weeks, the moral superiority ($P < 0.05$) continued in favor of the T3 treatment, as the mean live body weight reached 2225.9 gm and 0.90317 gm, respectively, compared to the control treatment, which recorded the lowest body weight, which amounted to 1977.87 and 2701.33 gm, respectively. They did not differ significantly from 2T, 4T, and T5 in the fifth week and from 4T and T5 in the fourth week, as the same Table showed no significant differences between T2 and control at the sixth week of bird life.

The rate of weight gain (gm).

The results of Table (3) indicate a significant effect when adding different levels of artichoke leaf extract powder to Ross 308 broiler diet or water for 42 days in the rate of weight gain, as the T4 treatment was significantly ($P < 0.05$) superior in the fourth week. The highest rate of weight gain was recorded, which amounted to 621.67 gm, and it did not differ significantly from the rest of the treatments in the same week, except for the control treatment, which recorded the lowest weight gain rate of 621.67 gm. In the fifth and sixth weeks, the superiority was at the level ($P < 0.05$) in favor of the T3 treatment, as the average weight gain was 758.40 gm and 944.80 gm, respectively. We also note from the Table that all addition treatments were superior to the control treatment in the fifth week, except for the T4 treatment, which did not differ significantly from the control treatment. In the sixth week, all the additional treatments were superior to the control treatment. The results of the same Table showed that there were no significant differences between the experimental treatments at the first week and Two and three years old. As for the cumulative weight gain for 1-6 weeks, it is noted from the Table that treatment T3 was superior to control treatment and T2 in the cumulative weight gain, and there were no significant differences between them and T4 and T5.

Age (Week)	Variables					Significant
	T1	T2	T3	T4	T5	
1	158.27	1.48±160.67	1.04±168.06	5.01±157.93	156.40	

	0.66±				7.96±	N.S
2	6.30±427.83	13.67±443.33	11.18±461.67	8.64±425.13	429.00	N.S
					25.13±	
3	23.72±812.20	1.53±846.47	22.89±866.06	29.47±786.07	814.07	N.S
					38.02±	
4	b	ab	a	ab	ab	*
	3023±1306.53	17.4±1413.07	8.87±1467.53	40.47±1406.73	22.53±1409.20	
5	b	Ab	a	ab	ab	*
	32.97±1977.87	16.90±2116.80	13.58±2225.9	58.49±2060.27	48.57±2143.87	
6	b	B	a	ab	ab	**
	17.24±2701.33	29.21±2887.27	79.58±3170.90	52.93±2900.67	88.13±2900.66	

*- The different letters within the same column indicate the presence of significant differences at the level ($p < 0.05$). N.S.- Indicates that there are no significant differences between the treatments. T1- control treatment (without addition), T2, T3 (150.75 mg/l artichoke extract) and T4, T5 (2.3 g/kg fodder artichoke extract).

Table 2. Effect of adding leaves of artichoke leaf extract (*Cynara scolymus* L.) at two different levels of water or ration on the average weekly body weight (gm) of broilers from 1 day to 42 days old (mean ± standard error).

Age (Week)	Variables					Significant
	T1	T2	T3	T4	T5	
1	114.24	116.30	123.70	113.57	112.04	
	0.35±	1.48±	1.04±	5.01±	7.96±	N.S
2	269.46	280.67	293.60	267.23	272.60	
	5.93±	12.77±	10.28±	3.63±	17.23±	N.S
3	384.47	405.13	404.40	360.93	385.06	
	19.62±	13.19±	18.06±	12.93±	17.58±	N.S
4	b	ab	ab	a	ab	*
	494.33	566.67	601.33	621.67	595.33	
	14.97±	16.95±	13.70±	12.54±	18.41±	
5	c	b	a	c	ab	*
	671.33	703.73	758.40	653.53	734.67	
	13.20±	15.77±	12.25±	19.90±	13.61±	
6	d	c	a	b	c	*
	723.47	767.47	944.80	840.40	750.67	
	16.38±	12.40±	15.54±	10.41±	17.10±	
6+1	b	b	a	ab	ab	**
	2657.30	2842.97	3126.24	2856.30	2850.17	
	17.09±	29.22±	79.46±	52.93±	88.13±	

*- The different letters within the same column indicate the presence of significant differences at the level ($p < 0.05$). N.S.- Indicates that there are no significant differences between the treatments. T1- control treatment (without addition), T2, T3 (150.75 mg/l artichoke extract) and T4, T5 (2.3 g/kg fodder artichoke extract).

Table 3. Effect of adding leaf extract of artichoke (*Cynara scolymus* L.) at two different levels of water or ration on the rate of weight gain (gm) for broilers from 1 day to 42 days old (mean ± standard error).

Feed consumption rate (gm/bird).

Table (4) indicated a significant effect on the feed consumption rate when adding different levels of artichoke leaf extract powder to Ross 308 broiler water and diets for 1-2 days. Treatment T3 and T5 in the first week recorded the highest feed consumption rates of 118.06 and 115.31 g/fowl, while in the second week, the second treatment recorded the highest feed consumption rate of 319.57 g/fowl. It did not differ significantly from the other treatments except for the control treatment, which recorded the lowest feed consumption rate of 275.67 g/fowl. It was also noticed in the sixth week that the control treatment was superior in recording the highest rate of feed consumption, which was 1193.00 g/fowl, which did not differ significantly from the two treatments, T2 and 3T. At the same time, the two treatments, T4 and T5, recorded the lowest consumption rate, which amounted to 1164.33 and 1160.67 g/fowl, respectively. The same Table showed no significant differences between the experimental treatments at the third, fourth and fifth weeks of life and in the cumulative feed consumption rate (1-6 weeks). In feed consumption rate.

Age (Week)	Variables					Significant
	T1	T2	T3	T4	T5	
1	b 106.66 0.77±	c 90.53 0.94±	a 118.06 3.96±	ab 106.20 9.64±	a 115.31 2.35±	*
2	b 275.67 5.20±	a 319.57 7.07±	ab 306.23 2.27±	ab 295.23 6.05±	ab 285.88 13.92±	*
3	484.67 8.33±	469.33 1.86±	475.67 6.17±	462.33 15.17±	467.00 3.46±	N.S
4	768.67 7.57±	760.67 4.05±	735.67 10.91±	755.67 26.59±	747.67 12.17±	N.S
5	980.40 4.60±	967.40 1.11±	973.37 3.56±	969.69 5.18±	971.78 6.70±	N.S
6	a 1193.00 4.50±	ab 1168.67 2.40±	ab 1172.67 2.67±	b 1164.33 6.11±	b 1160.67 9.83±	**
6+1	3809.06 6.24±	3776.16 7.36±	3781.67 7.65±	3753.45 13.40±	3748.30 14.35±	N.S

*- The letters within the same column indicate significant differences at the level ($p < 0.05$). N.S.- Indicates that there are no significant differences between the treatments. T1-control treatment (without addition), T2, T3 (150.75 mg/L artichoke extract) and T4, T5 (2%,3%/kg of artichoke extract ration).

Table 4. Effect of adding an extract of leaves of artichoke plant (*Cynara scolymus* L.) at two different levels to water or ration on feed consumption rate (gm/bird) for broilers from 1 day to 42 days old (mean \pm standard error).

Feed conversion efficiency

Table (5) results indicated a significant effect when adding different artichoke leaf extract powder levels to Ross 308 broiler water and broiler diets for 42 days in the feed conversion efficiency. The rest of the treatments, except treatment T5, recorded the lowest food conversion efficiency, 1.04. Whereas treatments T3, 4T

and T5 recorded the highest efficiency of food transfer in the fourth week, which amounted to 1.22, 1.21, and 1.26 g, respectively, and did not differ significantly from treatment T2. In contrast, the control treatment recorded the lowest efficiency of food transfer in the same week, amounting to 1.56. As for the sixth week, treatment 3T recorded the highest efficiency of food transfer, which amounted to 1.26, and it did not lag significantly from the rest of the treatments except for the control treatment, which recorded the lowest efficiency of food transfer, amounted to 1.65,

It is also noted in the cumulative feed conversion efficiency that the T3 treatment was superior in recording the highest food conversion efficiency of 1.16 and did not significantly lag behind the rest of the treatments except for the control treatment, which recorded the lowest food transfer efficiency of 1.32. The same Table also showed no significant differences between the experimental treatments for the same trait at the second, third and fifth weeks of life.

Age (Week)	Variables					Significant
	T1	T2	T3	T4	T5	
1	ab 0.93 0.04±	a 0.78 0.01±	ab 0.95 0.04±	ab 0.93 0.05±	b 1.04 0.06±	*
2	1.02 0.36±	1.14 0.07±	1.05 0.04±	1.10 0.03±	1.06 0.04±	N.S
3	1.28 0.12±	1.16 0.36±	1.18 0.07±	1.29 0.08±	1.24 0.13±	N.S
4	b 1.56 0.09±	ab 1.34 0.04±	a 1.22 0.06±	a 1.21 0.05±	a 1.26 0.07±	*
5	1.49 0.14±	1.40 0.04±	1.29 0.04±	1.49 0.04±	1.33 0.06±	N.S
6	b 1.65 0.06±	ab 1.53 0.04±	a 1.26 0.12±	ab 1.40 0.09±	ab 1.56 0.09±	**
6+1	b 1.32 0.005±	ab 1.22 0.003±	a 1.16 0.02±	ab 1.24 0.03±	ab ± 1.25 0.03	**

*- The different letters within the same column indicate significant differences at the level ($p < 0.05$). N.S.- Indicates that there are no significant differences between the treatments. T1-control treatment (without addition) T2, T3 (150.75 mg/l artichoke extract), and T4, T5 (2.3 g/kg fodder artichoke extract).

Table 5. Effect of adding an extract of leaves of artichoke plant (*Cynara scolymus* L.) at two different levels to water or ration on feed conversion efficiency (gm) for broilers from 1 day to 42 days old (mean \pm standard error).

Production Index

The results of Table (6) showed a significant effect when adding different levels of artichoke leaf extract powder to Ross 308 broiler water and broiler diets for 1-2 days in the production index, as the treatment T3 was significantly superior ($P < 0.05$). The highest productivity index rate was recorded, which amounted to

611.16, and all other additional treatments, T2, T4, and T5, were superior, reaching 451.76, 449.27, and 447.03, respectively, compared to the control treatment, which recorded 392.53.

Variables	Production Index
T1	15.25±392.53 C
T2	17.41±451.76 B
T3	68.21±611.16 A
T4	36.99±499.27 B
T5	38.02±447.03 B
Significant	*

*- The different letters within the same column indicate significant differences at the level ($p < 0.05$). N.S.- Indicates that there are no significant differences between the treatments. T1-control treatment (without addition), T2, T3 (150.75 mg/l artichoke extract) and T4, T5 (2.3 g/kg fodder artichoke extract).

Table 6. Effect of adding leaf extract of artichoke (*Cynara scolymus* L.) at two different water or ration levels on broilers' productivity index from 1 to 42 days of age (mean ± standard error).

Discussion

The results of Tables (2), (3), (4), and (5) showed a positive effect when adding different levels of artichoke leaf extract powder to Ross 308 broiler water and diets for 142 days. The reason for improving the productive qualities of broilers may be due to the critical role of artichoke leaf extract because it contains the active substance Cynarin, which performs a vital function in the body's activity for broilers. It acts as a highly effective antioxidant because it contains hydroxyl groups (O.H.-) that prevent the production of free radicals by donating an electron to them so that their outer orbit is in a state of equilibrium¹⁷.

Cynarin acts as a chelator for metal ions, the most important of which are iron Fe + 2 and copper Cu + 2, and prevents their association with hydrogen peroxide (H₂O₂) to prevent the formation and production of hydroxyl and peroxy radicals, which prevents the effect of these free radicals on cell components. Hence, it protects fats, D.N.A., and proteins and prevents the destruction of body proteins¹⁸. Thus, it increases body weight and weight gain for broilers. On the other hand, caring protects the liver, removes toxins, and renews its cells¹⁹.

Also, artichoke contains a high percentage of fiber, magnesium, vitamin C, folic acid, biotin, manganese, potassium, vitamins niacin, riboflavin, thiamine, and vitamin A, which have a significant effect on improving the growth rate, productive and immune performance of broilers^{20, 21}. Despite its extensive use, artichoke extract had an essential effect in improving growth during the advanced weeks of broiler life²². artichoke leaf extract helps treat functional dyspepsia and relieves symptoms of I.B.S. and dyspepsia in birds²³. In addition to the role of flavonoids, the most important of which is apigenin, which works to remove free radicals resulting from toxins because it has antioxidant properties and stimulates the action of the enzymes glutathione reductase, catalase, and superoxide dismutase to remove toxins from the liver by binding to it and excreting it outside

the body, which Prevents damage and damage to the liver cell membranes. In addition to containing phenolic compounds represented by chlorogenic acid compounds, it effectively improves the growth performance of its influential role as an antioxidant to prevent the production of inflammatory cytokines, which prevents damage to the mucous layer lining the intestines, especially the ileum region. Thus, it enhances the health of the small intestine and, on the other hand, prevents oxidative stress, which gives a high performance in the body growth of broilers²⁴ and thus leads to improved broiler productivity and an improvement in the intestinal flora within the digestive system²⁴. These results agree with the results reached by²⁵ when adding artichoke leaf extract to water and broiler diet from 1-3 weeks on average body weight and feed consumption at 42 days of age and with the findings of¹². Adding 1.5% of artichoke leaf extract to the diet of broiler-type (Ross-308) causes an improvement in broilers' productive characteristics, while our experiment's results did not agree with the results reached by²⁶. When commercial artichoke extract was added at rates of 300 and 600 g/ton for a period of 1-3 weeks in average body weight and average feed consumption at 42 days of age, the results also did not agree with the results of²⁷ when adding commercial artichoke extract in different proportions 100 and 200 And 300 and 500 mg/liter in drinking water during the period 35-21 days in the average body weight and the average weight gain of broilers at the age of 42 days, as they did not notice significant differences between the addition and control treatments in the mentioned traits.

Conclusion

Because of the importance and benefits of artichoke and its content of antioxidants and compounds that contribute to enhancing the body's immunity and raising the productive performance of broilers, the current study concluded the effect of its use in water and diets at different levels on the productive, physiological and immune performance of broilers.

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