

## Comparative Efficacy of Norfloxacin, Clarithromycin and Cefpodoxime Against Experimentally Induced Colibacillosis in Pigeons

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**Abstract:** Avian colibacillosis has been found to be a major infectious disease of all ages of birds. The study was conducted to check the efficacy of three antibiotics both *in vitro* and *in vivo* in pigeon birds. Total 30 pigeons of both sexes were randomly divided into 5 groups. One group was kept as un-infected control. The rest of the groups were inoculated with *E. coli* orally ( $3 \times 10^8$  CFU/0.25 ml). All the infected birds were examined for the development of clinical symptoms. One group was kept as infected, un-medicated control. One group was medicated with Norfloxacin, other with Clarithromycin and third one with Cefpodoxime at the dose rate of 10mg/kg b.wt respectively. Before infection, during infection, during medication and in post medication period, blood samples were collected for analysis of hematological parameters. At the end of the experiment, all the birds were slaughtered to check the gross pathological lesions. Blood profile was in normal range in un-infected control group. There was alteration in blood picture in the group having infections. In the group medicated with norfloxacin, blood cellular levels were in reference range as compared to clarithromycin and cefpodoxime. The gross pathological lesions were also severe in norfloxacin medicated group as compared to the others. The results showed that norfloxacin was highly effective against *E. coli* than clarithromycin and cefpodoxime. Moreover, the serum concentrations of these antibiotics were checked in pigeon birds. The results showed a maximum serum level (Cmax) of 7µg/ml for norfloxacin after 180 min (Tmax) of its administration. The maximum serum levels of clarithromycin and cefpodoxime were less than norfloxacin and also having long Tmax. It has been concluded that for game birds, for colibacillosis, norfloxacin is the drug of choice.

**Key words:** Avian Colibacillosis • Antibiotic Sensitivity Test • Norfloxacin • Clarithromycin • Cefpodoxime

### INTRODUCTION

*Escherichia coli* (*E. coli*) is a Gram-negative, non-acid-fast, uniform staining, non-spore-forming bacillus, usually 2-3 micrometer. *Escherichia coli* is a normal inhabitant of the gastrointestinal tract of all warm-blooded animals, but variants of this species is also among the important etiological agents of enteritis and several extra intestinal diseases in pigeon birds [1]. Avian colibacillosis is an infectious disease of birds caused by *Escherichia coli*, which causes a variety of disease manifestations

in poultry including yolk sac infection, omphalitis, respiratory tract infection, swollen head syndrome, septicemia, polyserositis, coligranuloma, enteritis, cellulitis and salpingitis. Colibacillosis of poultry is characterized in its acute form by septicemia resulting in death and in its sub-acute form by pericarditis, airsacculitis and perihepatitis [2]. Avian colibacillosis has been noticed to be a major infectious disease in birds of all ages. The majority of economic losses result from mortality and decrease in productivity of the affected birds [3]. Resistant fecal *E. coli* from poultry can infect

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humans both directly and via food. These resistant bacteria may colonize the human intestinal tract and may also contribute resistance genes to human endogenous flora [4]. Avian pathogenic *E. coli* (APEC) spreads into various internal organs and cause colibacillosis characterized by systemic fatal disease [5]. Experimental studies have shown that the respiratory tract, principally the gas-exchange region of the lung and the interstitium of the air sacs are the most important sites of entry for avian pathogenic *E. coli*. After colonization and multiplication, the bacteria enter the bloodstream causing septicemia that leads to massive lesions in multiple internal organs and ultimately sudden death of the birds [6]. In orally infected broiler chickens, stress resulted in bacteremia and mortality. Stress seems to cause penetration of the pathogenic bacteria into the bloodstream, which in turn can cause severe disease and mortality [7]. Antibiotics are used for the treatment and prevention of infectious disease in both animals and humans. Some are also used for growth promotion and improving feed efficiency in animals. Cefpodoxime is a semi-synthetic, third generation cephalosporin. The drug is active against common Gram-positive cocci like *staphylococci* including penicillinase producing strains, streptococci and Gram negative bacteria like Hemophilus, *E. coli*, Klebsiella, Moraxella, Meningococci and Gonococci etc. [8]. Norfloxacin is a broad-spectrum antibiotic that is active against both Gram-positive and Gram-negative bacteria, occasionally used to treat common as well as complicated urinary tract infections [9]. Clarithromycin (6-O-methylerythromycin) is synthesized by substituting a methoxy group for the C-6 hydroxyl group of erythromycin. This substitution creates a more acid-stable antimicrobial agents and thus increases acid stability of clarithromycin resulting into improved oral bioavailability and reduced gastrointestinal intolerance [10]. The aim of the present study was to (1) test the sensitivity of available drugs *in vitro* against *E. coli*. (2) To check the efficacy of antibiotics against experimentally induced colibacillosis *in vivo*. (3) To check serum levels of administered antibiotics in pigeon bird.

## MATERIALS AND METHODS

*E. coli* was cultured on Nutrient broth, Nutrient agar, McConkey agar and eosin-methylene blue agar in the present study. From the fresh culture of the strain, smears were made; morphology and staining characteristics were

studied. All the isolates were Gram negative, rods and motile. The colonies developed on McConkey agar were pin pointed, smooth, glossy and translucent and were rose pink in color. The experiment was conducted in two phases. In Phase I, antibiogram was performed for antibiotics against *Escherichia coli*. In Phase II, the infection was given to birds, medication was initiated and blood samples were taken prior to infection, during infection and after infection, for complete blood profiling using Sysmex KX 31 (Japan) as well as determination of serum concentration of the three administered antibiotics. The efficacy of drugs was determined on the basis of alteration in clinical signs, changes in hematological parameters and gross pathological findings after conducting postmortem of the birds during and at the end of experiment.

Commercially available antimicrobial discs (OXOID UK) of Amoxicillin (AMC) 30 µg, Cefphradine (CE) 30 µg, Clarithromycin 30µg, Cefepime (FEP) 30 µg, Ciprofloxacin (CIP) 5 µg, Cefpodoxime 5µg, Gemifloxacin (GMC) 30 µg, Levoflaxcine 30 µg, Moxifloxacin 30 µg, Norfloxacin 5 µg, Piperacilline 30 µg and Tetracycline 5 µg were used in this study. The protocol of Haneef *et al.* 1990 [11] was followed for this study.

In Phase two experiment, there was initiation of an infection to all the groups except group A, which was kept as non-infected, non-medicated control. The purified strained of *E. coli* ( $0.3 \times 10^8/0.25$  ml) was administered through oral route to groups B, C, D and E. The clinical symptoms appeared within twelve hours after inoculation of *E. coli*. After the clinical symptoms appear medication was started to the groups. Group B was kept as infected control that was not medicated with either antibiotic. Group C was given Norfloxacin at the dose rate of 10 mg/kg b.wt. Group D was medicated with Clarithromycin at the dose rate of 10 mg/kg b.wt. Group E was medicated with Cefpodoxime at the dose rate of 10 mg/kg b.wt. The medication to all the groups was continued for regular three days. Before the administration of the drugs, during the medication and after the cessation of drug administration, blood samples were taken from all the groups for complete blood profile. Blood samples were also taken from all the medicated groups when the medication was started in order to check the serum level of these administered antibiotics. The efficacy of these drugs was determined on the basis of alteration in clinical signs, changes in hematological parameters and gross pathological findings after conducting postmortem of the birds during and at the end of experiment.

Table 1: Medication schedule for phase II experiment

Groups	Number of birds	Antibiotics Used	Dose Administered (mg/kg b.wt)	Blood sample collection (Minutes)
A	3	Nil	Nil	0,60,120,180,240,300,360, 420,480,540,600.
B	3	Nil	Nil	
C	3	Norfloxacine	10	
D	3	Clarithromycin	10	
E	3	Cefpodoxime	10	

Table 2: Gross pathological lesions of *Colibacillosis* in all the groups during infection

Groups	Organs		
	Liver	Lung	Intestine
A (Un-infected, un-medicated)	Normal	Normal	Normal
B (Infected but not medicated)	Necrotic and hemorrhagic	Sever congestion	Enteritis
C (Infected)	Necrotic and hemorrhagic	Sever congestion	Enteritis
D (Infected)	Necrotic and hemorrhagic	Sever congestion	Enteritis
E (Infected)	Necrotic and hemorrhagic	Sever congestion	Enteritis

Table 3: Gross pathological lesions of *Colibacillosis* in all the groups during medication

Groups	Organs		
	Liver	Lung	Intestine
A (Un-infected, un-medicated)	Normal	Normal	Normal
B (Infected but not medicated)	Necrotic and hemorrhagic	Sever congestion	Enteritis
C (Medicated with Norfloxacine)	Necrotic and hemorrhagic	Congestion	Congestion
D (Medicated with Clarithromycin)	Necrotic and hemorrhagic	Congestion	Congestion
E (Medicated with Cefpodoxime)	Necrotic and hemorrhagic	Congestion	Enteritis

Table 4: Gross pathological lesions of *Colibacillosis* in all the groups after medication

Groups	Organs		
	Liver	Lung	Intestine
A (Un-infected, un-medicated)	Normal	Normal	Normal
B (Infected but not medicated)	Necrotic and hemorrhagic	Sever congestion	Enteritis
C (Medicated with Norfloxacine)	Mild necrosis	Mild congestion	Mild congestion
D (Medicated with Clarithromycin)	Necrotic	Mild congestion	Mild congestion
E (Medicated with Cefpodoxime)	Necrotic	Congestion	Mild enteritis

## RESULT

The clinical symptoms appeared with in twelve hours after inoculation of *E. coli*. The clinical symptoms observed were; rise in temperature, in-appetite, dullness, dysentery, shock and depression. Postmortem lesions of the dead pigeons showed slight inflammation of liver, lungs and intestine. There was accumulation of whitish inflammatory fluid in thoracic region as well as splenomegaly and enteritis and confirmation was made for presence of organisms. Same morphological staining reactions were found which confirmed the presence of *E. coli*.

**Postmortem Findings:** Postmortem was performed during infection, during medication and after medication. Postmortem findings for all the groups have been given in Tables 2, 3 and 4.

## Blood Profile

**Total Red Blood Cells (TRBC) Count:** The TRBC count was analyzed for all the groups at different days as shown in Figure 1. In negative control group (A) TRBC was in normal range throughout experiment. In positive control group (B) mean TRBC count was  $6.5 \pm 0.1$  million/cmm,  $5.2 \pm 0.10$  mil/cmm and  $4 \pm 0.01$  mil/cmm before, during and post infection. In group C mean TRBC count was  $6.5 \pm 0.1$  mil/cmm,  $5.5 \pm 0.10$  mil/cmm,  $5.8 \pm 0.10$  mil/cmm and  $6.4 \pm 0.10$  mil/cmm before infection, during infection, during and after medication with Norfloxacine. In group D mean TRBC count was  $6.5 \pm 0.1$  mil/cmm,  $5 \pm 0.01$  mil/cmm,  $5 \pm 0.00$  mil/cmm and  $5.7 \pm 0.15$  mil/cmm before infection, during infection, during and after medication with Clarithromycin. Similarly in group E mean TRBC was  $6.5 \pm 0.1$  mil/cmm,  $5.5 \pm 0.10$  mil/cmm,  $5.5 \pm 0.15$  mil/cmm and  $5 \pm 0.01$  mil/cmm before infection, during infection, during and after medication with Cefpodoxime. Overall results showed that

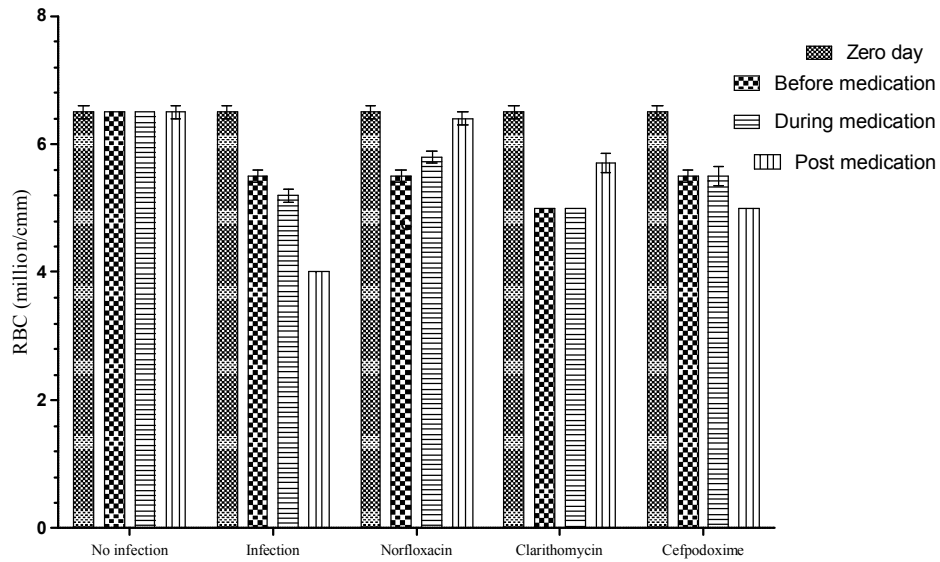


Fig. 1: Comparison of total red blood cell count of control, infected and medicated groups at different periods.

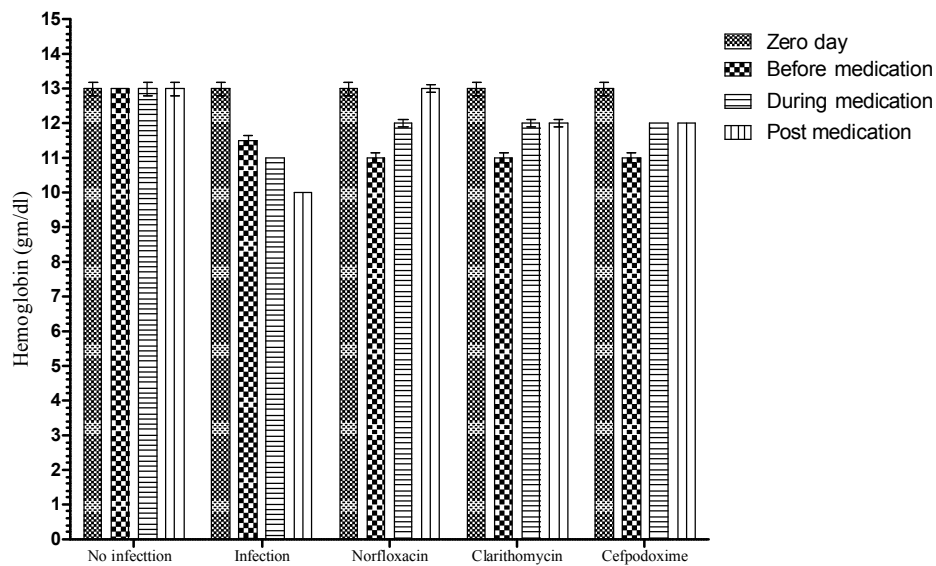


Fig. 2: Comparison of hemoglobin level of control with infected and medicated groups at different periods.

*E. coli* decreases TRBC count in infected group. It was also found that Norfloxacin and Clarithromycin tended to increase mean TRBC count while Cefpodoxime tended to decrease mean TRBC count. There was a significant ( $P < 0.05$ ) difference in increase of TRBC count in group medicated with Norfloxacin as compared to the others. No significant difference was found in increase in TRBC of the groups medicated with Clarithromycin and Cefpodoxime ( $P < 0.05$ ).

**Hemoglobin (Hb):** Hemoglobin levels for all the groups were analyzed and the results are shown in Figure 2. The results showed that in group A mean hemoglobin

level was in normal range ( $13 \pm 0.2$  gm/dl) throughout the study. In group B mean Hb level was  $13 \pm 0.2$ ,  $11 \pm 0.15$  gm/dl before and during *E. coli* infection and then constantly decreased throughout the study. In group C mean Hb level was  $13 \pm 0.2$ ,  $11 \pm 0.15$ ,  $12 \pm 0.1$  and  $13 \pm 0.1$  gm/dl while for group D mean Hb level was  $13 \pm 0.2$ ,  $11 \pm 0.15$ ,  $12 \pm 0.1$  and  $12 \pm 0.1$  gm/dl before infection, during infection, during and after medication. Similarly in group E mean Hb level was  $13 \pm 0.2$ ,  $11 \pm 0.15$ ,  $12 \pm 0.01$  and  $12 \pm 0.01$  gm/dl during the course of the study. Overall results showed that *E. coli* decreases Hb Level. On the other hand Norfloxacin, Clarithromycin and Cefpodoxime tended to increase Hb level significantly ( $P < 0.05$ ) as compared to infected

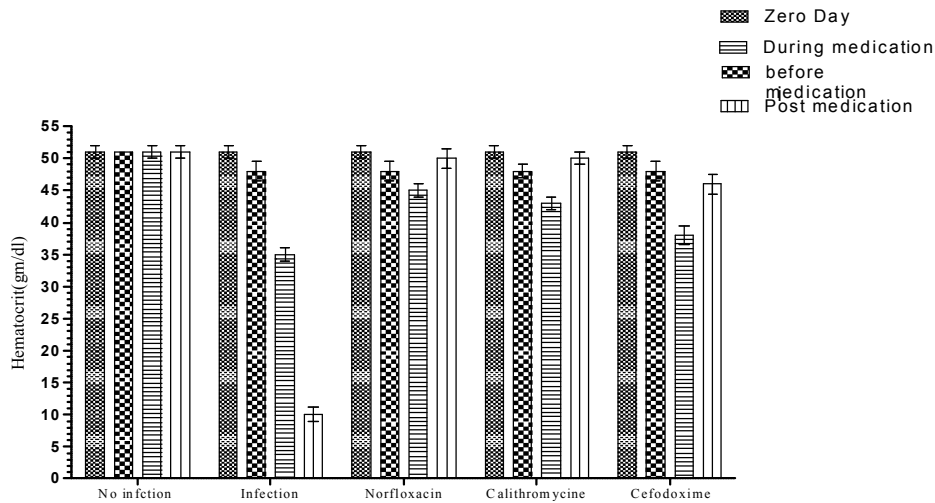


Fig. 3: Comparison of hematocrit value of control, infected and medicated groups at different periods.

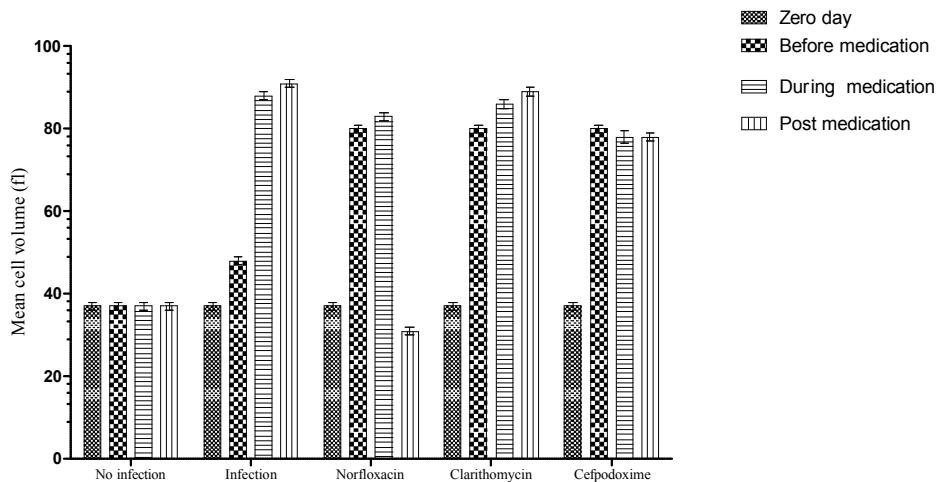


Fig. 4: Comparison of mean cell volume value of control infected and medicated groups at different periods.

control. There was no significant ( $P<0.05$ ) difference in effect of these antibiotics on elevation of Hb level after medication.

**Hematocrit (HCT) Value:** The results for HCT value in various groups are summarized in Figure 3. In group A mean HCT value was normal ( $51\pm 1.0$  gm/dl) during experiment but in group B, mean HCT value was  $51\pm 1.0$ ,  $48\pm 1.5$  gm/dl before and during infection and then continuously decreases. Similarly mean HCT value in group C was  $51\pm 1.0$ ,  $48\pm 1.5$ ,  $45\pm 1.0$ ,  $50\pm 1.5$  in group D was  $51\pm 1.5$ ,  $48\pm 1.0$ ,  $43\pm 1.0$ ,  $50\pm 1.0$  and in group E was  $48\pm 1.5$ ,  $48\pm 1.0$ ,  $38\pm 1.5$ ,  $46\pm 1.5$  gm/dl before infection, during infection and during and post medication. It is concluded from the results that, *E. coli* infection decreases HCT value. There was a significant difference ( $P<0.05$ ) in increase in HCT value in group medicated with

Norfloxacin and Clarithromycin as compared to Cefpodoxime. However, no significant difference ( $P<0.05$ ) was found in increase in HCT value of the groups medicated with Norfloxacin and Clarithromycin.

**Mean Corpuscular Volume (MCV):** The results for MCV have been shown in Figure 4. In group A mean MCV value throughout experiment was normal range ( $37\pm 0.1$  fl) however, in group B mean MCV value before and during infection was  $37\pm 1.0$ ,  $48\pm 1.0$  fl and then further increases continuously. Similarly mean MCV value before infection, during infection and during and post medication in group C was  $37\pm 1.0$ ,  $80\pm 1.0$ ,  $78\pm 1.0$ ,  $78\pm 1.0$  fl, in group D was  $37\pm 1.0$ ,  $80\pm 1.0$ ,  $86\pm 1.0$ ,  $89\pm 1.0$  and in group E was  $37\pm 1$ ,  $80\pm 1.0$ ,  $78\pm 1.5$  and  $83\pm 1.0$  fl. The results suggest that *E. coli* decreases MCV in infected group. Results also showed that norfloxacin decreases significantly ( $P<0.05$ )

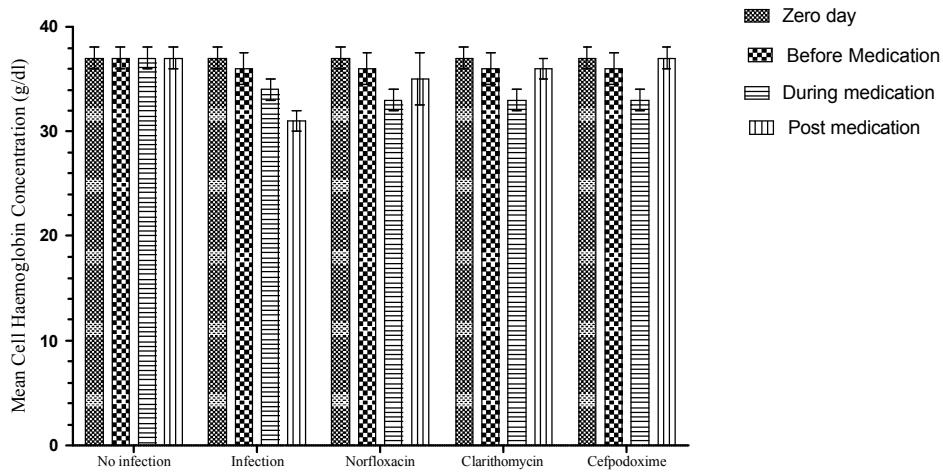


Fig. 5: Comparison of control mean cell hemoglobin concentration value of control, infected and medicated groups at different periods.

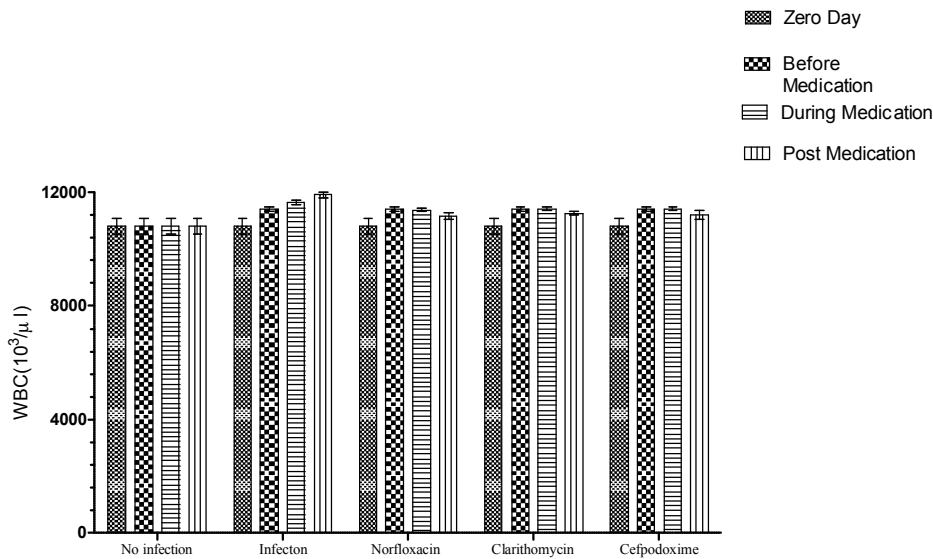


Fig. 6: Comparison of TLC of control infected and medicated groups at different periods.

MCVas compared to clarithromycin and cefpodoxime. There was a significant difference ( $P < 0.05$ ) in all the three antibiotics, norfloxacin, clarithromycin and cefpodoxime on elevation of MCV after medication.

**Mean Corpuscular Hemoglobin (MCH):** The results for MCH are summarized in Fig 5. In group A, MCH was normal ( $51 \pm 1.00$  pg) throughout experimental period while in group B, it was  $51 \pm 1.0$ ,  $35 \pm 1.5$ ,  $35 \pm 1.00$  and  $25 \pm 1.00$  pg before infection, during infection and during and post medication. Similarly in group C, it was  $51 \pm 1.0$ ,  $48 \pm 1.5$ ,  $45 \pm 1.00$ ,  $32 \pm 1.00$  pg in group D,  $51 \pm 1.0$ ,  $48 \pm 1.5$ ,  $43 \pm 1.50$ ,  $33 \pm 0.58$  pg and in group E it was  $51 \pm 1.0$ ,  $48 \pm 1.5$ ,  $38 \pm 1.00$  and  $31 \pm 1.00$  pg before infection, during infection and during and post medication. Overall results showed that

*E. coli* lead to decrease in MCH in infected group. It was also found that Norfloxacin, Clarithromycin and Cefpodoxime tended to significantly ( $P < 0.05$ ) increase the MCH level as compared to infected control. There was no significant ( $P < 0.05$ ) difference in effect of these antibiotics on elevation of MCH after medication.

**Total Leukocyte Count (TLC):** The results for TLC are shown in Figure 6. In group A, TLC was in normal range ( $10800 \pm 265 \times 10^3/\mu l$ ) throughout the experimental period. In group B it was  $10800 \pm 265 \times 10^3/\mu l$ ,  $11397 \pm 95 \times 10^3/\mu l$  before and during infection and constantly increased throughout experiment. In group C it was  $10800 \pm 265 \times 10^3/\mu l$ ,  $11397 \pm 95 \times 10^3/\mu l$ ,  $11370 \pm 66 \times 10^3/\mu l$ ,  $11150 \pm 132 \times 10^3/\mu l$ , in group D it was  $10800 \pm 265 \times 10^3/\mu l$ ,  $11397 \pm 95 \times 10^3/\mu l$ ,

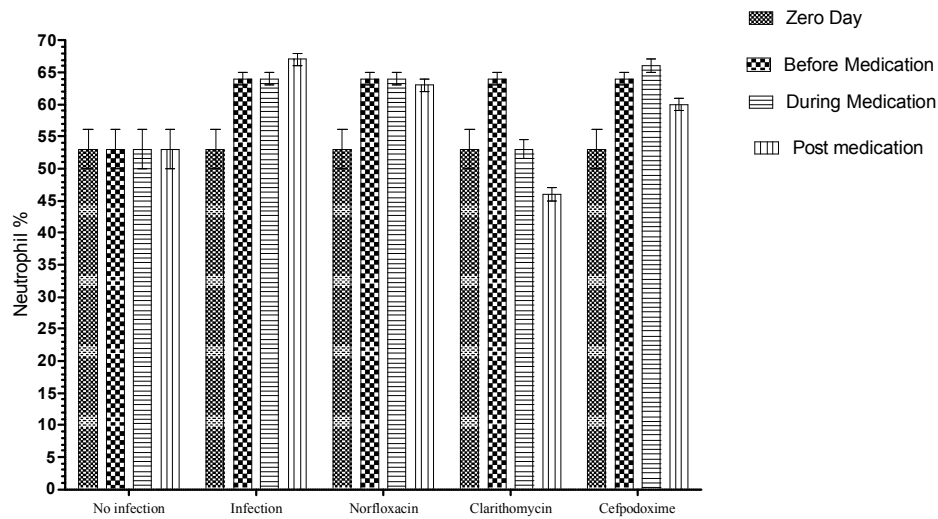


Fig. 7: Comparison of neutrophils counts of control, infected and medicated groups at different periods.

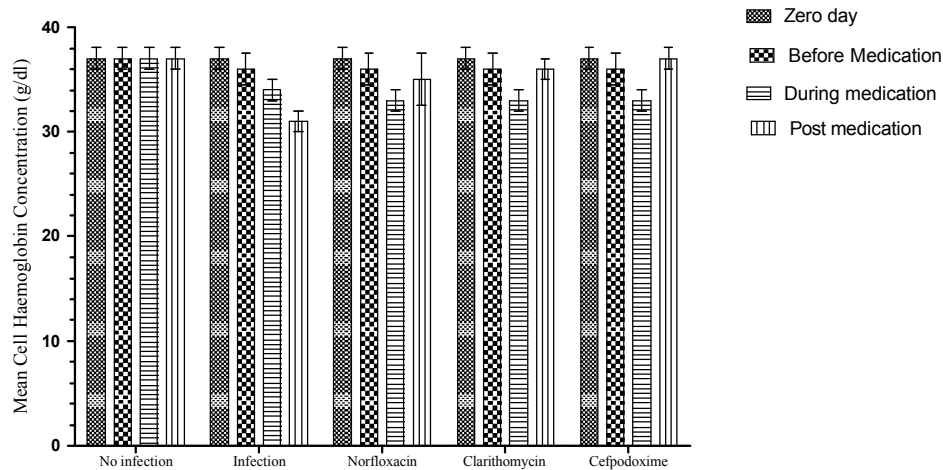


Fig. 8: Comparison of mean cell hemoglobin concentration of control infected and medicated groups at different periods.

11407±60×10<sup>3</sup>/μl, 11247±55×10<sup>3</sup>/μl and in group E it was 10800±265×10<sup>3</sup>/μl, 11397±95×10<sup>3</sup>/μl, 11402±53×10<sup>3</sup>/μl, 11196±170×10<sup>3</sup>/μl before infection, during infection and during and post medications. Results showed that *E. coli* lead to increase in TLC. It was also found that, Norfloxacin, Clarithromycin and Cefpodoxime tended to decrease ( $P<0.05$ ) the TLC as compared to infected control. There was no significant ( $P<0.05$ ) difference in effect of these antibiotics on elevation of TLC after medication.

**Neutrophil:** Overall results are summarized in Figure 7. In group A, the level of neutrophil was normal (53±3.1 %) throughout experimental period. In group B, Neutrophil was 53±3.1 % and 64±1.0 % before and after infection and constantly increased throughout experiment. Neutrophil before infection, during infection and during and post medications in group C was, 53±3.1, 64±1.0, 64±1.0, 63±1.0,

in group D it was 53±3.1, 64±1.0, 53±1.5, 46±1.0 and in group E it was 53±3.1, 64±1.0, 66±1.0 and 60±1.0 %. It has been concluded that *E. coli* lead to an increase in neutrophil count. It was also found that clarithromycin tended to decrease ( $P<0.05$ ) the neutrophil level as compared to norfloxacin and cefpodoxime. There was a significant ( $P<0.05$ ) difference in all the three antibiotics, norfloxacin, clarithromycin and cefpodoxime on decrease of neutrophil after medication.

**Mean Cell Hemoglobin Concentration (MCHC):** Overall results of MCHC for all groups are summarized in Figure 8. Throughout the experiment in group A, MCHC was normal (37±1.0 g/dl). In group B, it was 37±1.0, 36±1.5 g/dl before and during infection and constantly decreased during experiment. In group C, mean MCHC was 37±1.0, 36±1.5, 33±1.0, 35±2.5, in group D, it was 37±1.0, 36±1.5, 33±1.0, 36±1.0 and in group E, it was 37±1.0, 36±1.5,

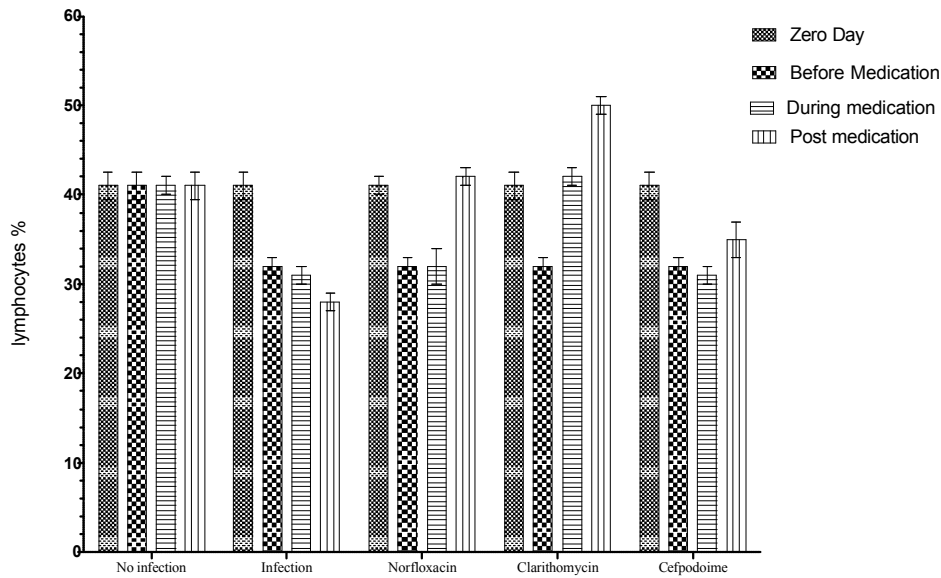


Fig. 9: Comparison of lymphocytes value of control, infected and medicated groups at different periods.

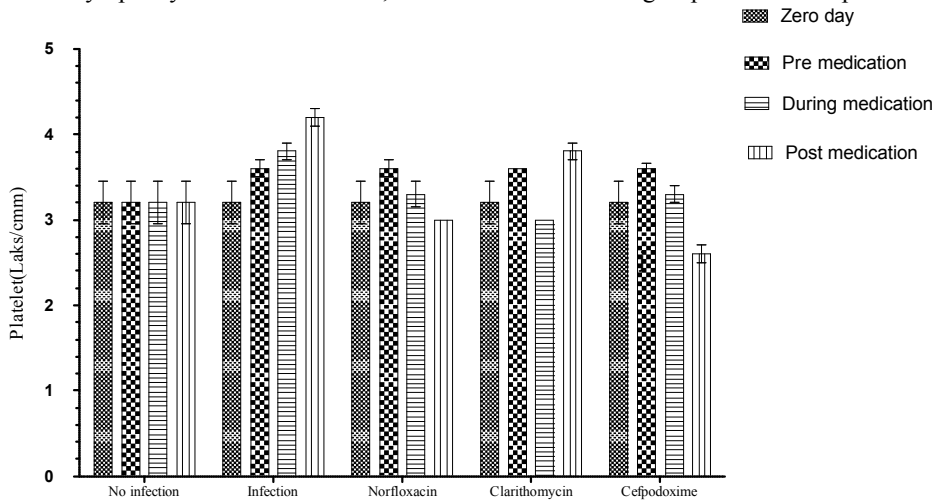


Fig. 10: Comparison of Platelets count of control, infected and medicated groups at different periods.

33±1.00, 37±1.00 g/dl before infection, during infection and during and post medications. From the overall results it is concluded that *E. coli* lead to decrease in MCHC in infected group. It was also found that Norfloxacin, Clarithromycin and Cefpodoxime tended to increase ( $P<0.05$ ) the MCHC as compared to infected control. There was no significant ( $P<0.05$ ) difference in effect of these antibiotics on elevation of MCHC after medication.

**Lymphocyte Count:** The results for lymphocytes in various groups have been shown in Figure 9. In group A, lymphocyte count was in normal range (41±1.5 %) throughout the study. In group B, it was 41±1.5 and 32±1.0 % before and during infection and then constantly decreased in the study. In group C, mean lymphocyte

count was 41±1.5, 32±1.0, 32±2.0, 42±1.0, in group D it was 41±1.5, 32±1.0, 42±1.0, 50±1.0 and in group E it was 41±1.5, 32±1.0, 31±2.0, 35±1.5 % before infection, during infection and during and post medication. It has been found that *E. coli* lead to decrease in lymphocytes count. It was also found that clarithromycin tended to increase ( $P<0.05$ ) the lymphocytes count as compared to norfloxacin and cefpodoxime. There was significant ( $P<0.05$ ) difference in all the three antibiotics on increase of lymphocyte count after medication.

**Platelets:** The results for platelets are shown in Figure 10. Platelets count was in normal range, 3.2±0.25 lac/cmm throughout the experimental period in group A. In group B, it was 3.2±0.25 and 3.6±0.100 lac/cmm before and during



infection and then constantly increased throughout the study. In group C, it was,  $3.2 \pm 0.25$ ,  $3.6 \pm 0.100$ ,  $3.3 \pm 1.50$ ,  $3 \pm 0.2$  in group D, it was  $3.2 \pm 0.25$ ,  $3.60 \pm 0.100$ ,  $3.70 \pm 0.10$ ,  $3.8 \pm 0.10$  and in group E, it was  $3.2 \pm 0.25$ ,  $3.60 \pm 0.100$ ,  $3.30 \pm 0.100$ ,  $2.60 \pm 0.10$  lac/cmm before infection, during infection and during and post medication. It has been concluded that *E. coli* lead to increase in platelets level. It was also found that Norfloxacin, Clarithromycin and Cefpodoxime tended to decrease the platelets count. There was significant ( $P < 0.05$ ) difference in decrease of platelets count in group medicated with Norfloxacin and Clarithromycin as compared to the Cefpodoxime. No significant difference was found in increase in platelets of the groups medicated with Clarithromycin and Norfloxacin.

**Determination of Serum Concentration of Norfloxacin, Clarithromycin and Cefpodoxime in Pigeon:** Maximum serum level of (Cmax)  $7 \mu\text{g/ml}$  for Norfloxacin was observed at 180 minute (Tmax) after its administration. Maximum serum level of (Cmax)  $6 \mu\text{g/ml}$  for Clarithromycin was observed at 300 minute (Tmax) after its administration. Maximum serum level of (Cmax)  $4 \mu\text{g/ml}$  for Cefpodoxime was observed at 420 minute (Tmax) after its administration. The results showed that serum level of Norfloxacin was high and also the maximum level was achieved quickly as compared to Clarithromycin and Cefpodoxime.

## DISCUSSION

The clinical symptoms observed were; rise in temperature, in-appetite, dullness, dysentery, shock and depression. Zakiet *et al.* [12] observed a significant decrease in body weight and depression, loss of body weight, bloody diarrhea and ascites. Ahmed *et al.* [13] confirmed dullness, depression, reduced intake of food and water, huddling at the corner of the shed, loss of body weight and brown color droppings. According to Saif [14] there were ruffled feathers, enlarged and swollen navel, decreased appetite, depression, diarrhea and pasting of feathers around vent.

Postmortem lesions of the dead pigeons showed slight inflammation of liver, lungs and intestine. There was accumulation of whitish inflammatory fluid in thoracic region as well as splenomegaly and enteritis. Akber *et al.* and Arenas *et al.* [15-16] found generalized congestion, slight splenomegaly and slightly swollen duodenal mucosae. Same primary lesions were also observed in chickens [17-19]. Goren [20] observed

congestion of small intestine, liver, spleen and kidney. Wasteson [1] and Saif [14] also mentioned same clinical and postmortem findings. Post-mortem examination revealed pericarditis, petechial hemorrhages and formation of the fibrinous layer on the heart, air sac infection, enteritis, dilation of the last part of the intestine. Griffin and Tauxe [21] also found liver necrosis.

When medication was initiated, Norfloxacin lead to an increase in Hb, increase in TRBC, MCH, MCHC, HCT, lymphocytes and decrease in WBC, neutrophils and platelets as compared to Clarithromycin and Cefpodoxime. It showed that Norfloxacin had higher efficacy against *E. coli*. It has been stated that Norfloxacin is the first choice of drug for the treatment of bacterial infections of the urinary, biliary, respiratory tracts [22-23]. Gines [24] mentioned that Norfloxacin has considerable success to reduce the rate of bacterial peritonitis in patients with hepatic cirrhosis and ascites. In present study, clarithromycin showed little efficacy than norfloxacin but was higher than cefpodoxime against *Escherichia coli*. Clarithromycin is effective in sinusitis and otitis media [25-28], lung lesions [29], ventricular dysrhythmias and other chest infections [30-37]. It can also be used for the treatment of pharyngitis caused by *S. pyogenes* [38]. An impact of clarithromycin on the fecal flora with a decrease in enterococci and *E. coli* were also reported [39-40]. In present study, the cefpodoxime was least effective against *E. coli* infection as there was no significant difference between the hematological parameters of un-medicated, infected group and that which was medicated with cefpodoxime. The reason may be the resistance of the *E. coli* to this antibiotic or the use of low dose of cefpodoxime in present study against *E. coli*. Da Silva and Mendoca [41] found 06 % resistance in *E. coli* isolates to cefpodoxime. Kaneko *et al.* [42] mentioned that cephalosporin resistance is mediated by extended spectrum beta-lactamases (ESBL) and plasmidic AmpC beta-lactamases in *Salmonella* and *Escherichia coli*.

## CONCLUSION

The current experiment was designed to examine both *in vitro* and *in vivo* efficacy of three commercially available antibiotics against *E. coli*. After induction of *E. coli* infection in pigeons, clinical symptoms of colibacillosis such as depression, in-appetite, dullness, dysentery, shock and high temperature were observed. Postmortem lesions of the dead pigeons showed slight inflammation of liver, lungs and intestine. Antibiotics

medication was started after the development of clinical symptoms. The results of present study indicated that Norfloxacin was more effective against *E. coli* and better to control the *E. coli* infection as compared to Clarithromycin and Cefpodoxime.

**Recommendations:** Minimize the exposure level of *E. coli* in the birds' environment. Avoiding stress factors and other disease agents which may lower the resistance and predispose the birds to colibacillosis.

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