Tikrit Journal for Agricultural Sciences
ISSN:1813-1646 (Print); 2664-0597 (Online)
Journal Homepage: http://www.tjas.org
E-mail: tjas@tu.edu.iq
DOI: https://doi.org/10.25130/tjas.26.1.11

TJAS
Tikrit Journal for Agricultural Sciences

Evaluation of the Effects of Natural and Pharmacological Factors (*Prosopis farcta* Fruit Powder and Oxytetracycline) on Productive and Physiological Performance of Broiler Chickens under *Escherichia coli* Challenge

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KEY WORDS:
Prosopis farcta; Oxytetracycline; Productivity; Subsequent physiology;broiler; E.coli

Received: 14/09/2025
Revision: 19/11/2025
Proofreading: 10/01/2026
Accepted: 04/02/2026
Available online: 31/03/2026

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ABSTRACT

The experiment was carried out at poultry farm, Agricultural Research and Experiment Station, College of Agriculture, Al-Muthanna University, from November 17, 2024 to December 22, 2024. 360 unsexed one-day-old Ross 308 hybrid broiler chicks were used in this experiment. The chicks were randomly distributed into six experimental treatments, with 60 chicks per treatment and four replicates (15 chicks per replicate). The experimental treatments were: T1: Control treatment (not infected with *E. coli*). T2: Infected with *E. coli* (not treated). T3: Add 10 ml of Prosopis farcta aqueous extract powder (PFE) per liter of drinking water to broilers not infected with *E. coli*. T4: Add 10 ml of PFE powder per liter of drinking water to broilers infected with *E. coli*. T5: Add 10 mg of the antibiotic oxytetracycline per liter of drinking water to broilers not infected with *E. coli*. T6: Add 10 mg of the antibiotic oxytetracycline per liter of drinking water to broilers infected with *E. coli*. The results of our current study indicate that the use of PFE at a concentration of 10 ml/L of drinking water significantly improved ($P \leq 0.05$) the productive traits (body weight, weight gain, and feed conversion ratio), Immunological traits (relative weight and index of bursa, delayed-type hypersensitivity test, and enzyme-linked immunosorbent assay, biochemical blood parameters (cholesterol, low-density lipoprotein, high-density lipoprotein, triglycerides, glucose, albumin, globulin, and total protein), and oxidative stress markers (malondialdehyde), glutathione peroxidase, and catalase), comparison of other treatments whether infected or uninfected with *E. coli*. We conclude that the PFE gave better results than the antibiotic oxytetracycline, this is due to the presence of active compounds in PFE fruit powder, which act as a natural antibiotic against the pathogenic *E. coli* bacteria.

تقييم تأثيرالعوامل الطبيعية والدوائية(مسحوق نبات الخرنوب *Prosopis farcta* والمضاد الحيوي Oxytetracycline) في ألاداء الانتاجي والفسيولوجي لفروج اللحم تحت تحدي الاصابة ببكتريا القولون

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الخلاصة

أجريت التجربة في حقل الدواجن، محطة البحوث والتجارب الزراعية، كلية الزراعة، جامعة المثنى، من 2024/11/17 لغاية 2024/12/22، باستخدام 360 فرخ فروج اللحم Ross 308 بعمر يوم واحد غير مجنس في هذه التجربة. وزعت الافراخ عشوائيًا على ست معاملات تجريبية، بواقع 60 فرخًا لكل معاملة وأربع مكررات (15 فرخًا لكل مكرر). كانت المعاملات التجريبية: T1: معاملة السيطرة (غير مصابة بالإشريشية القولونية). T2: مصابة بالإشريشية القولونية (غير المعاملة). T3: إضافة 10 مل من المستخلص المائي لمسحوق ثمار الخرنوب *Prosopis farcta* (PFE) لكل لتر من مياه الشرب إلى افراخ فروج اللحم غير المصابة بالإشريشية القولونية. T4: إضافة 10 مل من PFE لكل لتر من مياه الشرب إلى فروج اللحم المصاب بالإشريشية القولونية. T5: إضافة 10 ملغم من المضاد الحيوي أوكسي تتراسيكلين لكل لتر من مياه الشرب إلى فروج اللحم غير المصاب بالإشريشية القولونية. T6: إضافة 10 ملغم من المضاد الحيوي أوكسي تتراسيكلين لكل لتر من مياه الشرب إلى فروج اللحم المصاب بالإشريشية القولونية. تشير نتائج دراستنا الحالية الى ان استخدام PFE وبتركيز 10 مل / لترمن ماء الشرب قد ادى الى تحسن معنوي ($P\leq0.05$) في الصفات الانتاجية (وزن الجسم، الزيادة الوزنية ومعامل التحويل الغذائي)، وكذلك في الصفات المناعية (الوزن النسبي لغدة فابريشيا، دليل غدة فابريشيا، اختبار فرط الحساسية المتاخرة واختبار المقايسة المناعية المرتبط بالانزيم ELISA، كما ادى الى تحسن في معايير الدم الكيموحيوية (الكوليسترول، البروتينات الدهنية واطئة الكثافة، البروتينات الدهنية عالية الكثافة، الدهون الثلاثية، الكلوكوز، الالبومين، الكلوبيولين والبروتين الكلي) اضافة الى مؤشرات الاجهاد التاكسدي (المالون داي الديهايد، الكلوتاثيون بيروكسيديز وانزيم الكاتاليز) مقارنة ببقية طيور المعاملات التجريبية سواء كانت مصابة او غير مصابة بالايشريشيا القولونية. نستنتج بان PFE اعطى نتائج أفضل من استخدام المضاد الحيوي أوكسي تتراسيكلين بسبب احتواء مسحوق ثمار PFE على المركبات الفعالة والتي تؤدي دور المضاد الحيوي الطبيعي في مقاومة بكتيريا الإشريشية القولونية المسببة للأمراض.

الكلمات المفتاحية: الانتاجية، الإشريشية القولونية، الخصائص الفسلجية، المضاد الحيوي Oxytetracycline، ثمار الخرنوب، فروج اللحم.

INTRODUCTION

The poultry industry is one of the most important industries that contributes to food security by meeting consumers' needs for meat and eggs (Mottet and Tempio, 2017). Despite the advancements in poultry, they suffer from a number of health problems. Flocks of poultry are susceptible to many diseases, the most important of which is *Escherichia coli*, which poses a significant threat to bird health, causing economic losses to broiler chickens (Hasan *et al*., 2020). The prevalence of *E. coli* infections in poultry has driven interest in alternative strategies to enhance birds' resistance to pathogens and minimize the reliance on antibiotics (Tellez *et al*., 2012). *E. coli* bacteria belong to the Enterobacteriacea family, which belongs to the genus Escheriachia (Veloo *et al*., 2025). They are anaerobic, Gram-negative rods, they cause several diseases, including coli septicaemia, Swollen head syndrome, Panophthalmitis, Yolk sac infection, and Air sac disease (Ye *et al*., 2025). *E. coli* is the main cause of colibacillosis in poultry, caused by the inappropriate use of antibiotics and poor management (Shareef and Saeed, 2005).

These days, people are more conscious of the importance of using natural plant-based products to maintain their health because they are effective, cheap, easily metabolized, have few negative health effect, and don't pollute the environment (Alagbe, 2022; Qader and Tayeb, 2024a). One such plant which improve the health and productivity of broiler chickens is *Prosopis farcta*, a leguminous shrub known for its bioactive phytochemicals, including flavonoids, tannins, alkaloids, and phenolic compounds (Mohammed *et al*., 2019). These compounds have demonstrated antimicrobial, antioxidant, and anti-inflammatory properties, which may enhance the immune system and mitigate the effects of bacterial infections (Abdel-Hameed, 2009; Rahawi *et al*., 2022).

By modulating gut microbiota, promoting intestinal health, and enhancing immune responses, *P. farcta* may serve as a natural alternative to synthetic growth promoters. This is particularly relevant in the context of an *E. coli* challenge, where improving birds' resilience can significantly impact growth performance and overall health

status. that promotes health and sustainability in poultry production systems (Gadde *et al*., 2017). This study aimed to evaluate effect of *P. farcta* aqueous extract on growth, immune response, and oxidative stress parameters in broilers challenged with *E. coli*.

MATERIALS AND METHODS

The experiment was conducted in the poultry farm (broiler hall) at the Agricultural Research and Experiment Station, College of Agriculture, Al-Muthanna University, from November 17, 2024, to December 22, 2024. 360 one-day-old, unsexed Ross 308 hybrid broiler chicks were used in this experiment. The chicks were raised inside a four-story battery, each containing 1.5 ×1 m cage. The chicks were randomly distributed into six experimental treatments, with 60 chicks per treatment and four replicates (15 chicks per replicate). The experimental treatments were:

T1: Control treatment (not infected with *E. coli*).
T2: Infected with *E. coli* (not treated).
T3: Add 10 ml of PFE per liter of drinking water to broiler chicks not infected with *E. coli*.
T4: Add 10 ml of PFE per liter of drinking water to broiler chickens infected with *E. coli*.
T5: Add 10 mg of the antibiotic oxytetracycline per liter of drinking water to broiler chickens not infected with *E. coli*.
T6: Add 10 mg of the antibiotic oxytetracycline per liter of drinking water to broiler chickens infected with *E. coli*.

The chicks were reared in four-level batteries, each level measuring 1.5×1 m, each level contained 15 broiler chicks (each level represented one replicate for each treatment). The temperature was regulated using a mercury thermometer from one day of age until marketing (35 days). Gas incubators and air extractors were used according to the Ross 308 hybrid manual. All conditions suitable for broiler rearing were provided. Fed and water were provided *ad libitum*. A 24-hour continuous lighting system was used from the first day of the chicks' life. Plastic feed trays with a diameter of 38 cm were used for the first week, one tray per floor, these were then gradually replaced with the cylindrical feeders used in the battery-rearing system. Clean water was provided in 5-liter inverted plastic troughs until the end of the experiment. The birds were fed two types of feed (Ismael *et al.,* 2025); Starter diet" (1-15 days), and Finisher diet" (16 -35 days) (Table 1).

Table 1: The feeds used and the chemical analysis during the starter and finisher periods.

Items*	**The starter diet (1-15 days)**	**The finisher diet (16-35 days)**
Maize	60.2	65.7
Soybean meal	34.3	29.3
Premix**	2.5	2.5
Oil	1	1
Limestone	1	0.7
Dicalcium phosphate	0.6	0.4
Antitoxins	0.4	0.4
Total	%100	%100
		Chemical analysis***
Protein (%)	20.51	18.80
metabolizable energy (kcal/kg diet)	2960	3027
Calcium (%)	0.93	0.85
Phosphorus (%)	0.48	0.45
Methionine (%)	0.55	0.50
Lysine (%)	1.35	1.25
Methionine+ Cysteine (%)	0.91	0.85

* The feed provided to birds is pellets produced by Al-Hafedh Feed Factory in Karbala.

** Premix: Each 1 kg contains 64.42 g of protein, 879.66 kcal/kg of metabolizable energy, 0.18 g/kg of tryptophan, 0.43 g/kg of threonine, 0.41 g/kg of lysine, 65.05 g/kg of methionine, 65.36 g/kg of cysteine+ methionine, 183.67 g/kg of calcium, 36.19 g/kg of phosphorus, 3.01 g/kg of magnesium, 0.54 g/kg of potassium, 47.00 g/kg of sodium, 55.00 g/kg of chloride, 512.83 mg/kg of vitamins B+E+D.

*** According to chemical analysis based on N.R.C. (1994).

Dried *P. farcta* fruits were obtained from local markets in Muthanna Governorate. After the seeds were isolated, they were ground into a powder. The aqueous extraction process was carried out according to the method described by Al Salman and Al-Gharawi (2019), with some minor modifications. 100 ml of distilled water was added to approximately 20 gm of dried *P. farcta* fruit powder in a glass flask, stirred well, and left for 7 days. The filtration process was then carried out using Whatman No. 1 filter paper. The filtrate was concentrated using a rotary evaporator to obtain a highly concentrated extract by evaporating the maximum possible amount of solvent. The final extract was prepared by dissolving 5 g in 1 ml of sterile distilled water and placing it in opaque glass bottles and refrigerating until use.

Broiler waste infected with E. coli was collected, after conducting bacterial isolation experiments on special plates containing 50 ml of tryptic soy broth, the plates were incubated at 37°C for 18 hours, then, they were washed with sterile saline. The plates were centrifuged at 1800 rpm for 15 minutes. The washing process was repeated three times. The number of E. coli colonies was determined on plates containing Mac Conkey agar. These bacteria were maintained at 4°C for 16 hours. A bacterial suspension was formed by diluting the bacteria with distilled water at a ratio of 1:10. One-day-old chicks were dosed with 0.5 ml of the drug per chick. Bacterial isolates of Escherichia coli were obtained from infected chickens in the laboratory of the College of Science, Al-Qadisiyah University, and were exposed to the birds in isolation from the rest of the treatments. The infection was confirmed through pathological changes and clinical signs.

Data was analyzed using the SPSS (2018) statistical software, a completely randomized design (CRD) was used, Duncan's test was used to test for differences among means, with a significance level of ($P \leq 0.05$) .

An indirect method was used for the ELISA test to measure antibodies in serum. This test relies on the ability of many antigens to bind to polystyrene. Delayed type hypersensitivity test (DTH) was performed. The antigen was injected intradermally into the right scrotum. The left wattle was injected with sterile functional saline solution. The thickness of the injected wattle was measured using a vernia test 24 hours after injection. The results were recorded after measuring the thickness of the injected wattle.The activity of glutathione peroxidase (GSH-(PX)), superoxide dismutase (SOD), and catalase enzymes was estimated in a laboratory in Baghdad Governorate using a ready-made testing kit .

RESULTS AND DISCUSSION

Table (2) shows the effect of *P. farcta* and oxytetracycline in drinking water under *E. coli* challenge on some productive traits of broilers. Mean body weight results indicate that T3 provided higher significant ($P \leq 0.05$) of mean body weights for broiler at 21 and 35 days of age, with average weights of 786.59 and 2019.44 g, compared to T4, with mean of 690.51 and 1821.72 g, which significantly ($P \leq 0.05$) outperformed T5, with mean of 682.16 and 1712.62 g. T6 with mean of 647.44 and 1685.52 g, and the control treatment, with mean of 677.37 and 1697.45 g. Treatments T1, T5, and T6 significantly ($P \leq 0.05$) outperformed compare with T2, which produced the lowest mean weights of 565.38 and 1462.73 g.

Concerning weight gain at 1-21 days of age, it was observed that T3 yielded the highest significant ($P \leq 0.05$) weight gain (748.64 g), compared to T4 and T5, at 652.04 and 643.26 g. This significantly outperformed on T6 (609.22 g), which yielded the lowest weight gain (781.29 g). At 22-35 and 1-35 days of age, it was observed that treatment T3 produced the highest average weight gain (1233.13 and 1981.77 g), compared to T4, which produced average weight gain of 1131.21 and 1783.25 g. This significantly outperformed on T1 (1020.08 and 1658.73 g), T5 (1030.46 and 1673.72 g), and T6 (1038.08 and 1647.30 g). Treatments T1, T5, and T6 significantly outperformed as compared to T2, which produced the lowest average weight gain of 897.35 and 1423.55 g.

Regarding feed intake at 1-21 days of age, T3 showed a significant increase, averaging 926.82 g, compared to treatments T1, T4, T5, and T6, which consumed 863.33, 867.91, 861.33, and 837.53 g, respectively. This significantly increased feed intake compared to treatment T2, whose birds consumed the lowest average (781.29 g). At 22-35 and 1-35 days of age, T3 also showed a significant increase in feed intake, with averages of 2103.72 and 3030.54 g, compared to T4 (1987.04 and 2854.95 g), which showed a significant increase compared to T1 (1932.03 and 2795.36 g), T5 (1932.11 and 2793.44 g), and T6 (1922.48 and 2760.01 g), that significantly increased compared to T2, which showed the lowest feed intake (1752.28 and 2533.57 g).

Concerning feed conversion ratios at 1-21 days of age, treatment T3 showed a significant improvement, yielding 1.238 g feed per g gain, compared to treatments T1, T4, T5, and T6, which yielded means of 1.352, 1.331, 1.339, and 1.375 g feed intake per gm weight gain, respectively. These improved significantly compared to treatment T2

(1.485 g feed intake per g weight gain). At 22-35 days of age, treatment T3 showed a significant improvement, with an average of 1.706 g feed /g gain, compared to T4 (1.756 g feed /g gain), which also showed a significant improvement, compared to T6 (1.852 g feed /g gain), which showed a significant improvement compared to the control treatment (1.894 g feed /g gain). This significantly improved compared to T2, which produced an average of 1.953 g feed /g gain. A significant improvement was also observed in treatment T3 at 1-35 days of age, with an average of 1.529 g feed /g gain, compared to treatment T4 (1.601 g feed /g gain), which showed a significant improvement compared to T5 (1.669 g feed /g gain), with a significant improvement compared to the control treatment (1.685 g feed /g gain), and then T2 (1.779 g feed /g gain).

Table 2: Impact of *Prosopis farcta* and Oxytetracycline of broiler under *E. coli* challenge on some productive traits.

Traits	T1	T2	T3	T4	T5	T6	SEM	P-value
Body weight (g)								
1 day	38.72	39.18	37.95	38.47	38.90	38.22	0.637	0.7694
21 days	677.37 bc	565.38 d	786.59 a	690.51 b	682.16 b	647.44 c	1.765	0.0106
35 days	1697.45 c	1462.73 d	2019.44 a	1821.72 b	1712.62 c	1685.52 c	3.478	0.0028
Weight gain (g)								
1-21 day2	638.56 bc	526.20 d	748.64 a	652.04 b	643.26 b	609.22 c	0.622	0.8044
22-35 days	1020.08 c	897.35 d	1233.13 a	1131.21 b	1030.46 c	1038.08 c	1.742	0.0115
1-35 days	1658.73 c	1423.55 d	1981.77 a	1783.25 b	1673.72 c	1647.30 c	3.282	0.0033
Feed Intake (g)								
1-21 days	863.33 b	781.29 c	926.82 a	867.91 b	861.33 b	837.53 b	2.066	0.0346
22-35 days	1932.03 c	1752.28 d	2103.72 a	1987.04 b	1932.11 c	1922.48 c	4.248	0.0175
1-35 days	2795.36 c	2533.57 d	3030.54 a	2854.95 b	2793.44 c	2760.01 c	5.497	0.0061
Feed conversion ratio (g feed/ g gain)								
1-21 days	1.352 b	1.485 c	1.238 a	1.331 b	1.339 b	1.375 b	0.0056	0.0174
22-35 days	1.894 d	1.953 e	1.706 a	1.756 b	1.875 cd	1.852 c	0.0027	0.0209
1-35 days	1.685 d	1.779 e	1.529 a	1.601 b	1.669 c	1.675 cd	0.0063	0.0096

Different letters within row indicating of significant differences ($p<0.05$)

The results of Table (2) indicate that adding 10 ml of aqueous extract of powdered *P. farcta* fruits per liter of drinking water to broiler chickens not infected with *E. coli*, produced the best results across all studied production traits. This may be due to its content of active compounds, most notably phenolic compounds, which reached 6.4% in the alcoholic extract of the fruits (Karimi *et al*., 2017). Studies have shown that phenolic compounds are the most effective compounds that are anti-oxidants and anti-inflammatory (Rabeea *et al*., 2021; Qader and Tayeb, 2024b). Phenolic compounds are natural compounds with multiple health benefits for broiler chickens. They can help improve gut health, boost immunity, prevent disease, and enhance meat quality. Various plant sources containing these compounds can be used in chicken feed to enhance growth and health (Mahfuz *et al*., 2021; Gatea *et al*., 2023). Phenolic compounds stimulate the growth of farm animals by enhancing the

secretion of digestive enzymes, thus reducing pathogenic microorganisms (Valenzuela-Grijalva *et al*., 2017). The improvement in the productive performance of broiler chickens may be due to the change in the surface area of the intestines in addition to the activity of digestive enzymes, which improves the absorption of nutrients (Mountzouris *et al*., 2011). Studies have shown that plant extracts, whether aqueous or alcoholic, play a major role in maintaining microbial balance in the digestive tract due to their active compounds (Franz *et al*., 2010; Gadde *et al*., 2017; Giannenas *et al*., 2018).

Table (3) shows the effect of *P. farcta* and oxytetracycline in drinking water under *E. coli* challenge on the immune response of broilers. The results indicate that T3 significantly outperformed the relative weight of bursa the broiler by 0.143%, compared to T1 and T4, by 0.126 and 0.131%, respectively. These treatments significantly outperformed T6, by 0.115%, and significantly outperformed T2, by 0.088%. There were no significant differences between treatments T1, T4, and T5, and between treatments T5 and T6. The bursa gland index also showed a significant superiority for T3, with a mean of 1.127, compared to T1 and T4, with mean scores of 1.000 and 1.039. T6 was significantly superior to T6, with a mean score of 0.912, and T2, with a mean score of 0.698. There were no significant differences between treatments T1, T4, and T5, and between treatments T5 and T6. Regarding the delayed-type hypersensitivity test (DTH), it was observed that T3 produced a significant increase of 0.622, compared to T4, with a mean of 0.548, and compared to T2, with a mean of 0.441. There were no significant differences between treatments T1 and T4, treatments T1 and T5, treatments T5 and T6, and treatments T2 and T6. As for the Enzyme Linked Immunosorbent Assay (ELISA). A significant increase was observed in T3 (2283.97) compared to T4 (1922.54), significantly superior to the control treatment (1861.35), significantly superior to T5 (1724.41), significantly superior to T6 (1647.33), compared to T2 (1419.24).

Table 3: Impact of *Prosopis farcta* and Oxytetracycline of broiler under *E. coli* challenge on some Immunity response.

Traits	T1	T2	T3	T4	T5	T6	SEM	P-value
Relative weight of Bursa gland (%)	0.126 b	0.088 d	0.142 a	0.131 b	0.123 bc	0.115 c	0.002	0.0033
Bursa Index	1.000 b	0.698 d	1.127 a	1.039 b	0.976 bc	0.912 c	0.009	0.0019
DTH	0.531 bc	0.441 e	0.622 a	0.548 b	0.496 cd	0.472 de	0.001	0.0104
ELIZA	1861.35 c	1419.24 f	2283.79 a	1922.54 b	1724.41 d	1647.33 e	12.533	0.0007

Different letters within row indicating of significant differences ($p<0.05$).
DTH: delayed -type hypersensitivity test, ELIZA: enzyme linked immunosorbent assay.

The results of our study indicated that *P. farcta* improved the immune response of broiler chickens. This may be due to its active compounds that boost immunity, as a result of its significant role in inhibiting inflammatory prostaglandins and nitric oxide, which reduces pathological inflammation (Noroozi *et al*., 2019). The primary role of immunomodulatory compounds is the production of immunoglobulins and the secretion of cytokines, as well as increased phagocytosis and enhanced interferon release (Christaki *et al*., 2020). This may be due to the activation of mononuclear cells, thus increasing the phagocytic response, through their influence on the MAPK and nuclear factor-κB (NF-κB) signaling pathways (Artuso-Ponte *et al*., 2020; Al-Gharawi and Ebade, 2020). The active compounds in *P. farcta* enhance intestinal function and thus nutrient absorption, which boosts immunity and thus improves the overall health of broiler chickens (Adaszynska-Skwirzynska and Szczerbinska, 2017). The aqueous extract of *P. farcta* fruit powder reduced the activity of *E. coli* bacteria. Studies have shown that medicinal plants play a positive role in reducing the risk of disease, especially those caused by pathogenic bacteria. This is due to their active compounds, including alkaloids and phenolic compounds, particularly flavonoids and glycosides. Badri *et al.* (2017) observed that when using an alcoholic extract of *P. juliflora* leaf powder at a dose of 100 mg/ml, it inhibited the activity of seven types of bacteria, including Escherichia coli. Tajbakhsh *et al*. (2015) observed that the alcoholic extract of *P. juliflora* fruit increased the inhibition of several pathogenic bacteria, most notably *E. coli*.

Table (4) shows the effect of *P. farcta* and oxytetracycline in drinking water under *E. coli* challenge on some biochemical blood parameters of broiler blood serum. The results indicate a significant decrease in cholesterol concentration in T3, compared to T4, followed by the control treatment, then T5, then T6, and finally T2, with an average of 253.32, 264.19, 276.62, 282.71, 292.39, and 301.48 mg/100 ml of broiler blood serum. As for Low Density Lipoprotein (LDL), a significant decrease was observed in T3 compared to T4, which significantly decreased compared to the control treatment. T5, which significantly decreased compared to T6, and T2, which significantly decreased compared to T2. The averages reached 207.47, 227.63, 193.15, 201.72, 210.04, and 214.58 mg/100 ml of serum for broiler chickens in treatments T1, T2, T3, T4, T5, and T6, respectively. Regarding High Density Lipoprotein (HDL), a significant increase was observed in T3 compared to treatment T4, which was significantly superior to the control treatment. The control treatment showed a significant increase compared to T6, which was significantly superior to T2. The average HDL levels were 29.78, 25.60, 35.64, 31.07, 28.07, and 27.49 mg/100 ml of serum for broiler chickens in treatments T1, T2, T3, T4, T5, and T6, respectively.

Regarding triglycerides and glucose, a significant decrease was observed in T3, compared to T4, which was significantly lower than the control treatment, compared to treatments T5 and T6. Treatments T2 were significantly lower than the control treatment. Triglycerides were 155.16, 161.47, 146.33, 153.42, 157.42, and 158.38 mg/100 ml of serum. Glucose levels were 194.75, 202.46, 188.52, 191.13, 197.68, and 199.18 mg/100 ml of serum for broiler chickens in treatments T1, T2, T3, T4, T5, and T6, respectively. For albumin, globulin, and total protein, a significant increase was observed in T3, compared to T4, which showed a significant increase, compared to the control treatment, which was significantly superior, compared to T5, which was significantly superior, compared to T6, which was significantly superior compared to T2. The average albumin concentrations were 2.107, 2.014, 2.417, 2.274, 2.094, and 2.078 g/100 ml of serum. The average globulin concentrations were 1.989, 1.843, 2.187, 2.015, 2.009, and 1.914 g/100 ml of serum. The average total protein concentrations were 4.096, 3.857, 4.607, 4.289, 4.103, and 3.992 g/100 ml of broiler serum for treatments T1, T2, T3, T4, T5, and T6, respectively.

Table 4: Impact of *Prosopis farcta* and Oxytetracycline of broiler under *E. coli* challenge on some biochemical blood traits.

Traits	T1	T2	T3	T4	T5	T6	SEM	P-value
Cholesterol (mg/ 100ml)	276.62 d	301.48 a	253.32 f	264.19 e	282.71 c	292.39 b	11.315	0.0000
LDL (mg/ 100ml)	207.47 c	227.63 a	193.15 e	201.72 d	210.04 c	214.58 b	7.5482	0.0003
HDL (mg/ 100ml)	29.78 c	25.60 e	35.64 a	31.07 b	28.07 cd	27.49 d	0.0841	0.0011
Triglycerides (mg/ 100ml)	155.16 c	161.47 a	146.33 e	153.42 d	157.55 b	158.38 b	4.945	0.0108
Glucose (mg/ 100ml)	194.75 c	202.46 a	188.52 e	191.13 d	197.68 b	199.18 b	3.178	0.0487
Albumin (gm/ 100ml)	2.107 c	2.014 f	2.417 a	2.274 b	2.094 d	2.078 e	0.0014	0.0000
Globulin (gm/ 100ml)	1.989 c	1.843 f	2.187 a	2.015 b	2.009 d	1.914 e	0.0008	0.0001
Total Protein (gm/ 100ml)	4.096 c	3.857 f	4.604 a	4.289 b	4.103 d	3.992 e	0.0009	0.0010

Different letters within row indicating of significant differences ($p<0.05$)
HDL: low density lipoprotein, HDL: high density lipoprotein

Table (5) shows the effect of *P. farcta* and oxytetracycline in drinking water under *E. coli* challenge on oxidative stress indicators in broiler serum. Malondialdehyde results show a significant decrease in T3 compared to T6 and a significant decrease compared to T2. No significant differences were found between treatments T5 and T6, treatments T1 and T5, treatments T1 and T4, and treatments T3 and T4. Regarding glutathione peroxidase (GSH-px), a significant increase was observed in T3 compared to T4, which significantly outperformed the control

treatment, and which significantly outperformed the control treatment T2. No significant differences were found between the control treatment and T5, and between treatments T5 and T6. As for the Catalase enzyme, a significant increase was also observed in the T3 at the expense of the control treatment and T4, which was significantly increase compared to the T5 and T6 treatments and T5, T6 significantly increase as compared to the T2 treatment.

Table 5: Impact of *Prosopis farcta* and Oxytetracycline of broiler under *E. coli* challenge on some oxidative indicators.

Traits	T1	T2	T3	T4	T5	T6	SEM	P-value
Malondialdehyd (mg/ 100ml)	3.96 cd	4.69 a	3.63 e	3.81 de	4.16 bc	4.27 b	0.0004	0.0207
GSH-px (U/ L)	31.97 c	27.74 e	35.11 a	33.29 b	31.09 cd	29.61 d	0.0017	0.0144
Catalase (IU)	49.50 b	44.15 d	52..88 a	50.75 b	47.55 c	46.36 c	0.0157	0.0011

Different letters within row indicating of significant differences ($p<0.05$)

The aqueous extract of *P. farcta* fruits improved blood biochemical parameters, possibly due to its active compounds, it reduced the concentrations of cholesterol, triglycerides, glucose, and LDL, while increasing the concentration of HDL. This may be due to the reduction of lipid oxidation, which reduces the deposition of fat in the blood vessels (Abdul-Majeed *et al*., 2022). It also prevents the oxidation of unsaturated fatty acids, which reduces the deposition of cholesterol in the blood serum and maintains a proper lipid balance in the blood vessels, which leads to a decrease in blood cholesterol (Yan *et al*., 2020; Alkado *et al*., 2022).

CONCLUSIONS

We conclude that adding 10 ml of aqueous extract of *Prosopis farcta* powder per liter of drinking water to broiler chicks, whether infected or not with *E. coli*, improved growth performance, physiological response, and immune response compared to the antibiotic oxytetracycline and control. This indicates that birds were resistant to E. coli infection when using *P. farcta* powder.

CONFLICT OF INTEREST

The authors declare no conflicts of interest associated with this manuscript.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the staff of the animal production department, Agriculture College, Al-Muthanna University for their technical and general support.

ETHICAL APPROVAL

We obtained approval from the Research Ethics Committee of the College of Agriculture, Al-Muthanna University, to conduct this scientific research by exposing broiler chickens to infection with *Escherichia coli* in the broiler chicken field affiliated with the Agricultural Research and Experimental Station in the College of Agriculture.

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