Biochemical Study on the Effect of Some Antibiotics in Blood of Chicken

Biochemistry, Avian and rabbit medicine ¹ Departments, Faculty of Veterinary Medicine, Suez Canal University, Ismailia, Egypt.

Abstract
Enrofloxacin and colistin sulfate are among the most frequently prescribed antibiotics in poultry industry however they may cause side effects to birds as hepatotoxicity and nephrotoxicity. This study was done to evaluate the biochemical alterations of these antibiotics in broiler chicken. It was carried out on 186 one day old healthy chicks, classified into 6 groups; the first served as control group, the second and third groups treated with ENRO 20% (10mg/kg b. wt.) and colistin sulfate 6 MIU/ gm (50 mg/kg b. wt.) respectively for 5 days. The other three groups were experimentally infected with E.coli at 14 day old. The fourth group left without treatment. However, the fifth and sixth groups were treated with ENRO and colistin sulfate respectively at day 16 after the appearance of clinical signs of colibacillosis for 5 days. Serum samples were collected after finishing the course of treatment at 21 day (1 day post treatment), 28 day (1 week PT) and 35 day (2 weeks PT). The biochemical results of ENRO groups were significant decrease in total protein and γ globulin While significant increase in Interleukin-6, CAT activity, MDA, GOT, creatinine. However, the biochemical results of colistin sulfate groups were a significant decrease in total protein. Moreover, significant increase in IL-6, CAT activity, MDA, GOT and creatinine. So using of these antibiotics with their therapeutic dose in farms must be only in necessary with adjusted dosage.

Introduction
Antibiotics (Formally antimicrobials) are one of Xenobiotics classes that can produce a variety of biologic effects, including pharmacologic responses, toxicity, immunologic reactions, and cancer. They are subjected to metabolism leading to chemical alteration in the body (Murray et al, 2009). So more screening and studies must be carried out to evaluate the possible drawbacks of some obligatory used antibiotics in poultry manufacture that will aid in their therapeutic regimens, changing the outlook towards their preventive and treatment measures in the future (Rashed, 1997). Enrofloxacin (ciprofloxacin) is one of fluoroquinolones (FQs); broad spectrum antibiotics used for human and veterinary medicine (Piddock, 2002 and Threlfall, 2002). It is used for prophylaxis and treatment of respiratory, renal and digestive
infections of poultry (Martinez et al, 2006). However Colistin sulfate is an old antibiotic known as polymyxin E which is one of polymyxins; cationic lipopeptides. (Li et al, 2005). Their use was restricted due to its toxicity (Husain, 2008). But they are now the last resort for treatment of serious Gram-negative infections caused by multiresistant strains (Varaa et al, 2010). ENRO and Colistin Sulfate can be effectively used for treatment of colibacillosis where Escherichia coli (E.coli) is highly susceptible for both drugs (Jeong et al, 2009). E. coli infection in broiler chicken which results in air sacculitis and septicemia is one of the major threats to poultry farming worldwide (Dozois et al, 1994). So this work was carried out to evaluate some biochemical alterations due to Enrofloxacin and Colistine sulfate administration in healthy broiler chicken and after challenge with E.coli.

Material and methods
A total number of 186 one day old chicks apparently healthy (Cobb 500) were supplied from Ismailia-Masr Poultry Company, Ismailia, Egypt. The chicks were raised in identical built-up litter poultry house up to 35 days with a source of heat to give a starting temperature of 34 °C, reduced gradually to a constant temperature of 24 (±2)°C at the end of the third week. Continuous photoperiod was applied for 24 h. in the farm. The chicks were maintained on commercial ration, feed and water were provided ad libitum. All experimental birds were vaccinated against Newcastle and Gumboro diseases according to vaccination program.

Drugs used: Entril 20% obtained from Vet Pharm, Ltd-UK. 1 liter containing 200 mg/ml enrofloxacin., Colistan obtained from ATCO PHARMA, Egypt. Each 100 gm contains 600 MIU/ 100 gm colistin sulfate.

Microbial infection: E. coli strain O78 obtained from Animal Health Research Institute, Ismailia, Egypt.

Chemicals: Kits were purchased from Biodiagnostic Company, Egypt for the determination of total protein, catalase (CAT), nitric oxide (NO), malondialdehyde (MDA) and Glutamate oxaloacetate transaminase(GOT).

ELISA kit for determination of interleukin-6 (IL-6) from RayBiotech Company. Protein electrophoresis was done in department of clinical pathology, faculty of medicine, Suez Canal University, using cellulose acetate membrane from Helena lab. Uric acid Kit were purchased from Centronic- GmbH Company, Germany. Glutamic pyruvic transaminase (GPT) kit from BioSTC Company, Egypt and creatinine kit from Analyticon Company, Germany.

Experimental design: Antibiotic sensitivity test was done to examine the sensitivity of E. coli to antibiotics using different antibiotic discs (Cloud et al, 1985). The results showed that E. coli was highly sensitive to colistin sulfate (+++++) followed by ENRO (++) comparing to other drugs. 186 Chicks were divided into 6 groups; 3 groups (96 chicks) were
experimentally infected with *E.coli* strain O\(_{78}\). At day 14, They were injected intracrop with 0.5 ml saline suspension contain 2.5x10\(^7\) C.F.U. of *E. coli* on 2 successive days (Hamed, 2000). The dose was adjusted by plate count technique (Macfaddin, 1980).

After appearance of clinical signs of colibacillosis (at 16\(^{th}\) day old), therapeutic doses of ENRO and colistin sulfate were administered according to (Watts et al, 1997) and (Sato et al, 1972) respectively as shown in table (1).

**Table (1): Experimental design**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Infection</th>
<th>Antibiotics</th>
<th>No. of chicks/group</th>
<th>No. of chicks collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>-</td>
<td>-</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Enrofloxacin</td>
<td>-</td>
<td>10 mg/kg b.wt</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Colistin sulfate</td>
<td>-</td>
<td>50 mg/kg b.wt</td>
<td>30</td>
<td>10</td>
</tr>
<tr>
<td>Infected</td>
<td>+</td>
<td>-</td>
<td>32</td>
<td>10</td>
</tr>
<tr>
<td>Infected+ ENRO</td>
<td>+</td>
<td>10 mg /kg b.wt</td>
<td>32</td>
<td>10</td>
</tr>
<tr>
<td>Infected+colistin sulfate</td>
<td>+</td>
<td>50 mg /kg b.wt</td>
<td>32</td>
<td>10</td>
</tr>
</tbody>
</table>

After end of treatment, samples were collected 3 times. First collection was one day post treatment (21 day old), second, a week later (28 day old) and third, were 2 weeks post treatment (35 day old). Ten chicks were randomly selected from each group bled for serum sampling. Blood were collected rapidly after slaughtering the chicks into 2 clean, dry, sterile and labeled centrifuge tubes. Serum was obtained by centrifugation at 3000 r.p.m. for 15 minutes. Then all sera were kept for biochemical analysis in deep freeze at 20°C. Sera were used for the following biochemical parameters: total protein (Gornall et al, 1949), protein electrophoresis by using cellulose acetate membranes (Henry et al, 1974), Interleukin-6 (Van Oers et al, 1993), Nitric oxide (Montgomery and Dymock, 1961), Catalase (CAT) (Aebi, 1984) Malondialdehyde (MDA) (Ohkawa et al, 1979). Glutamate oxaloacetate transaminase (GOT) (Reitman and Frankel, 1957), Glutamic pyruvic transaminase (GPT) (Reitman and Frankel, 1957), Uric acid (Thomas, 1984) and creatinine (Whelton, 1994).

**Statistical analysis:** The data were analyzed using the statistical software "Instate". The means and standard deviation of each of the parameter were obtained. The Kruskal-Wallis ANOVA was used to compare between groups. A statistical significance of the comparison between groups was followed by a multiple comparison criterion to identify the group that was significantly different from the rest.

**Results and discussion**

The infected birds showed ruffled feathers, inability to stand, dropping wings, sunken eyes, bloody diarrhea, in-appetence, general weakness, dullness, depression, air sacculitis, pericarditis, They were similar with those found by El-Ghayaty (2002).The mortality rate was 6% in infected group and 3% in infected treated with ENRO all over the experiment.

The reduction in mean body weight of infected group at 35 days (table 2)
could be attributed to the decreased feed intake or impaired protein metabolism (Kumar et al, 2003). However, the decrease in mean body weight of infected ENRO at 35 day might be attributed to non-observed gastrointestinal disturbance which may hinder nutrient absorption (Kobayashi, 1985) or might be due to its broad spectrum bactericidal effect including beneficial microflora (Gram +ve) in the intestine of birds (Bernsten, 1994). However, colistin sulfate groups showed significant increase in mean body weight compared to ENRO groups. This may owe to the bactericidal effect of colistin on harmful microflora (Gram –ve) which may consume most essential nutrients. Total protein (Table 2) was significantly decreased in infected group at 35 day as the infection with E. coli increase the breakdown of plasma protein, increase the renal excretion and impaired protein synthesis as a result of liver disorders caused by colibacillosis (Dooley et al, 1988). Thus, this was reflected on the body weight as mentioned before. These results were similar to Moursi et al (2008). However, infected enrofloxacin treated group showed significant decrease in serum total protein at 35 days indicating hepatic damage, because the liver is responsible for the production of a great proportion of plasma protein (Coles, 1986). This was disagreed with Ramadan (1996) who mentioned that the oral administration of FQs to healthy chicks at first 3 days of age produced a significant decrease in total serum protein levels at the end of the experiment, and these changes regained their normality one week post treatment. The colistin sulfate groups showed a significant decrease in total protein at 28 day which came in agreement with Michalopulos and Falagas (2008) who reported that the administration of polymyxins can decrease total protein due to hematuria and proteinuria. The infected colistin group at 21 day showed a significant increase in albumin level (Table 2) comparing to control with no explanation. While a significant decrease in albumin level in colistin and infected ENRO treated chicken was observed at 28 day. However at 35 day, a significant decrease in albumin of infected ENRO was noticed. The secretion of albumin not only stimulated by a fall in osmotic pressure but also by pathophysiological changes such as during infectious or inflammatory disease when the secretion is reduced. Reduced albumin concentration in acute and chronic inflammation caused by proinflammatory cytokines such as IL-1, IL-6, and Tumor necrosis factor-α (TNF-α) (Kaneko et al, 2008). This explain the results of this study where the IL-6 (table 4) was the highest in infected ENRO. The elevation in serum IL-6 in ENRO treated groups at 21 and 28 days (Table 4) were in accordance with (Bailly et al, 1991) who found that lower doses of ciprofloxacin enhance production of IL-1, IL-6 and TNF-α by human monocytes in vitro. In addition, these cytokines are simultaneously
responsible for the increased synthesis and secretion of the acute phase protein (APP) which include $\alpha_1$--antitrypsin, $\alpha_1$--acid glycoprotein, Haptoglobin, Ceruloplasmin, C4, C3 and C reactive protein (Johnson et al, 2001). This came in accordance with our results which showed that $\alpha_1$-globulin significant increased in infected and infected ENRO treated groups (Table 3). The significant increase of $\alpha_1$-globulin in infected group might caused by lipopolysaccharide (LPS) of gram-negative bacteria (E.coli) which triggers an innate immune response by inducing the production of pro-inflammatory cytokines (IL-6) that stimulate acute phase protein (Sijben et al, 2003; Bliss et al 2005). A non significant increase in $\gamma$ globulin at 21 day in ENRO treated chicken was observed (Table 3). This disagreed with Rashed (1997) who found that the administration of danofloxacin (FQ) to broiler chicken caused a gradual increase in the $\gamma$ globulin till become significantly higher at last 3 days of the experiment. However, the significant decrease of globulin in enrofloxacin treated groups at 28 day agreed with El–Mosallamy (1995) who mentioned that enrofloxacin had a slight depressant effect on the HI titer and decreased the protective power of NDV vaccine. In contrary with Behr et al (1988) reported that the humoral immune response following Newcastle disease vaccination was not reduced by treatment with enrofloxacin.

The increased IL-6 (table 4) in infected group came in agreement with Nakamura et al (1998) who studied the inflammatory response of E.coli LPS in chicks using rhIL-6 (recombinant human interleukin-6). However, the significant increase in IL-6 (table 4) of colistin groups at 21 day explained with Anne and Abrahamsen (1995) who mentioned that polymyxin B (PmB) stimulates monocytes to produce increased amounts of both complement factors and cytokines which are essential factors in local inflammatory response. PmB is also an agent often used to neutralize the effects of bacterial lipopolysaccharide (LPS) and was shown to exert a dose-dependent stimulatory effect on the biosynthesis of C3, factor B and IL-6 in human monocytes (Scholz et al, 1990). IL-6 showed the highest value in ENRO infected chicken among all groups which may owe to the effect of ENRO and Infection on cytokine production as we mentioned before.

Nitric oxide (NO) (table 4) showed significant increase in ENRO and infected colistin groups at 21 day, NO of infected colistin sulfate remained elevated till the end of the experiment. However, no significant change in case of infected ENRO group. This was agreed with Benzer et al (2009) who revealed that in case of infection with Salmonella and enrofloxacin administration for 9 days, the NO not elevated except in groups treated with antibiotics alone. Szczyzka et al (2005) reported that the administration of orbifloxacin (FQ) in E. coli-infected
mice modulated the effects of infection on NO production.

The significant decrease in serum CAT activity in infected groups at 21 day (table 4) may be due the decrease in its level in erythrocyte as was detected in case of Eimeria Tenella (Eraslan et al, 2004) and Salmonella infection (Benzer et al, 2009). The decrease in CAT activity may be attributed to the formation of reactive compounds in a higher level than which could be compensated by the cellular defense systems, or these reactive compounds may inhibit the enzyme activity. Thirdly, the decrease in the antioxidant vitamin level, which was involved in the non-enzymatic mechanisms, resulted in the occurrence of oxidative damage. There have been data that the parasitic infections may lead to a decrease in the blood level of antioxidant vitamin (Dede et al, 2002). The significant increase in CAT activity of ENRO and infected ENRO at 28 day expained by Goswami et al (2006). They concluded that H2O2 may be involved in antibacterial action of ciprofloxacin and that quinolones at a therapeutic conc. differentially increase phagocytosis, adhesion and the production of hydrogen peroxide by macrophages.

ENRO administration alone in healthy chicken showed higher catalase activity than when administered in case of infection at 21 days, meanwhile at 28 days the reverse relationship was observed. This may attributed to the pharmacokinetic of drug in both cases which explained by Soliman (2000) who reported that after enrofloxacini

oral administration (10mg/kg for 3 days), its absorption half life in the E. coli infected broilers was significantly longer than in healthy birds while its elimination half life was significantly shorter. Moreover, the bioavailability was higher in infected birds as compared to healthy one.

The significant increase in CAT activity of ENRO treated group remained till the end of experiment. This was in accordance with Carreras et al (2004) who found significant differences in CAT activity between the chicken received the therapeutic dose of ENRO (50 mg /L drinking water) 5 days without withdrawal (T2) and chicken slaughtered 12 day after the withdrawal time (T3). The enzymatic activities were higher when the antibiotic was withdrawn (T3) compared to (T2) and control. But, this disagreed with our results that showed higher CAT activity in the first collection (1 day post treatment) than after the withdrawal at 2 weeks post treatment.

MDA is the main final product of lipid peroxidation and has been often used for determining oxidative damage which is indicated by increase its level (Ciftci et al, 2010). The serum MDA (table 4) level was significantly increased in all groups as compared to control. The increase in MDA level in chicks infected with E. coli agreed with (Yazar et al, 2010). Bacterial LPS (endotoxin) induces extensive damage to a variety of organs, including liver, due to the increased production of reactive oxygen intermediates and a resultant rise in lipid peroxidation.
The increased MDA level in groups received antibiotics was agreed with Benzer et al (2009) who stated that the plasma MDA was increased in all groups that were infected with Salmonella Enterica and those who received enrofloxacin therapy as compared to the control. The significant elevation in MDA level in case of ENRO group all over the experiment may be due to the oxidation of the drug by liver microsomal enzymes of the cytochrome P450 family. So as a result of the oxidation, free radicals generated leading to lipid peroxidation (Carreras et al, 2004). In addition to the previously mentioned cause, Goswami et al (2006) reported that H₂O₂ involved in antibacterial action of ciprofloxacin.

Regarding to the harmful effect on liver tissue, the activity of GOT (table 5) was significantly elevated in E. coli infected group at 28 days while return to normal level at the end of the experiment. This came in agreement with El-Ghayaty (2002) and Youssef (2005). These elevations might be due to hepatic injury during the detoxication of E.coli bacterial toxin (Galab, 1994). However the increase in GOT in enrofloxacin treated group was aggravated in presence of infection indicating liver injury. These results also supported by Khodary and El-Sayed (1997) and Shawky et al (1998).

The detrimental effect on liver tissue may be due to the level of NO production which was significantly increased in ENRO at 21 day and colistin groups which stayed elevated till the end of the experiment. This explained by Farzaneh-Far and Moore (2001) who reported that increased NO synthesis is responsible for the development of the hyperdynamic circulation in cirrhosis. Unlike mammals, many studies recorded that GPT enzyme doesn’t increase in all cases of hepatic diseases in birds and therefore is not usual as diagnostic indicator of liver disease in these species but GOT is the specific diagnostic for liver (Harrison and Harrison, 1986). Pertaining to the results of renal function test, Uric acid is the primary catabolic end product of protein, non protein nitrogen and purines in birds. Birds are uricotelic and produce uric acid not urea as the major nitrogenous end product of metabolism; therefore blood urea nitrogen is not a useful test of renal function in birds (Harrison and Harrison, 1986). The significant increase in creatinine (table 5) of infected group came in agreement with El-Ghayaty (2002) and Youssef (2005). While, the non significant elevation in serum uric acid (table 5) of infected group was not agreed with them. However, enrofloxacin treated group showed significant increase in creatinine level which was disagreed with Elkholly et al (2009) while agreed with Ellakany et al (2007). In addition, ENRO showed non significant increase in uric acid which is disagreed with Khodary and El-Sayed (1997). Ciprofloxacin (ENRO) appears to increase the risk of nephrotoxicity owing to its longer and
wider spread over the other newer fluoroquinolones (Lomaestro, 2000).
Colistin treated group showed a significant increase in uric acid and creatinine where creatinine remained elevated along the whole experiment. While in infected colistin group, only uric acid was significantly increased with no change in creatinine as compared to control. This may be due to the amphipathic property of colistin (Husaln, 2008). Thus the drug enabled to be nephrotoxic as it is hydrophilic; this property renders the drug to be eliminated by the kidney (Kelly, 1993). Polymyxins can cause a direct toxic effect in kidneys that result in acute tubular necrosis and renal insufficiency or failure (Michalopulos and Falagas, 2008).

It could be concluded that, although the beneficial effect of both antibiotics (Enrofloxacin and Colistin sulfate) in treatment of bacterial infection, they induced biochemical alterations in tissues. So using of these antibiotics with their therapeutic dose in farm must be only in necessary. The dose and duration must be controlled and never exceed the dose. It could be suggested, never using ENRO at time of vaccination due to decreased γ globulin at 1 week PT. So it has adverse effect on antibody production. Further investigation is needed for the effect of antibiotics on oxidative stress and on molecular level in different tissues also the residues of these antibiotics in tissues must be determined.

Table (2) Effect of Enrofloxacin or colistin sulfate on body weight (g) serum total protein (g/dl) and albumin (g/dl) of healthy and experimentally infected chicken.

<table>
<thead>
<tr>
<th></th>
<th>Body weight (g)</th>
<th>TP (g/dl)</th>
<th>Albumin (g/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14 day</td>
<td>21 day</td>
<td>28 day</td>
</tr>
<tr>
<td>Control</td>
<td>305.17 a± 12.5</td>
<td>543.19 a ±18.9</td>
<td>955.33 a± 15.0</td>
</tr>
<tr>
<td>ENRO</td>
<td>302.67 a± 7.4</td>
<td>560.54 b ±12.3</td>
<td>970.71 b± 14.3</td>
</tr>
<tr>
<td>Colistin</td>
<td>313.33 a ±9.5</td>
<td>595.91 a ±10.3</td>
<td>1007.9 a ±13.8</td>
</tr>
<tr>
<td>Infected</td>
<td>303.57 a ±10.8</td>
<td>504.84 b ±13.4</td>
<td>900.83 b± 20.3</td>
</tr>
<tr>
<td>ENRO infected</td>
<td>323.33 a ±5.5</td>
<td>553.28 a ±10.3</td>
<td>964.12 a ±19.0</td>
</tr>
<tr>
<td>Colistin infected</td>
<td>313.33 a ±8.0</td>
<td>582.71 a ±10.3</td>
<td>996.32 a ±19.3</td>
</tr>
</tbody>
</table>

Values expressed as mean ±SE
Values with different letters in the same column are significantly different.
PT: Post treatment
Table (3): Effect of Enrofloxacin or colistin sulfate on globulin fractions (g/dl) in healthy and experimentally infected chicken.

<table>
<thead>
<tr>
<th></th>
<th>Globulin (g/dl)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 day PT (21 day)</td>
<td>1 week PT (28 day)</td>
<td>2 weeks PT (35 day)</td>
<td></td>
</tr>
<tr>
<td>a1</td>
<td>a2</td>
<td>β</td>
<td>γ</td>
<td>a1</td>
</tr>
<tr>
<td>Control</td>
<td>0.27b±0.03</td>
<td>0.46a±0.05</td>
<td>0.59a±0.04</td>
<td>0.53ab±0.07</td>
</tr>
<tr>
<td>ENRO</td>
<td>0.21b±0.05</td>
<td>0.49a±0.05</td>
<td>0.31b±0.07</td>
<td>0.69a±0.10</td>
</tr>
<tr>
<td>Colistin</td>
<td>0.22b±0.06</td>
<td>0.44a±0.05</td>
<td>0.38ab±0.01</td>
<td>0.73ab±0.12</td>
</tr>
<tr>
<td>Infected</td>
<td>0.84a±0.17</td>
<td>0.57a±0.1</td>
<td>0.42ab±0.09</td>
<td>0.36b±0.06</td>
</tr>
<tr>
<td>ENRO infected</td>
<td>0.81a±0.01</td>
<td>0.46a±0.06</td>
<td>0.53ab±0.05</td>
<td>0.21b±0.03</td>
</tr>
<tr>
<td>Colistin infected</td>
<td>0.37ab±0.08</td>
<td>0.38b±0.02</td>
<td>0.28b±0.03</td>
<td>0.38b±0.23</td>
</tr>
</tbody>
</table>

Values expressed as mean ±SE. Values with different letters in the same column are significantly different. PT: Post treatment

Table (4): Effect of Enrofloxacin or colistin sulfate on serum IL-6 (Pg/ ml), Nitric oxide (NO) (μmol/Liter) , Catalase (CAT) (U/L) , Malondialdehyde (MDA) (nmol/ml) in healthy and experimentally infected chicken.

<table>
<thead>
<tr>
<th></th>
<th>IL-6 (Pg/ml)</th>
<th>NO (μmol/Liter)</th>
<th>CAT (U/L)</th>
<th>MDA (nmol/ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21 day</td>
<td>28 day</td>
<td>35 day</td>
<td>21 day</td>
</tr>
<tr>
<td>Control</td>
<td>0.079a±0.004</td>
<td>0.064b±0.005</td>
<td>0.069a±0.004</td>
<td>31.97b±1.04</td>
</tr>
<tr>
<td>ENRO</td>
<td>0.76b±0.021</td>
<td>0.071b±0.003</td>
<td>0.070a±0.008</td>
<td>38.05b±0.92</td>
</tr>
<tr>
<td>Colistin</td>
<td>1.37b±0.310</td>
<td>0.076b±0.006</td>
<td>0.068a±0.007</td>
<td>35.08b±1.31</td>
</tr>
<tr>
<td>Infected</td>
<td>1.09b±0.450</td>
<td>0.060b±0.005</td>
<td>0.056a±0.001</td>
<td>32.24b±1.36</td>
</tr>
<tr>
<td>ENRO infected</td>
<td>5.04b±0.890</td>
<td>0.11c±0.010</td>
<td>0.073a±0.007</td>
<td>36.16b±1.37</td>
</tr>
<tr>
<td>Colistin infected</td>
<td>1.60b±0.260</td>
<td>0.062b±0.009</td>
<td>0.064a±0.006</td>
<td>38.81b±1.35</td>
</tr>
</tbody>
</table>

Values expressed as mean ±SE . Values with different letters in the same column are significantly different. IL-6: interleukin-6, NO: nitric oxide, CAT: catalase enzyme, MDA: malondialdehyde.
Table (5): Effect of Enrofloxacin or colistin sulfate on serum Glutamate oxaloacetate transaminase(GOT) (U/ml), Glutamic pyruvic transaminase (GPT)(U/L),Creatinine (mg/dl) and Uric acid (mg/dl) in healthy and experimentally infected chicken.

<table>
<thead>
<tr>
<th></th>
<th>GOT (U/ml)</th>
<th>GPT (U/L)</th>
<th>Creatinine (mg/dl)</th>
<th>Uric acid (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21 day</td>
<td>28 day</td>
<td>35 day</td>
<td>21 day</td>
</tr>
<tr>
<td>Control</td>
<td>207.91±1.14</td>
<td>219.75±10.8</td>
<td>206.70±17.4</td>
<td>26.46±0.30</td>
</tr>
<tr>
<td>ENRO</td>
<td>271.87±4.5</td>
<td>297.14±9.6</td>
<td>205.11±16.3</td>
<td>28.77±0.40</td>
</tr>
<tr>
<td>Colistin</td>
<td>238.86±4.8</td>
<td>291.48±12.1</td>
<td>376.87±18.9</td>
<td>28.2±0.80</td>
</tr>
<tr>
<td>Infected</td>
<td>193.97±6.8</td>
<td>279.78±11.4</td>
<td>219.35±15.5</td>
<td>26.87±1.00</td>
</tr>
<tr>
<td>ENRO infected</td>
<td>290.70±7.2</td>
<td>323.59±7.9</td>
<td>327.15±22.2</td>
<td>30.82±0.60</td>
</tr>
<tr>
<td>Colistin infected</td>
<td>228.57±5.0</td>
<td>306.02±6.1</td>
<td>217.98±22.1</td>
<td>27.1±0.20</td>
</tr>
</tbody>
</table>

Values expressed as mean ±SE Values with different letters in the same column are significantly different

References


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