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Effects of Probchick® On *E. Coli* O157:H7 Experimental Infection in Broilers

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E.COLI infection have a great impact on poultry production since the first days after chicks hatching. We aimed in the current study to evaluate the effect of ProbChick® on the production and pathological aspect of broiler infected experimentally with *E. coli*. A total of 200 one-day-old chicks were divided randomly into five groups. The first group was considered a control group. The second group consumes ProbChick® with drinking water. The third group was orally inoculated with *E. coli* at dose 0.5 ml containing $6x10^8$ CFU/ml. The fourth group was orally inoculated with *E. coli* at dose 0.5 ml containing $6x10^8$ CFU/ml then after 7 days consume ProbChick®. The fifth group was orally inoculated with *E. coli* at dose 0.5 ml containing $6x10^8$ CFU/ml and consume ProbChick® at the same day. The result showed that, ProbChick® enhance the weight gain, food conversion ratio, relative weight for kidney and liver, in contrast in groups that infected with *E. coli*, the ProbChick® help to reduce the effect of experimental infection with this bacterium, especially when it is give at the same day of infection, this was obtained from the improvement of the histopathological changes that were less in their severity in comparison with the group infected with *E. coli* only. We conclude that adding ProbChick® to broiler feed will enhance their production properties in addition, and cause noticeable reduction in the severity of lesions induced by experimental infection with pathogenic *E. coli*.

Keywords: Poultry, *E. coli*, ProbChick®, Liver, Kidney.

Introduction

Probiotics are live bacteria, fungi, or yeasts that replenish the flora of the gastrointestinal tract and aid in the maintenance of a healthy digestive system, which promotes bird growth and alternative to antibiotics; probiotics are becoming more widely used in poultry diets [1]. The word probiotic is derived from two Greek words, pro and biotic, which mean for life [2]. In 1965 Lilly and Stillwell were the first to use the word [3]; according to a joint FAO/WHO work-group, Probiotics are live microorganisms that, when supplied in suitable proportions, impart a health benefit on the host [4]. Elie Metchnikoff was the first scientist who discovered that the microbiota present in the intestine plays an important role in maintaining a healthy body when he found that the Lactobacillus bacteria that produce lactic acid present in fermented milk products were able to increase the longevity of Bulgarian peasants [5]. For the most part, live apathogenic bacterial strains are used in animals and poultry that are generally considered as probiotics are *Lactobacillus acidophilus*, *L. sporogenes*, *L. bulgaricus*, *Streptococcus thermophilus*; *Bacillus subtilis*, and *Saccharomyces cerevisiae* [6]. Probiotics have various mechanisms of action such as inhibition of all pathogens by producing organic acids and antibacterial substances such as hydrogen peroxide, bacteriocins and defensins [7]; probiotics compete with pathogenic bacteria on both intestinal epithelial binding sites and for

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essential nutrients [8]; enhance the immune response by releasing regulatory T cells, effector T and B cells and antigen-presenting cells [9]. ProbChick® is a feed additive for poultry that have multiple types of beneficial bacteria *Lactobacillus plantarum*, *L. sporogenes*, *L. acidophilus*, *Streptococcus thermophilus, Bacillus subtilis, Bifidobacterium bifidum and Saccharomyces cerevisiae*, also contain digestive enzymes, which maintain good gut flora leads to a high rate of feed utilization and increase weight gain of broiler, inhibit the growth of pathogenic bacteria in the gut and enhance the immune response of broiler [10]. Colibacillosis affects all ages, but young birds are more frequently affected; the surviving infected chicks can be a source of *E. coli* infection for other chicks in the same hatch and lead to yolk sac infection (omphalitis), another form of colibacillosis such as coliform cellulitis, colisepticemia, coliform enteritis and panophthalmitis in older age [11]. We aimed in the current study to investigate the effect of ProbChick® as protective and therapeutic against *E. coli* infection in broilers.

Materials and Methods

Experimental designs

This study is conducted under the ethical approval by the scientific committee of department of pathology and poultry diseases, college of veterinary medicine, university of mosul, under the approval number VetMed-1246 dated 11-09-2021.

ProbCkick®

ProbChick® contains 10 billion CFU/gram of various strains of different beneficial bacteria like *Lactobacillus plantarum*, *Lactobacillus sporogenes*, *Lactobacillus acidophilus*, *Streptococcus thermophilus*, *Bacillus subtilis*, *Bifidobacterium bifidum* and *Saccharomyces cerevisiae*.

Experimental designs

A total of 200 one-day-old chicks were included in the current study and divided randomly into five groups (40 chicks in each group). The first group was considered as the control group left without any treatment all over the experiment. The second group (positive control) was treated with ProbChick® in daily doses of 1 gram/litter of drinking water. The third group (negative control) was orally inoculated with *E. coli* at dose 0.5 ml containing $6x10^8$ CFU/ml of *E. coli* O157:H7, on the first day of age. The fourth group (therapeutic group) was orally inoculated with *E. coli* at dose 0.5 ml containing $6x10^8$ CFU/ml, at the 7th day of age treated with ProbChick® in a dose of 1 gram/liter of drinking water, daily till the end of the experiment. The fifth group (protective group) was orally inoculated with *E. coli* at dose 0.5 ml containing $6x10^8$ CFU/ml, was also treated with ProbChick® in a dose of 1 gram/liter of drinking water, daily till the end of the experiment. Ten birds from each group were euthanized at the end of each first, second, third and fourth week of age. A thin blood smear was stained with Wright-Giemsa to calculate the stress index [12]. Weekly body weight, weekly feed consumption, food conversion ratio [13]. Samples from the liver and kidney were fixed in 10% neutral buffered formalin [14].

E. coli O157:H7 isolate and infective dose

The pure *E. coli* O157:H7 isolate was obtained from RNA lab, left coast of Mosul, Iraq; these bacteria were isolated from poultry cases suffered from colisepticemia, in which *E. coli* O157:H7 were isolated on *E. coli* chromogen agar media and identified by PCR in RNA lab. The pure culture colony was re-cultured on *E. coli* O157 chromogen agar media, and the infective dose was prepared in 0.5 ml to be orally administrated at a concentration of $6x10^8$ CFU/ml [15].

Histopathology

Samples of liver and kidney were fixed in 10% neutral buffered formalin for 72 hours at least, later represented samples were collected and dehydrated by ethyl alcohol, cleared in xylene, infiltrated and embedded in hot paraffin, the tissue blocks were then sectioned at 5µm and stained with Harris' hematoxylin and eosin [16].

Statistical analysis

The means included in the current study were analyzed using one-way ANOVA, with Duncan's test as post Hock test, at $P<0.05$.

Results

Average body weight

The effects of *E. coli* infection and probiotic (Probchick®) are shown in table 1. On day one no significant variation $p<0.05$ among the BW means in all groups. On week 1 the chicks in G2 showed the highest BW means 162.6 gm. On week 2 also the chicks in G2 showed the highest BW which significantly higher $p<0.05$ among all groups 446.5 gm, G1 and G5 are significantly higher than G3 and G4 with no significant variation between them. On Week 3 and week 4 the higher BW means are showed in G2 997.7 gm, 1610 gm, respectively.

Body weight gain and feed conversion rate

The average weekly weight gains and feed conversion rate FCR are summarized in Table 2. The effects of *E. coli* and probiotic (Probchick®) on weekly weight gain at week 1 showed that the G1 and G2 are significantly higher $p<0.05$ among all groups with no significant differences between them, G4, G5 are significantly higher $p<0.05$ than G3 with no significant differences between them. On week 2 the G1 are significantly higher $p<0.05$ among all groups, and G3 showed less weekly weight gain among all groups. On Week 3 and week 4 the chick in G2 showed higher weekly body weight gain with significant among all groups at $p<0.05$. The FCR was higher in G2 1.34 among all groups and less value of FCR were in G3 1.79.

Liver relative weight

The effects of *E. coli* and probiotic (Probchick®) on liver relative weight are showed in table 3. On week 1 the chick in G3, G4 and G5 showed significant difference with other groups at $P<0.05$ and with no significant difference between the three groups. On week 2 G1, G4 and G5 are significantly higher $p<0.05$ than G2 and G3 with no significant difference between them. On week 3 the G3 are significantly higher $p<0.05$ among all groups, and there is no significant variation between the others groups. On week 4 the G3 and G4 are significantly higher $p<0.05$ than others groups with no significant difference between them.

Kidney relative weight

The effects of E. coli and probiotic (Probchick®) on kidney relative weight are showed in Table 4. On week 1 the G1, G3, G4 and G5 are significantly higher $p<0.05$ than G2 with no significant difference between them. On week 2, 3 and week 4 the G3, G4 and G5 are significantly higher $p<0.05$ than G1 and G2 with no significant difference between them.

TABLE 1. Show effects of *E. coli* and probiotic on weekly average body weight

Groups	Age (Average Body weight [gm] ± SD)				
	Day one	Week 1	Week 2	Week 3	Week 4
G1	40.1±0.4^{a}	158.6±0.7^{b}	417.2±2.7^{b}	889.2±4.8^{b}	1456.6±7.5^{b}
G2	41.6±0.4^{a}	162.6±1.1^{a}	446.5±6.9^{a}	997.7±4.9^{a}	1610.0±6.9^{a}
G3	40.8±0.9^{a}	141.3±0.6^{d}	370.5±5.6^{d}	775.8±7.6^{c}	1291.6±6.0^{d}
G4	40.1±0.5^{a}	144.2±1.4^{c}	387.5±2.8^{c}	795.8±7.7^{c}	1340.0±6.2^{bd}
G5	40.7±0.9^{a}	145.4±0.8^{c}	406.1±2.7^{b}	887.1±9.2^{b}	1400.0±5.7^{bc}

-Different letters within the same column mean statistically significant differences at $p < 0.05$

G1: Control group

G2: Positive Control group (Probchick® only)

G3: Negative control group (*E. coli* infection)

G4: Therapeutic group (*E. coli* infection day 1 Probchick® day 7)

G5: Protective group (*E. coli* infection and Probchick® in the same day)

TABLE 2. Show Effects of *E. coli* and probiotic on weekly body weight gain and FCR

Groups	Weeks (Average body weight gain [gm] ± SD)				FCR
	Week 1	Week 2	Week 3	Week 4	
G1	118.5±0.7^{a}	258.6±1.8^{b}	472.0±5.6^{b}	567.4±7.6^{b}	1.49±0.15
G2	121.0±0.8^{a}	283.9±1.7^{a}	551.2±5.9^{a}	612.3±5.6^{a}	1.34±0.21
G3	100.5±0.6^{c}	229.2±1.9^{e}	405.3±2.4^{c}	515.8±6.7^{d}	1.79±0.18
G4	104.1±0.7^{b}	243.3±1.5^{d}	408.3±3.8^{c}	544.2±3.4^{c}	1.62±0.11
G5	104.7±0.9^{b}	260.7±1.9^{c}	481.0±3.3^{b}	512.9±6.4^{d}	1.66±0.17

-Different letters within the same column mean statistically significant differences at $p < 0.05$.

TABLE 3. Show Effects of *E. coli* and probiotic on liver relative weight

Groups	Weeks (liver relative weight[gm] ± SD)			
	Week 1	Week 2	Week 3	Week 4
G1	3.38±0.15[b]	3.08±0.15[a]	2.62±0.16[b]	1.82±0.18b
G2	3.84±0.15[b]	2.82±0.18[b]	2.62±0.15[b]	1.80±0.17b
G3	4.13±0.21[a]	2.89±0.12[b]	2.81±0.12[a]	2.40±0.12[a]
G4	4.01±0.24[a]	3.00±0.19[a]	2.68±0.14[b]	2.22±0.14[a]
G5	4.05±0.22[a]	3.13±0.12[a]	2.63±0.12[b]	1.90±0.21[b]

-Different letters within the same column mean statistically significant differences at $p < 0.05$.

TABLE 4. Show Effects of *E. coli* and probiotic on kidney relative weight

Groups	Weeks (kidney relative weight[gm] ± SD)			
	Week 1	Week 2	Week 3	Week 4
G1	0.787±0.039[a]	0.386±0.017[b]	0.389±0.053[b]	0.437±0.031[b]
G2	0.657±0.031[b]	0.363±0.011[b]	0.379±0.051[b]	0.481±0.021[b]
G3	0.792±0.041[a]	0.404±0.021[a]	0.459±0.021[a]	0.594±0.034[a]
G4	0.793±0.015[a]	0.404±0.029[a]	0.469±0.059[a]	0.551±0.037[a]
G5	0.795±0.031[a]	0.409±0.012[a]	0.448±0.024[a]	0.532±0.029[a]

-Different letters within the same column mean statistically significant differences at $p < 0.05$.

Histopathological changes

The result of current study showed that the control group showed normal histological features in both liver (Fig. 1) and kidney tissue (Fig. 2). In addition, the same result was recorded in group that consume ProbChick® only were the liver (Fig. 3) and kidney (Fig. 4) showed normal histological architectures.

In contrast the group infected with E. coli only after 7 days of infection showed massive infiltration of inflammatory cells, with hyperplasia of fibrocytes, and other renal tubules showed coagulative necrosis, with complete destruction of glomerular tuft, while at 14 days of infection the kidney showed coagulative necrosis affected most of renal tubules, hyper cellularity of glomerular tuft, infiltration of lymphocytes, at 21 days of infection kidney showed massive fibrosis in partial part of affected kidney, in compare with necrotic and inflamed tissue, the glomeruli showed complete loss of function and appeared as cellular debris, with increase in thickness of Bowman's capsule, with interstitial fibrosis, which surrounded few necrotic tubules, while at 28 days of infection the kidney showed massive fibrosis in whole kidney tissue, with capsular fibrosis, the glomeruli showed complete loss of function and appeared as cellular debris, with complete destruction of renal tubule structure and appeared as cellular debris, and interstitial fibrosis which surrounded few necrotic tubules, with infiltration of inflammatory cells (Fig. 5). In liver sections at 7 days of infection there was small vacuoles in cytoplasm of hepatocytes, infiltration of macrophages around portal area, deposition of collagen fibers around portal area, at 14 days of infection there was small vacuoles in cytoplasm of hepatocytes, infiltration of macrophages around portal area, while at 21 days of infection liver sections showed presence of small multiple vacuoles in cytoplasm of hepatocytes, other hepatocytes showed coagulative necrosis, increase in number of Kupffer cells, at 28 days of infection liver tissue showed coagulative necrosis in the hepatocytes around portal area, hyperplasia of bile cuniculi, infiltration of macrophages (Fig. 6).

In the fourth group that infected with E. coli at first day then consume ProbChick® after one week, the result showed improving in the histopathological lesions in compare with the third group (infected with *E. coli* only) in general there was hyperplasia in portal area, infiltration of inflammatory cells, hepatocytes showed vacuolar degeneration, necrotic changes in other hepatocytes, and deposition of collagen fiber around portal area (Fig. 7). In general, the same result was obtained in kidney were the lesions can

be described as coagulative necrosis in renal tubules, hyper cellularity of the glomerular tuft, infiltration of inflammatory cells in the interstitial tissue, sloughing of necrotic epithelial cells as cellular debris inside renal lumen, and hemorrhage (Fig. 8).

While in the fifth group which infected with *E. coli* and consume ProbChick® at the same day, the result of histopathological examination showed an increase in improving in tissue histology in compare with the fourth and third groups, were in general, Liver sections showed hemorrhages between hepatocytes, dilatation of sinusoids, hepatocytes showed vacuolar degeneration (Fig. 9). The same were observed in kidney and the lesions was recorded are necrosis and sloughing of renal tubules, vacuolar degeneration in other tubules, interstitial edema (Fig. 10).

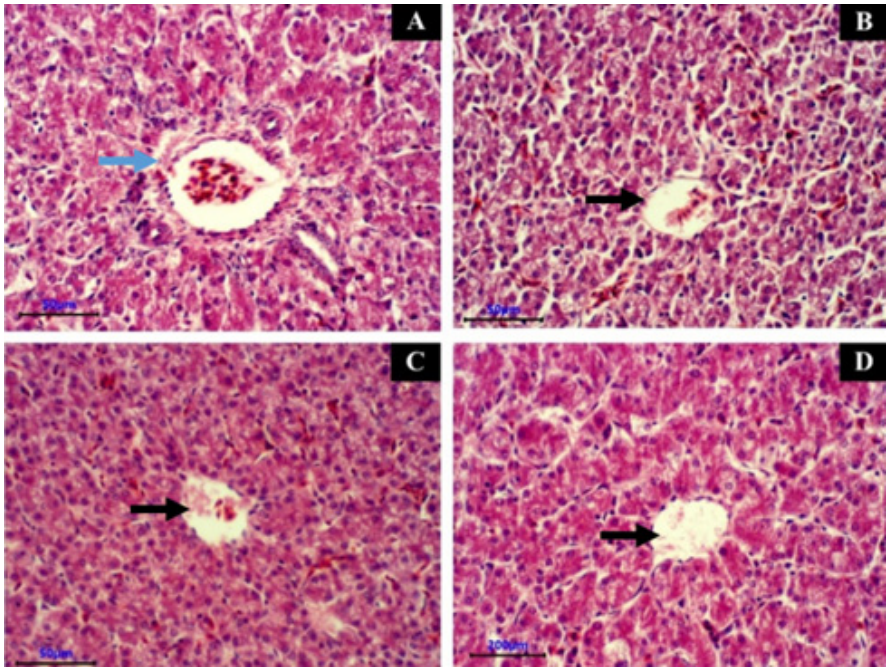

Fig. 1. Control group (G1); (a) 7 days, (b) 14 days, (c) 21 days, (d) 28 days. Liver sections showed normal histological architectures of liver histology, composed cord arrangement of hepatocytes around central vein (arrow), and portal area (arrow). H&E.

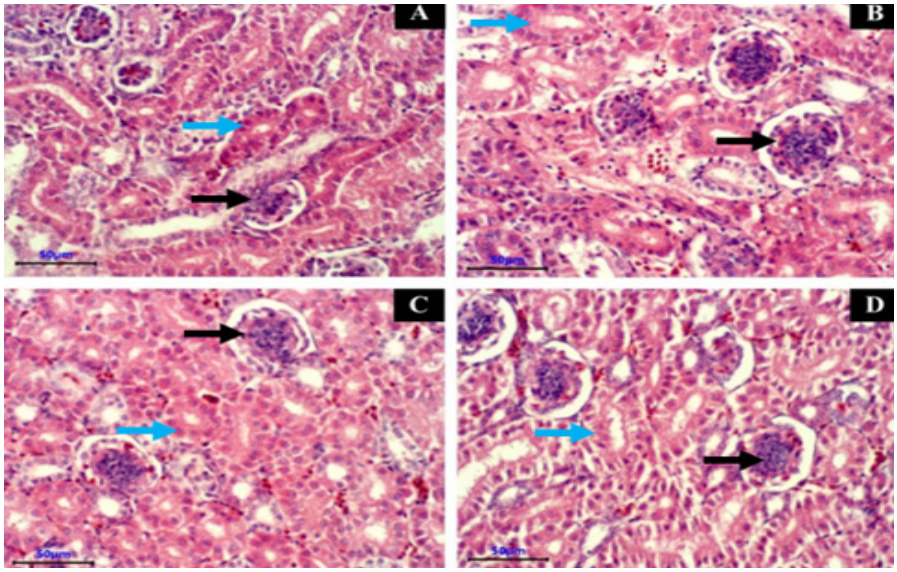

Fig. 2. Control group (G1); (a) 7 days, (b) 14 days, (c) 21 days, (d) 28 days. Kidney sections showed normal histological architectures of kidney histology, composed renal glomeruli (arrow), and different types of renal tubules (arrow). H&E.

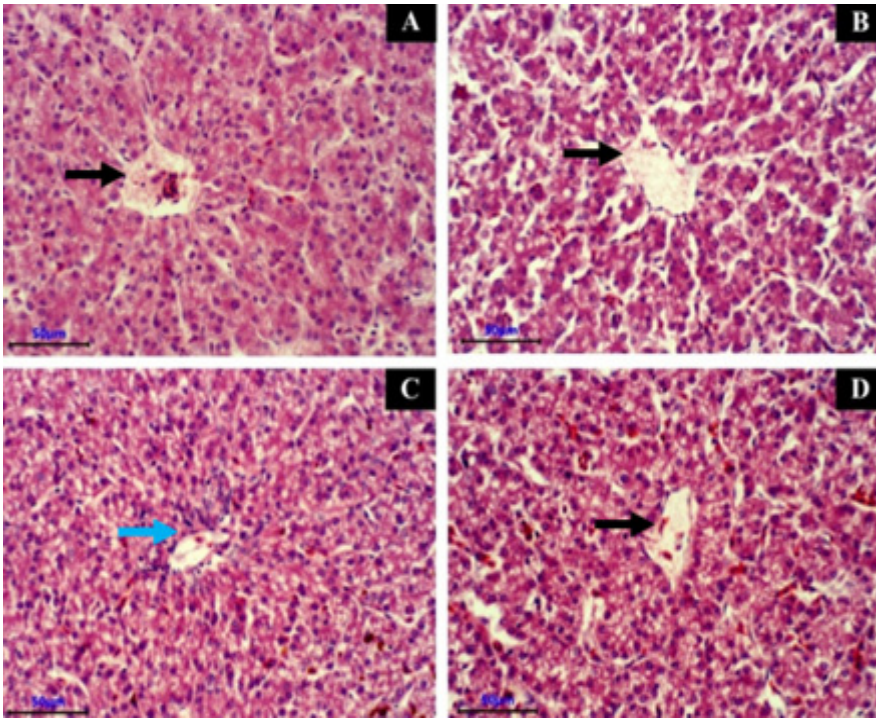

Fig. 3. ProbChick® group (G2); (a) 7 days, (b) 14 days, (c) 21 days, (d) 28 days. Liver sections showed normal histological architectures of liver histology, composed cord arrangement of hepatocytes around central vein (arrow), and portal area (arrow). H&E.

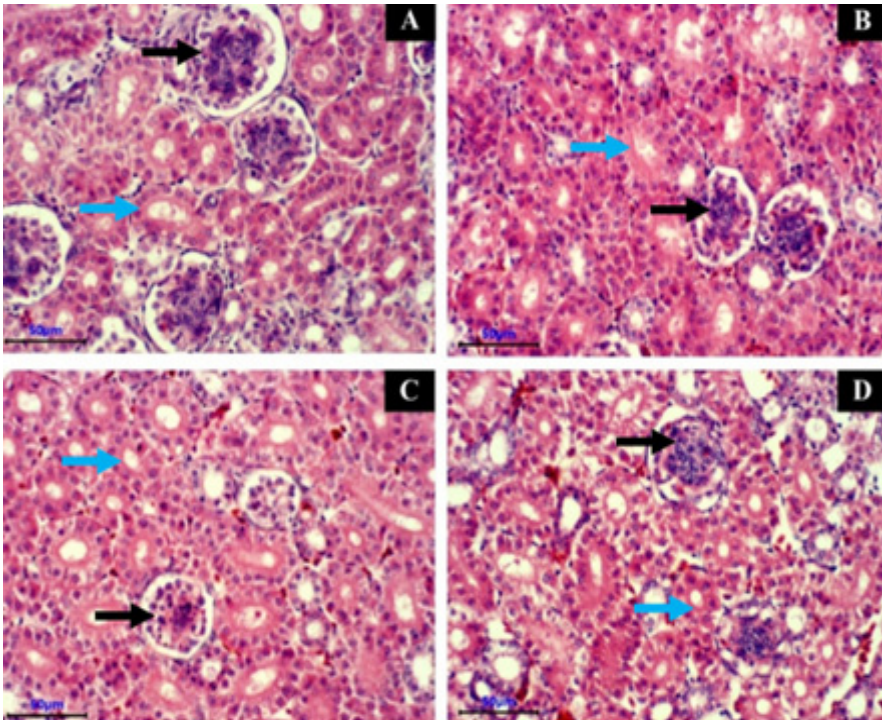

Fig. 4. ProbChick® group (G2); (a) 7 days, (b) 14 days, (c) 21 days, (d) 28 days. Kidney sections showed normal histological architectures of kidney histology, composed renal glomeruli (arrow), and different types of renal tubules (arrow). H&E.

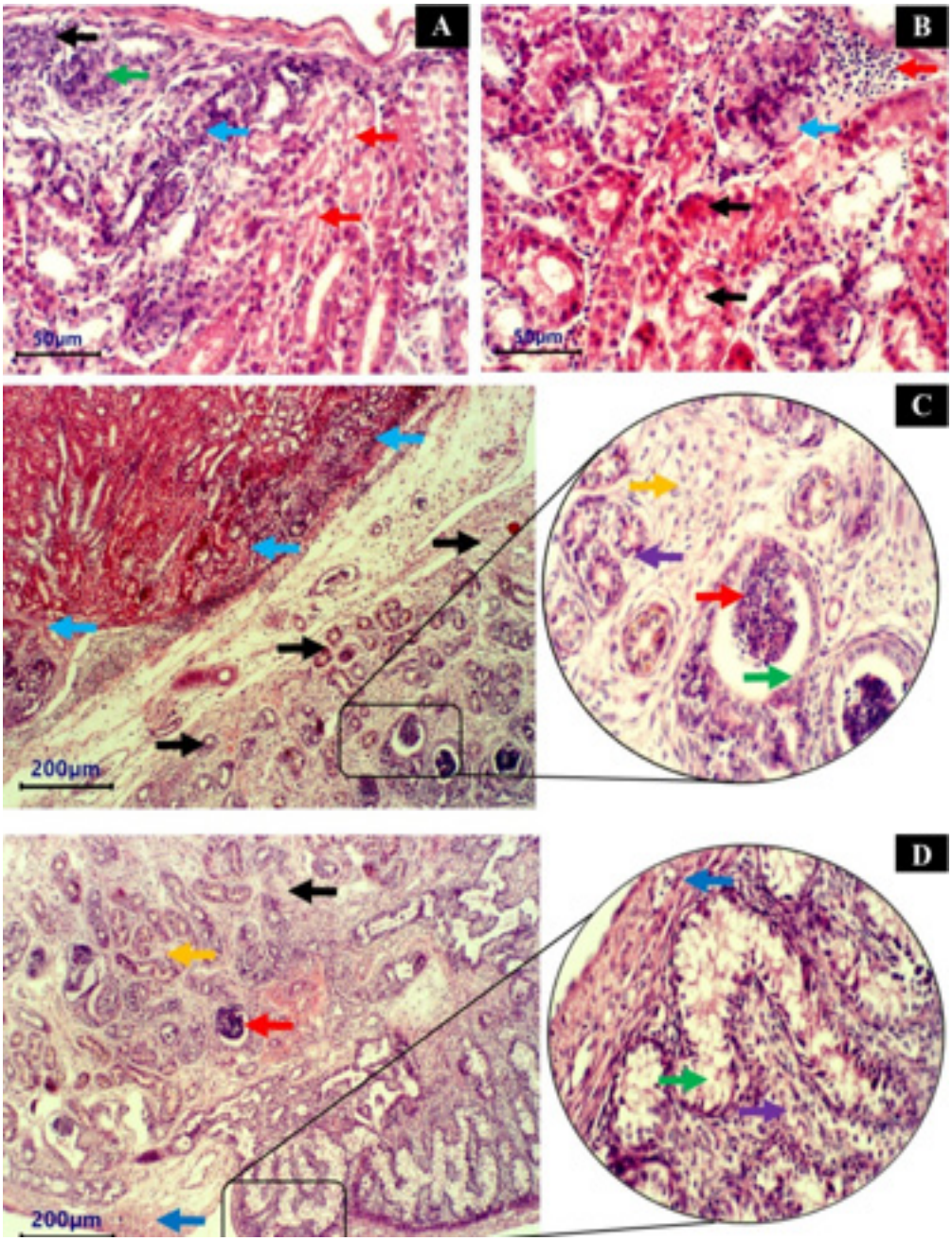

Fig. 5. E. coli group (G3); Kidney sections. (a) after 7 days of infection. Showed massive infiltration of inflammatory cells (arrow), with hyperplasia of fibrocytes (arrow), and other renal tubules showed coagulative necrosis (arrow), with complete destruction of glomerular tuft (arrow). (b) after 14 days of infection. Showed coagulative necrosis affected most of renal tubules (arrow), hyper cellularity of glomerular tuft (arrow), infiltration of lymphocytes (arrow). (c) after 21 days of infection. Showed massive fibrosis in partial part of affected kidney (arrow), in compare with necrotic and inflamed tissue (arrow), the glomeruli showed complete loss of function and appeared as cellular debris (arrow), with increase in thickness of Bowman's capsule (arrow), with interstitial fibrosis (arrow), which surrounded few necrotic tubules (arrow). (d) after 28 days of infection. Showed massive fibrosis in whole kidney tissue (arrow), with capsular fibrosis (arrow), the glomeruli showed complete loss of function and appeared as cellular debris (arrow), with complete destruction of renal tubule structure and appeared as cellular debris (arrow), and interstitial fibrosis which surrounded few necrotic tubules (arrow), with infiltration of inflammatory cells (arrow). H&E.

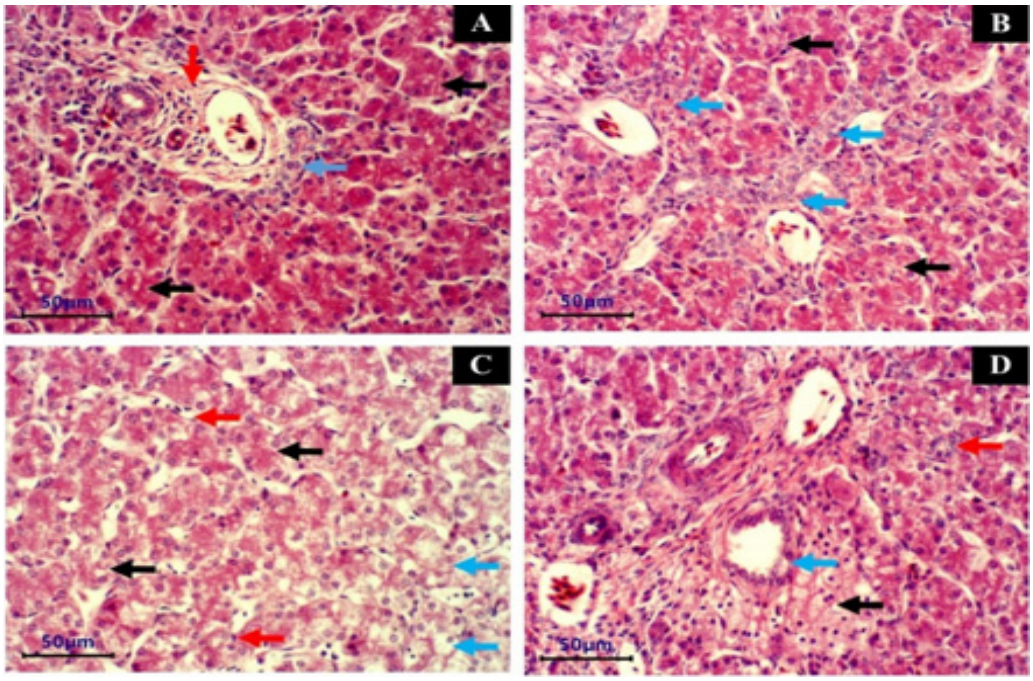

Fig. 6. E. coli group (G3); Liver sections. (a) after 7 days of infection. Showed presence of small vacuole in cytoplasm of hepatocytes (arrow), infiltration of macrophages around portal area (arrow), deposition of collagen fibers around portal area (arrow). (b) after 14 days of infection. Showed presence of small vacuole in cytoplasm of hepatocytes (arrow), infiltration of macrophages around portal area (arrow). H&E. (c) after 21 days of infection. Showed presence of small vacuole in cytoplasm of hepatocytes (arrow), other hepatocytes showed coagulative necrosis (arrow), increase in number of Kupffer cells (arrow). (d) after 28 days of infection. Showed coagulative necrosis in the hepatocytes around portal area (arrow), hyperplasia of bile cuniculi (arrow), infiltration of macrophages (arrow). H&E.

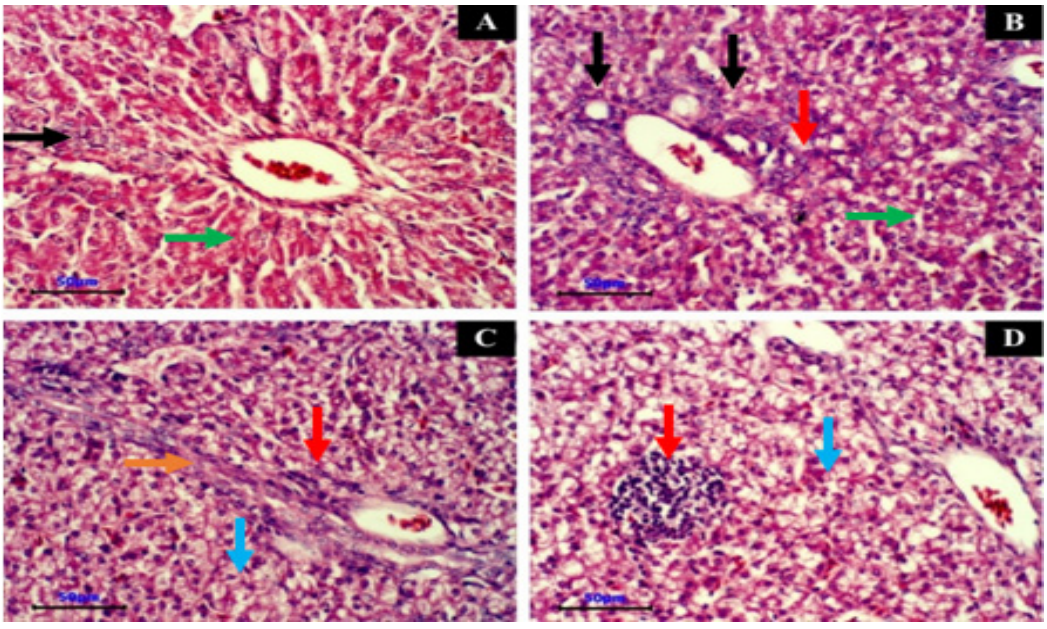

Fig. 7. E. coli at first day the ProbChick® after 7 days group (G4); (a) 7 days, (b) 14 days, (c) 21 days, (d) 28 days. Liver sections showed hyperplasia in portal area (arrow), infiltration of inflammatory cells (arrow), hepatocytes showed vacuolar degeneration (arrow), necrotic changes in other hepatocytes (arrow), and deposition of collagen fiber around portal area (arrow). H&E.

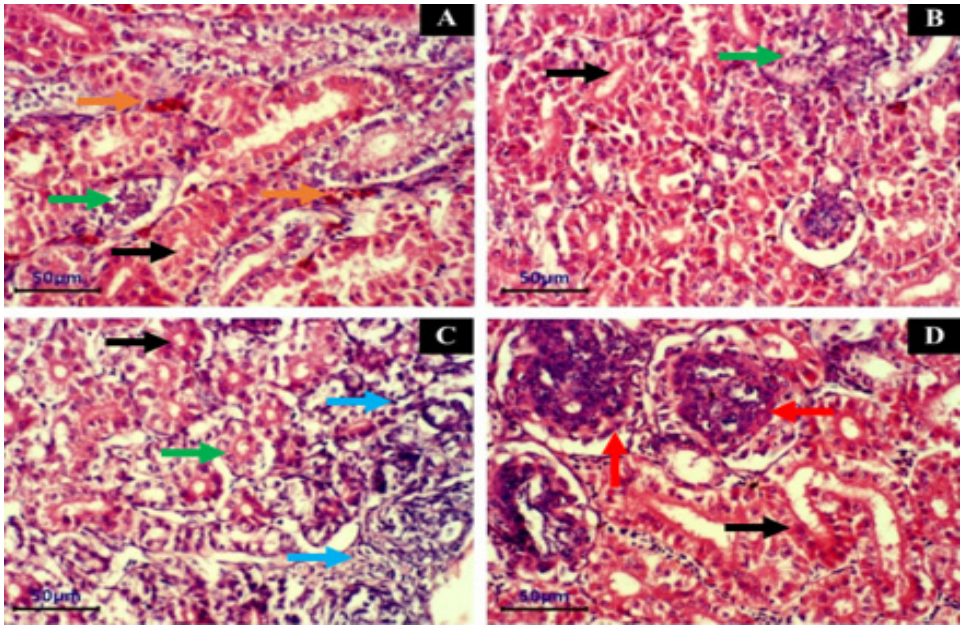

Fig. 8. E. coli at first day the ProbChick® after 7 days group (G4); (a) 7 days, (b) 14 days, (c) 21 days, (d) 28 days. Kidney sections showed coagulative necrosis in renal tubules (arrow), hyper cellularity of the glomerular tuft (arrow), infiltration of inflammatory cells in the interstitial tissue (arrow), sloughing of necrotic epithelial cells as cellular debris inside renal lumen (arrow), and hemorrhage (arrow). H&E.

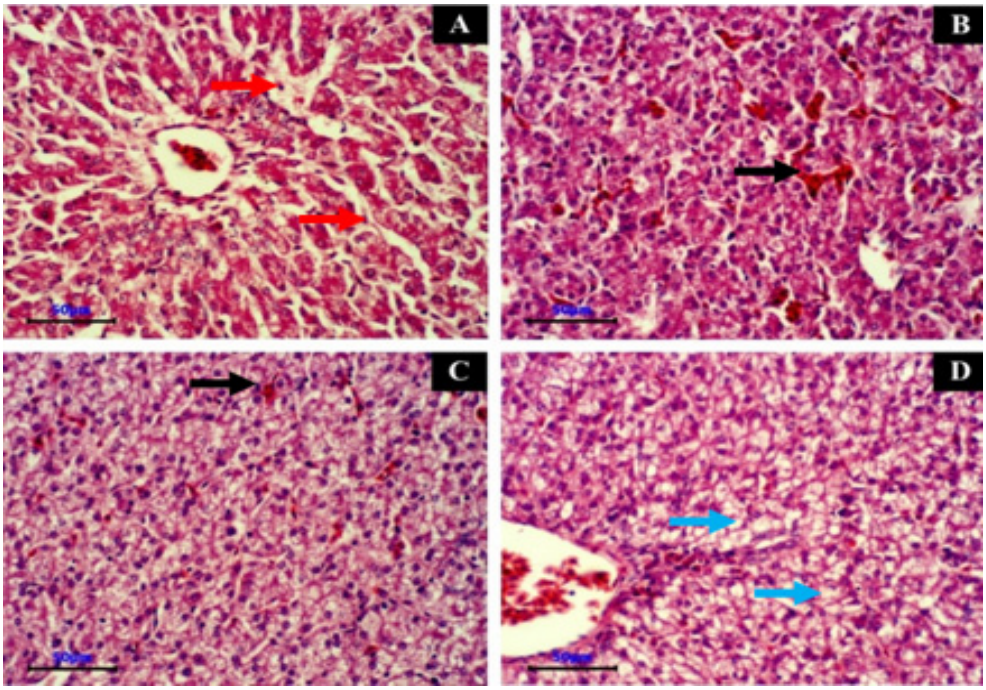

Fig. 9. E. coli and ProbChick® at first day group (G5); (a) 7 days, (b) 14 days, (c) 21 days, (d) 28 days. Liver sections showed hemorrhages between hepatocytes (arrow), dilatation of sinusoids (arrow), hepatocytes showed vacuolar degeneration (arrow). H&E.

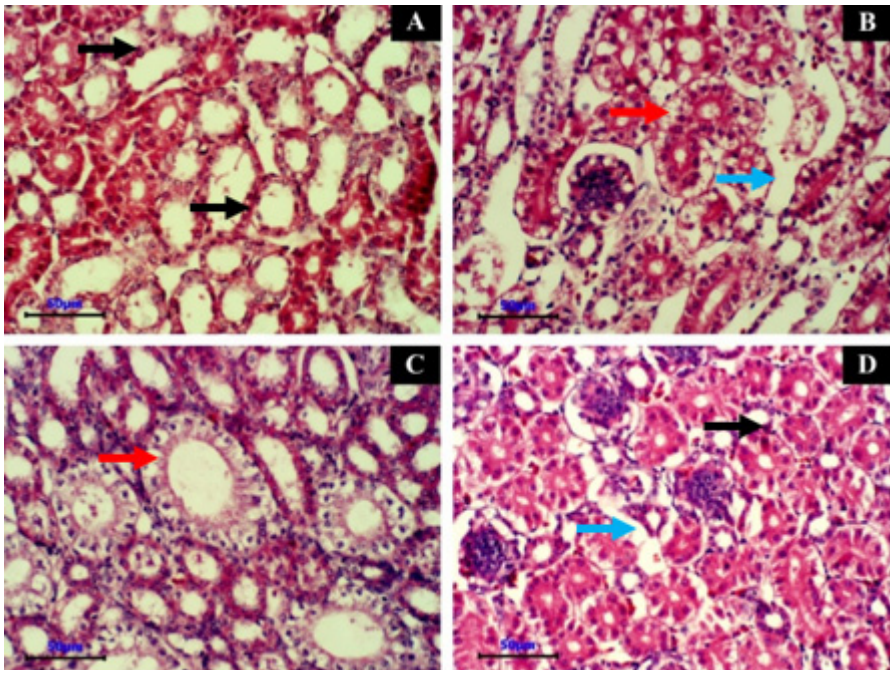

Fig. 11. E. coli and ProbChick® at first day group (G5); (a) 7 days, (b) 14 days, (c) 21 days, (d) 28 days. Kidney sections showed necrosis and sloughing of renal tubules (arrow), vacuolar degeneration in other tubules (arrow), interstitial edema (arrow). H&E.

Discussion

Adding probiotics to poultry feed have a great impact in the last two decays, since they have a major effect on other pathogenic microorganisms that infect chickens and lead to serious conditions that cause either high mortality rate or significant economic losses in this industry [17]. Infection with pathogenic *E. coli* cause a lethal condition to poultry due to renal and hepatic dysfunction, in which both of these organs play a major role in the metabolism and execration of food that absorbed from intestines [18]. The result of current study showed that adding Probchick® to chicken feed will have caused a significant improve in the weekly body weight, weekly weight gain, FCR, liver relative weight, and kidney relative weight in all group in compare with control group and group infected with *E. coli* only, this result where in agreements with other studies done by Marangoni et al. [19], Gupta and Das [20], Mountzouri et al. [21], Atela et al. [22], and Zukkifli et al. [23]. These improving of meat quality properties can be explained by the effect of these microorganism that present in the Probchick® which have a great impact at their site of action in the intestines by prevent and competitive with pathogenic bacteria and prevent them from attached and cross the intestinal wall and causing infection in these host which considered as the major source of stress in poultry production [24].

The result of current study showed that oral administration of chicks with $6x10^8$ CFU/ml will cause the pathognomic lesions in the kidney that represented by interstitial nephritis, fibrosis and cystic kidney, in addition to presence of inflammatory reaction in the liver represented by mononuclear infiltration of inflammatory cells in the portal area and around central vein. These results were found similar to those obtained by Elfadil *et al.* [25], Gomis et al. [26], and Norton et al. [27]. The result also indicates that feed of Probchick® as a therapeutic or preventive measures will cause decrease in the severity of these lesions and caused reduction in the damages to renal tissue specially since the fibrous tissue formation and cystic kidney were not recorded and focal infiltration of inflammatory cells were the predominant lesions that were observed during different period of experiment.

Conclusions

We conclude that adding Probchick® to broiler feed will enhance their meat quality and production properties in addition, adding this probiotic will cause noticeable reduction in the severity of lesions that induced by experimental infection with pathogenic *E. coli*.

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Conflict of interest

No conflict.

Funding Statement

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تاثير المعزز الحيوي ProbChick® على الإصابة التجريبية بجراثيم الاشريكيا القولونية O157:H7 في فروج اللحم

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ان لإصابة الايشريشيا كولاي القولونية تأثير مهم على صناعة الدواجن ومنذ اليوم الأول بعد فقس الافراخ. هدفت الدراسة الحالة الى تقييم تأثير المعزز الحيوي ProbChick® على إنتاجية وامراضية افراخ فروج اللحم المصاب تجريبيا بالايشريشيا كولاي القولونية. ٢٠٠ فرخ فروج لحم بعمر يوم واحد استخدمت في الدراسة الحالية وتم تقسيمها عشوائيا الى خمسة مجاميع. اعتبرت المجموعة الأولى مجموعة سيطرة. المجموعة الثانية أعطيت المعزز الحيوي مع ماء الشرب. المجموعة الثالثة جرعت في اليوم الأول من العمر فمويا بجراثيم الايشريشيا كولاي القولونية بجرعة ٦*١٠^٨ جرثومة مولدة للمستعمرة/ مليليتر. المجموعة الرابعة جرعت في اليوم الأول من العمر فمويا بجراثيم الايشريشيا كولاي القولونية بجرعة ٦*١٠^٨ جرثومة مولدة للمستعمرة/ مليليتر ثم بعد سبعة أيام تم البدء بإعطاء المعزز الحياتي ProbChick® عن طريق ماء الشرب. المجموعة الخامسة جرعت في اليوم الأول من العمر فمويا بجراثيم الايشريشيا كولاي القولونية بجرعة ٦*١٠^٨ جرثومة مولدة للمستعمرة/ مليليتر وفي اليوم الأول ايضاً تم البدء بإعطاء المعزز الحيوي ProbChick® عن طريق ماء الشرب. اشارت نتائج الدراسة الى ان إعطاء المعزز الحيوي ProbChick® علم على احداث زيادة في اكتساب الاوزان، وتحسبن معامل التحويل الغذائي، وتحسين الوزن النسبي لكل من الكبد والكلية، بالمقابل في المجاميع التي جرعت الاشيريكيا القولونية مع المعزز الحيوي ProbChick® فان هذا المعزز عمل على تقليل التأثيرات الضارة للإصابة التجريبية بهذه البكتريا، وبالأخص عندما تم البدء بإعطاء هذا المعزز الحيوي منذ اليوم الأول من العمر، كما عمل على تحسين الصورة النسجية وتقليل الآفات المرضية التي احدثتها الإصابة بجراثيم الايشريشيا كولاي القولونية في كل من الكبد والكلية هذا بالمقارنة مع مجموعة السيطرة والمجموعة المجرعة الايشريشيا كولاي القولونية فقط. نستنتج من الدراسة الحالية ان إضافة المعزز الحيوي ProbChick® الى علائق الدواجن تعلم على تحسين الخصائص الإنتاجية بالإضافة الى احداث تقليل محسوس في شدة الآفات التي تحدثها الإصابة التجريبية الايشريشيا كولاي القولونية.