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Hemato-biochemical assessment of induced *E. coli* infection in broiler birds and treated with Curry leaves powder (*Murraya koenigii*) and Leofloxacin

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Abstract

120, day old broiler chicks were randomly divided into 6 equal groups. Chicks from group II, III, IV and V were challenged with single oral dose of *E. coli* broth culture @ 0.3-0.5 ml (1×10^9 CFU/ml). Chicks from group III were fed with curry leaves powder @ 1% of feed. However, chicks from group IV and V were given with leofloxacin @ 1gm/10kg body weight orally and leofloxacin (1gm/10kg B.W.) plus curry leaves powder (1% of feed), respectively. Hematological and biochemical parameters were recorded on 0th, 7th, 14th and 21st day post infection interval. Significant decrease in mean values of Hb, PCV, TEC, lymphocytes, total protein, albumin and globulin, whereas, significant increase in TLC, heterophil, creatinine, AST and ALT were observed in birds of group II at 7th and 14th day post infection intervals of study. Birds infected with *E. coli* and treated with curry leaves powder showed partial improvement in altered values of all hematological and biochemical parameters at 7th and 14th day intervals of study. Combined treatment of curry leaves powder and leofloxacin in *E. coli* infected birds showed better ameliorative effect on all hemato-biochemical parameters than individual treatment at 7th and 14th day post infection intervals of study.

Keywords: Broiler, *E. coli*, hemato-biochemical, *Murraya Koenigii*

Introduction

Poultry is domesticated species of bird reared for production of eggs, meat etc. for human consumption. The productivity of indigenous chicken is very low in comparison to commercial broilers and layers. The low productivity is due to genetic makeup and mortality due to mismanagement, diseases, lack of balanced ration and predators. Higher mortality in poultry is found to be due to outbreaks of different infectious diseases. From last few decades it is observed that Indian poultry industry grows at around 8-10 percent annually; however during last three years growth was more than 15 percent^[1]. Avian colibacillosis caused by *Escherichia coli*, either as a primary pathogen or as a secondary pathogen in chicken^[2]. Broiler birds between 4-6 weeks age are primarily affected by avian colibacillosis and causes significant mortality. About 36-43 % of broiler carcasses condemned due to lesions of *E. coli* infection during processing which leads to multimillion-dollar annual losses to the world's poultry industry^[3, 4]. Now a day, antibiotic resistance developed by pathogenic bacteria is the biggest problem to treat the infection. Hence, day by day researchers develop their interest in the use of plant material as an alternative to synthetic antimicrobials to control pathogenic bacteria. *Murraya koenigii* is widely used in traditional system of medicine in India and all over the world. *Murraya koenigii* leaves contain alkaloids viz., mahanine, mahanimbine, murrayaziline which are having antibacterial property^[5, 6]. It has been also reported that *Murraya koenigii* leaves have anti-inflammatory, cardioprotective, hepatoprotective, antifungal, anti-cancer, antioxidant properties^[5, 6]. *Murraya koenigii* helps in digestion, helps to heal gastric ulcers and being a rich source of iron and folic acid, it is natural remedy to beat anemia^[5]. Considering the all properties of *Murraya koenigii*, an attempt was made to analyze its ameliorative effect on hemato-biochemical profile during experimentally *E. coli* induced infection in broilers.

Materials and Methods**Experimental birds**

For the present study 120 Healthy day old Vencob broiler chicks were purchased and housed

in poultry shed of College of Veterinary and Animal Sciences, Parbhani. Birds were randomly assigned to the control and treatment groups and were kept in separate pen. Permission for this experimental trial was obtained from Institutional Animal Ethics Committee (IAEC).

A 1 day old Marek's disease vaccinated 120 broiler birds

were randomly divided into 6 groups and each group containing 20 birds. Birds in all groups were given brooding and were acclimatized for 7 days. Commercial plain feed without antibiotic were given to all groups. The detail of group is given in table 1.

Table 1: Experimental design and protocol

Group	Number of birds	Treatment and Dose	Period of experiment
Group-I	20	Commercial plain feed daily (Healthy control)	29 days
Group-II	20	Commercial plain feed daily + <i>E. coli</i> @ 0.3-0.5ml broth culture (1×10^9 CFU/ml) by oral route at the age of 8 th day.	29 days
Group-III	20	Commercial plain feed daily + <i>E. coli</i> @ 0.3-0.5ml broth culture (1×10^9 CFU/ml) + Curry leave powder @ 1% of feed daily for 29 days.	29 days
Group-IV	20	Commercial plain feed daily + <i>E. coli</i> @ 0.3-0.5ml broth culture (1×10^9 CFU/ml) by oral route at the age of 8 th day + Leofloxacin @ 1gm/10kg B.W. through water for 7 days.	29 days
Group-V	20	Commercial plain feed daily + <i>E. coli</i> @ 0.3-0.5ml broth culture (1×10^9 CFU/ml) by oral route at the age of 8 th day + Curry leaves powder @ 1% of feed daily for 7 days + Leofloxacin @ 1gm/10kg B.W. through water for 7 days.	29 days
Group-VI	20	Commercial plain feed daily + Curry leaves powder @ 1% of feed daily.	29 days

Escherichia coli culture

Pure culture of known pathogenic strain of *E. coli* (1610) was obtained from the Microbial Type Culture Collection and Gene Bank, Institute of Microbial Technology (IMT), Chandigarh (India). This culture was used to infect chickens for the experimental trial. Laboratory strain of *E. coli* (1610) was maintained on MacConkey agar and Eosin Methylene Blue agar (Hi-media) during the period of the project. For experimental production of colibacillosis, the standard *E. coli* culture was sub cultured using nutrient broth (Hi-Media) and the same was incubated at 37 °C for 24 hours. After incubation, the bacterial count was adjusted to 1×10^9 CFU/ml by comparing the turbidity with McFarland tube no. 3.

Dose and route of administration of E. coli

The infection was given to the chicks at the 8th day by oral route with a single dose of 0.3 to 0.5 ml of nutrient broth (approximately bacterial concentration of 1×10^9 CFU/ml).

Preparation of curry leaves powder (CLP)

Fresh leaves of the *Murraya koenigii* were collected from area

in and around College of Veterinary and Animal Sciences, Parbhani. The leaves were washed and dried for 4 to 5 days and was kept in gunny bags. The powder was made by using Mixer

Antibiotic used for treatment

Leofloxacin antibiotic was purchased from the local medical store from the market of Parbhani.

Parameter studied

Hematological studies

The following hematological investigations were carried out as per the methods described below. The blood samples were collected directly from the heart and wing vein into sterilized vials containing anticoagulant (EDTA @ 1.0 mg/ml) for all hematological studies. The hematological parameters were recorded in six chicks randomly selected from all the six groups on pre treatment interval at 0 day (8th day of age) and on 7th day (15th day of age), 14th day (22nd day of age) and 21st day (29th day of age), post infection intervals of experimental trial.

Sr. No.	Parameter	Method of estimation
1	Hemoglobin (Hb)	Acid hematin ^[7]
2	Packed cell volume (PCV)	Microhematocrit ^[7]
3	Total erythrocyte count (TEC)	Neubaur's chamber ^[8]
4	Total leukocyte count (TLC)	Neubaur's chamber ^[8]
5	Differential leukocyte count (DLC)	Wright's stain ^[9]

Serum biochemical studies

The serum biochemical estimations were carried out in six birds sacrificed randomly from all the six groups at 0 day (8th day of age), 7th day (15th day of age), 14th day (22nd day of age) and 21st day (29th day of age) from each group. The blood samples were collected directly from heart and wing vein into tubes without anticoagulant for separation of serum. The serum samples were maintained at -20 °C until analyzed. The individual serum samples were analyzed for Serum Total protein (gm/dl), Albumin (gm/dl), Globulin (gm/dl), AST (IU/L), ALT (IU/L) and Creatinine (mg/dl). The biochemical estimations were done by Automatic Biochemical Analyzer. The methodology and the set of reagents used in respect of

each parameter were as per the recommendations of the manufacturer of the analyzer system.

Statistical analysis

Data generated for various parameters were statistically analyzed by applying Completely Randomized Design (CRD) or as per the method described by Snedecor and Cochran ^[10].

Results and Discussion

Hematological studies

Mean values of Hb, PCV, TEC, and TLC of experimental birds are given in table 2 and mean values of differential leukocytes count (DLC) are depicted in table 3.

Mean values of Hb, PCV, TLC, heterophils and lymphocyte in birds of all groups were at par with each other at 0th day (pre-infection) and 21st day (post-infection) intervals of study. Whereas, mean values of basophil, eosinophil and monocyte in birds of all different group did not differ significantly at all intervals of study. Similar findings were recorded by several earlier researchers [11, 12 & 13].

Group-II (*E. coli* infected)

Mean values of Hb, PCV, TEC and lymphocytes were found decreased than values in birds of healthy control group at 7th and 14th day post infection interval of study. Data also revealed that, there was leucocytosis at 7th, 14th and 21st day post infection and heterophilia at 7th and 14th day post infection of study. Decrease in Hb level observed in *E. coli* infected birds could be due to acute bacterial infection and

due to anemic condition. Earlier, several researchers [11-15] reported decrease in Hb level in *E. coli* infected birds. Decreases in PCV value due to *E. coli* infection in birds were noted by Sonwane [1], Phad [11], Deshmukh [12], Patil [13] and Godbole [16]. Patil [13] recorded decreased values of TEC in *E. coli* infected birds at 21st and 35th day post-infection intervals of study. Leucocytosis and heterophilia observed in this group could be due to Subsequent inflammatory response to *E. coli* induced tissue damage [13]. Sonwane [1], Patil [13] and Sharma [15] reported leucocytosis in *E. coli* infected birds. Phad [11] and Deshmukh [12] reported leucocytosis in *E. coli* infected birds up to 14th day post-infection intervals of study. Also, heterophilia could be due to involvement of heterophils in phagocytosis during *E. coli* infection [17]. Lymphocytopenia were observed by Phad [11], Deshmukh [12] Patil [13] and Nandanwar [14].

Table 2: Mean values of Hb, PCV, TEC and TLC in birds of different groups at 0th, 7th, 14th and 21st day of experiment

Group	Hb (g/dl)	PCV (%)	TEC (10 ⁶ /cumm)	TLC (10 ³ /cumm)
0th day of study				
Group-I	8.63(±0.22)	25.26(±0.28)	2.13(±0.06)	22.35(±0.07)
Group-II	8.50(±0.15)	24.98(±0.52)	2.10(±0.05)	22.15(±0.27)
Group-III	8.71(±0.16)	25.20(±0.59)	2.08(±0.06)	22.05(±0.29)
Group-IV	8.58(±0.21)	25.13(±0.50)	2.12(±0.06)	22.21(±0.98)
Group-V	8.50(±0.34)	25.03(±0.45)	2.09(±0.05)	21.78(±0.44)
Group-VI	8.48(±0.16)	25.08(±0.18)	2.11(±0.09)	22.36(±0.15)
CD (0.05%)	NS	NS	NS	NS
7th day of study				
Group-I	8.91 ^a (±0.27)	27.35 ^a (±0.37)	3.18 ^a (±0.06)	24.88 ^c (±0.47)
Group-II	6.66 ^c (±0.08)	21.71 ^c (±0.21)	2.26 ^c (±0.07)	33.65 ^a (±0.28)
Group-III	7.67 ^b (±0.12)	23.16 ^b (±0.13)	2.63 ^b (±0.09)	31.16 ^b (±0.64)
Group-IV	8.83 ^a (±0.24)	26.80 ^a (±0.33)	3.08 ^a (±0.15)	29.08 ^c (±0.53)
Group-V	8.90 ^a (±0.03)	26.90 ^a (±0.85)	3.23 ^a (±0.09)	27.51 ^d (±0.44)
Group-VI	8.61 ^a (±0.32)	27.01 ^a (±0.45)	3.20 ^a (±0.13)	24.85 ^c (±0.52)
CD (0.05%)	0.59 [*]	1.32 [*]	0.30 [*]	1.43 [*]
14th day of study				
Group-I	8.63 ^a (±0.10)	29.56 ^a (±0.14)	3.20 ^{ab} (±0.11)	25.75 ^c (±0.35)
Group-II	6.93 ^c (±0.11)	21.78 ^c (±0.07)	2.45 ^d (±0.04)	32.30 ^a (±0.43)
Group-III	7.78 ^b (±0.07)	23.25 ^b (±0.14)	2.78 ^c (±0.04)	30.30 ^b (±0.23)
Group-IV	8.51 ^a (±0.10)	28.73 ^a (±0.15)	3.01 ^b (±0.05)	28.13 ^c (±0.25)
Group-V	8.60 ^a (±0.03)	28.80 ^a (±0.26)	3.28 ^a (±0.07)	26.91 ^d (±0.49)
Group-VI	8.65 ^a (±0.24)	28.86 ^a (±0.61)	3.26 ^a (±0.07)	25.60 ^c (±0.48)
CD (0.05%)	0.37 [*]	0.84 [*]	0.21 [*]	1.13 [*]
21st day of study				
Group-I	9.70(±0.15)	28.66(±0.19)	3.48(±0.11)	27.28 ^c (±0.20)
Group-II	9.05(±0.10)	27.91(±0.37)	3.21(±0.04)	30.28 ^a (±0.17)
Group-III	9.15(±0.10)	28.15(±0.23)	3.33(±0.06)	28.30 ^b (±0.41)
Group-IV	9.36(±0.08)	28.65(±0.33)	3.26(±0.04)	27.48 ^c (±0.30)
Group-V	9.38(±0.29)	28.33(±0.12)	3.31(±0.11)	27.33 ^c (±0.19)
Group-VI	9.41(±0.32)	28.50(±0.27)	3.50(±0.08)	27.45 ^c (±0.13)
CD (0.05%)	NS	NS	NS	0.73 [*]

*Significant at <0.05; NS- Non significant, Means bearing different superscripts within rows differ significantly from each other.

Group-III (*E. coli* infected and Curry leaves powder treated)

Mean values of Hb, PCV, TEC, TLC, Heterophil and lymphocyte were partially improved than values in birds of group-II (*E. coli* infected) but values were not par with values in healthy control group at 7th and 14th day post infection intervals of study. From this study, it can be concluded that, addition of curry leaves powder in the diet of birds infected with *E. coli*, partially improved Hb and PCV level. According to Shinde [5], curry leaves are rich source of iron and folic acid, which are natural remedy to beat anemia. Improvement in the TLC, heterophil and lymphocyte counts might be due to less tissue damage caused due to antimicrobial property of

curry leaves powder [18, 19].

Group-IV (*E. coli* infected and Leofloxacin treated)

Mean values of Hb, PCV and TEC in birds of group-IV and group-I did not differ significantly at all intervals of study, whereas, they were significantly improved than values in birds of group-II and III at 7th and 14th day intervals of study. Data also revealed that there was leucocytosis, heterophilia and lymphocytopenia at 7th and 14th day intervals of study. From data it was also found that values of TLC, heterophil and lymphocyte were significantly improved than values in birds of group II and III at 7th and 14th day intervals of study. Significant improvements in the values of all hematological

parameter were recorded by Deshmukh^[12] in *E. coli* infected birds and treated with leofloxacin.

Group-V (*E. coli* infected, Curry leaves powder and Leofloxacin treated)

Mean values of Hb, PCV, TEC, TLC, heterophil and

lymphocyte counts in birds of group-V were comparable to values in birds of healthy control group at all intervals of study. Data also revealed that values of all hematological parameters in birds of group-V were significantly improved than values in birds of group II, III and IV at 7th and 14th day post.

Table 3: Mean values of differential leucocytes counts in birds of different groups at 0th, 7th, 14th and 21st day of experiment

Group	Heterophil (%)	Lymphocyte (%)	Basophil (%)	Eosinophil (%)	Monocyte (%)
0th day of study					
Group-I	27.55(±0.16)	59.41(±0.12)	1.41 (±0.02)	3.40 (±0.08)	8.61 (±0.04)
Group-II	27.39(±0.19)	59.18(±0.16)	1.59 (±0.07)	3.32 (±0.04)	8.65 (±0.08)
Group-III	27.52(±0.14)	58.91(±0.110)	1.57 (±0.09)	3.45 (±0.04)	8.68 (±0.19)
Group-IV	27.17(±0.03)	58.76(±0.54)	1.53 (±0.07)	3.31 (±0.06)	8.60 (±0.11)
Group-V	27.76(±0.09)	59.05(±0.37)	1.43 (±0.07)	3.44 (±0.05)	8.69 (±0.02)
Group-VI	27.63(±0.40)	59.30(±0.81)	1.51 (±0.06)	3.38 (±0.13)	8.66 (±0.29)
CD(0.05%)	NS	NS	NS	NS	NS
7th day of study					
Group-I	27.36 ^d (±0.25)	57.30 ^a (±0.15)	1.52 (±0.01)	4.35 (±0.04)	8.23 (±0.04)
Group-II	37.77 ^a (±0.07)	44.18 ^d (±0.07)	1.41 (±0.02)	4.37 (±0.09)	8.11 (±0.04)
Group-III	31.20 ^b (±0.27)	51.45 ^c (±0.13)	1.41 (±0.06)	4.24 (±0.07)	8.16 (±0.06)
Group-IV	29.15 ^c (±0.07)	54.96 ^b (±0.42)	1.56 (±0.13)	4.38 (±0.13)	8.43 (±0.38)
Group-V	27.68 ^d (±0.11)	57.00 ^a (±0.05)	1.53 (±0.33)	4.37 (±0.10)	8.25 (±0.07)
Group-VI	27.83 ^d (±0.27)	57.25 ^a (±0.54)	1.45 (±0.07)	4.38 (±0.06)	8.53 (±0.01)
CD(0.05%)	0.57 [*]	0.85 [*]	NS	NS	NS
14th day of study					
Group-I	28.15 ^d (±0.20)	58.18 ^a (±0.07)	1.46 (±0.06)	3.78 (±0.09)	8.36 (±0.10)
Group-II	35.45 ^a (±0.12)	51.65 ^d (±0.14)	1.42 (±0.08)	3.79 (±0.03)	8.37 (±0.07)
Group-III	30.25 ^b (±0.07)	53.48 ^c (±0.15)	1.37 (±0.04)	3.61 (±0.04)	8.30 (±0.10)
Group-IV	29.12 ^c (±0.06)	56.17 ^b (±0.06)	1.45 (±0.07)	3.78 (±0.06)	8.33 (±0.12)
Group-V	28.33 ^d (±0.16)	57.94 ^a (±0.01)	1.47 (±0.04)	3.66 (±0.01)	8.34 (±0.15)
Group-VI	28.26 ^d (±0.08)	58.13 ^a (±0.03)	1.53 (±0.06)	3.63 (±0.07)	8.31 (±0.14)
CD(0.05%)	0.41 [*]	0.28 [*]	NS	NS	NS
21st day of study					
Group-I	28.43(±0.09)	58.91(±0.11)	1.51 (±0.15)	4.07 (±0.04)	8.21 (±0.12)
Group-II	28.74(±0.08)	58.31(±0.27)	1.52 (±0.06)	4.09 (±0.11)	8.28 (±0.14)
Group-III	28.60(±0.05)	58.60(±0.07)	1.45 (±0.01)	4.15 (±0.06)	8.26 (±0.24)
Group-IV	28.53(±0.24)	58.92(±0.01)	1.57 (±0.10)	4.02 (±0.15)	8.23 (±0.44)
Group-V	28.47(±0.07)	58.84(±0.01)	1.52 (±0.01)	4.08 (±0.16)	8.25 (±0.07)
Group-VI	27.98(±0.06)	58.87(±0.40)	1.57 (±0.09)	4.10 (±0.18)	8.27 (±0.10)
CD(0.05%)	NS	NS	NS	NS	NS

*Significant at <0.05; NS- Non significant, Means bearing different superscripts within rows differ significantly from each other.

Infection intervals of study. Improvement in values of all hematological parameter could be due to combined action of curry leaves powder and leofloxacin. However, perusal of available literature did not reveal any reference related to findings of present study.

Serum biochemical studies

Mean values of Serum total protein, albumin, globulin, creatinine, AST and ALT are given in table 4.

Mean values of Serum total protein, albumin, globulin, creatinine, AST and ALT in birds of all groups were at par with at 0th day (pre-infection) and at 21st day (post-infection) intervals of study.

Group-II (*E. coli* infected)

From the data it was observed that mean values of total protein, albumin and globulin were decreased and values of creatinine, AST and ALT were increased at 7th and 14th day post infection intervals of study. Decrease in total protein could be due to decrease in feed intake and *E. coli* induced gut and hepatic damage. Increase in creatinine level might be due to damage to renal parenchyma or impaired renal function. Increase in AST and ALT levels in *E. coli* infected

birds indicate hepatic and muscular damage. Phad^[11], Deshmukh^[12], Patil^[13] and Sharma^[20] recorded hypoproteinaemia in *E. coli* challenged birds. Decreases in albumin level were also noted by Deshmukh^[12], Patil^[13] and Sharma^[20]. Deshmukh^[12] observed significant decrease in the mean values of serum globulin in *E. coli* challenged birds. Increase in serum creatinine levels in *E. coli* infected birds were also reported by several earlier researchers^[11, 12, 13 & 14]. Sonwane^[1], Patil^[13], Sharma^[20] and Zaki^[21] reported increased levels of AST in experimental colibacillosis in broiler birds. High levels of ALT in birds infected with *E. coli* were observed by several earlier researchers^[1, 13, 16, 20 & 21].

Group-III (*E. coli* infected and Curry leaves powder treated)

Mean values of total protein, albumin, globulin, creatinine, AST and ALT in birds of group-III were significantly improved as compared to mean values in birds of group-II at 7th and 14th day post-infection intervals of study. From data it can be concluded that, addition of curry leaves powder in diet of *E. coli* infected birds had partial ameliorative effect on total serum protein, albumin and globulin level up to 14th day post-infection intervals of study. Debosree^[22].

Table 4: Mean values of total protein, albumin, globulin, creatinine, AST and ALT in birds of different groups at 0th, 7th, 14th and 21st day of experiment

Group	Total Protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	Creatinine (mg/dl)	AST (IU/L)	ALT (IU/L)
0th day of study						
Group-I	4.14(±0.05)	2.10(±0.08)	2.04(±0.04)	0.79(±0.04)	111.01(±0.44)	10.71(±0.20)
Group-II	4.20(±0.03)	2.15(±0.04)	2.05(±0.05)	0.81(±0.04)	111.28(±0.11)	10.64(±0.06)
Group-III	4.31(±0.10)	2.17(±0.04)	2.13(±0.09)	0.78(±0.04)	111.60(±0.11)	10.74(±0.14)
Group-IV	4.21(±0.14)	2.18(±0.07)	2.03(±0.12)	0.83(±0.06)	111.38(±0.11)	10.91(±0.26)
Group-V	4.35(±0.09)	2.12(±0.02)	2.22(±0.09)	0.82(±0.05)	111.81(±0.26)	10.55(±0.21)
Group-VI	4.17(±0.03)	2.15(±0.01)	2.01(±0.03)	0.78(±0.04)	111.36(±0.16)	10.67(±0.09)
CD(0.05%)	NS	NS	NS	NS	NS	NS
7th day of study						
Group-I	4.51 ^a (±0.02)	2.31 ^a (±0.04)	2.19 ^a (±0.02)	0.73 ^d (±0.04)	112.55 ^c (±0.49)	10.69 ^c (±0.11)
Group-II	3.31 ^c (±0.06)	1.71 ^c (±0.02)	1.59 ^c (±0.07)	1.71 ^a (±0.04)	151.33 ^a (±2.23)	16.93 ^a (±0.21)
Group-III	3.83 ^b (0.05)	1.92 ^b (±0.03)	1.91 ^b (±0.04)	1.50 ^b (±0.03)	121.83 ^b (±0.79)	14.78 ^b (±0.13)
Group-IV	4.35 ^a (±0.03)	2.21 ^a (±0.04)	2.14 ^a (±0.03)	0.84 ^c (±0.01)	113.18 ^c (±0.27)	11.01 ^c (±0.05)
Group-V	4.40 ^a (±0.09)	2.29 ^a (±0.10)	2.18 ^a (±0.11)	0.79 ^{cd} (±0.06)	112.83 ^c (±0.30)	10.88 ^c (±0.03)
Group-VI	4.48 ^a (±0.06)	2.36 ^a (±0.01)	2.12 ^a (±0.05)	0.71 ^d (±0.02)	112.18 ^c (±0.41)	10.76 ^c (±0.03)
CD(0.05%)	0.17 [*]	0.15 [*]	0.19 [*]	0.09 [*]	2.93 [*]	0.34 [*]
14th day of study						
Group-I	4.73 ^a (±0.04)	2.42 ^a (±0.04)	2.30 ^a (±0.07)	0.67 ^c (±0.008)	116.35 ^c (±0.80)	10.74 ^c (±0.14)
Group-II	3.59 ^c (±0.05)	1.83 ^c (±0.03)	1.69 ^c (±0.06)	1.47 ^a (±0.08)	133.83 ^a (±0.87)	14.91 ^a (±0.68)
Group-III	4.09 ^b (0.02)	2.11 ^b (±0.04)	1.98 ^b (±0.03)	1.23 ^b (±0.03)	124.50 ^b (±0.99)	12.75 ^b (±0.23)
Group-IV	4.62 ^a (±0.13)	2.35 ^a (±0.01)	2.27 ^a (±0.13)	0.77 ^c (±0.005)	117.23 ^c (±0.08)	11.25 ^c (±0.04)
Group-V	4.68 ^a (±0.09)	2.39 ^a (±0.05)	2.29 ^a (±0.11)	0.72 ^c (±0.004)	116.92 ^c (±0.19)	10.99 ^c (±0.03)
Group-VI	4.69 ^a (±0.03)	2.41 ^a (±0.05)	2.26 ^a (±0.03)	0.69 ^c (±0.01)	116.60 ^c (±0.27)	10.78 ^c (±0.21)
CD(0.05%)	0.21 [*]	0.12 [*]	0.25 [*]	0.12 [*]	1.87 [*]	0.91 [*]
21st day of study						
Group-I	4.60(±0.05)	2.45(±0.01)	2.14(±0.05)	0.72(±0.02)	117.68(±2.97)	10.86(±0.25)
Group-II	4.51(±0.06)	2.42(±0.01)	2.09(±0.07)	0.78(±0.02)	118.51(±3.20)	10.78(±0.14)
Group-III	4.55(±0.04)	2.44(±0.01)	2.10(±0.04)	0.79(±0.01)	117.06(±2.53)	10.71(±0.09)
Group-IV	4.58(±0.07)	2.50(±0.05)	2.08(±0.07)	0.80(±0.03)	118.40(±2.15)	10.87(±0.25)
Group-V	4.50(±0.05)	2.43(±0.01)	2.06(±0.05)	0.76(±0.02)	117.63(±2.88)	10.67(±0.09)
Group-VI	4.53(±0.08)	2.52(±0.05)	2.01(±0.07)	0.74(±0.01)	117.88(±2.96)	10.68(±0.22)
CD(0.05%)	NS	NS	NS	NS	NS	NS

*Significant at <0.05; NS- Non significant, Means bearing different superscripts within rows differ significantly from each other.

Studied dose dependant protective effect of curry leaves extract against lead induced toxicity in rats and observed that there was improvement in the blood creatinine, serum AST and ALT levels.

Group-IV (*E. coli* infected and Leofloxacin treated)

Mean values of serum total protein, albumin, globulin, creatinine, AST and ALT were significantly improved in birds of group-IV as compared values in birds infected with *E. coli* (Group II) at 7th and 14th day post infection intervals of study. Data also revealed that all biochemical parameters were at par with the values in birds of healthy control group at all intervals of study. Deshmukh [12] reported improvement in the values of total protein, albumin, globulin and creatinine in birds infected with *E. coli* and treated with leofloxacin.

Group-V (*E. coli* infected, Curry leaves powder and Leofloxacin treated)

Mean values of serum total protein, albumin, globulin, creatinine, AST and ALT were significantly improved than values in birds of group-II, III and IV and mean values of all these parameters were at par with values in birds of group-I at 7th and 14th day post infection interval of study. Thus, treatment of curry leaves powder along with leofloxacin significantly improved altered values of all biochemical parameters in *E. coli* infected birds. However, perusal of available literature did not reveal any data related to findings of present study.

Conclusion

Based on results of present study, it is concluded that *E. coli* infection hamper the hemato-biochemical profile however, addition of *Murraya koenigii* leaves powder @ 1 % of feed in *E. coli* infected birds have partially improved all hemato-biochemical parameters at 7th and 14th day intervals of study. It was also concluded that, combined treatment of *Murraya koenigii* leaves powder and leofloxacin showed better ameliorative effect than individual treatment.

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