



Alterations in Biochemical Markers of Liver and Kidney Function and Oxidative Stress Indices on Sub-acute Exposure of Enrofloxacin in Albino Rats

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ABSTRACT

Background: The present study was performed to evaluate Alterations in biochemical markers of liver and kidney function and oxidative stress indices on sub-acute exposure of enrofloxacin in albino rats.

Methods: Albino rat weighing 200-300 gm were treated with enrofloxacin orally with the help of gavage needle and divided into three groups each group consist six rats. The rats of group I were served as control. However, rats of group II and III were treated with enrofloxacin @ 5 mg/kg b.wt., enrofloxacin @ 10 mg/kg b.wt. respectively. All the groups received medication orally, once daily for 28 days and blood samples were collected on the 28 day of experiment by the help of capillary tube and processed by laboratory methods.

Result: Enrofloxacin altered the functions of liver and kidney as indicated by the alteration in the biochemical markers of liver and kidney function. Enrofloxacin significantly enhanced the concentration of biochemical markers of liver function viz. ALT, AST, GGT, ALP, albumin and bilirubin as compared to control. The concentration of biochemical markers of kidney function viz. BUN and creatinine was significantly enhanced after enrofloxacin administration as compared to control. Enrofloxacin administration induced oxidative stress in rats as indicated by significant decrease in concentration of catalase, superoxide dismutase and reduced glutathione in blood as compared to control. However, lipid peroxidation was significantly enhanced as indicated by increased level of MDA in blood as compared to control. Thus, enrofloxacin have ability to altered the biochemical markers of liver and kidney and also have potency to induced oxidative stress in albino rats after the sub-acute exposure for 28 days.

Key words: Albino rats, Enrofloxacin, Oxidative stress.

INTRODUCTION

Enrofloxacin, a 6-fluoroquinolone, is one of the most widely used antimicrobials in veterinary practice. It is a bactericidal drug with a broad spectrum antibacterial activity against a range of bacteria, including the strains resistant to other antimicrobial agents. The mechanism of action of enrofloxacin consists of inhibition of bacterial DNA gyrase, which plays basic role in the process of DNA replication, leading to inhibition of synthesis of bacterial proteins. The metabolism of enrofloxacin takes place in the liver through the N-oxidation, N-dealkylation and de-ethylation processes. Enrofloxacin is mainly excreted through urine and bile (Vancutsem *et al.*, 1990).

Fluoroquinolone antibiotics may cause adverse effects such as chondrotoxicity, renal damage, retinal damage, dys-glycemia, cardiac arrhythmia and even tendon rupture. These side effects of fluoroquinolones are associated with reduced collagen synthesis and induced oxidative stress (Elbe *et al.*, 2015). Induction of oxidative stress has been reported with the administration of ofloxacin, ciprofloxacin, levofloxacin, gatifloxacin and enrofloxacin (Ibrahim and Yarsan, 2011). There is evidence that free radical formation plays an important role in fluoroquinolone induced cartilage defect and photo toxicity (Gurbay *et al.*, 2006).

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Keeping the following facts in mind, the present study was conducted to determine the oxidative stress induced by sub-acute exposure of enrofloxacin in albino rats.

MATERIAL AND METHODS

Experimental animals

The study was conducted on healthy albino rats of 6-7 wk age, weighing around 150-200 gm and carried out in

Department of Veterinary Pharmacology and Toxicology, (NDVSU), Jabalpur in year 2020. The experiment was approved by the Institutional Animal Ethical Committee (IAEC) of College of Veterinary Science and Animal Husbandry, Nanaji Deshmukh Veterinary Science University (NDVSU), Jabalpur.

Experimental design

Eighteen rats were randomly divided into three groups with six rats in each group. The oxidative stress induced by sub-acute exposure of enrofloxacin was evaluated in the groups of rats. The experiment was conducted for 28 days.

Design of experiment

Group	Treatment
I	Control
II	Enrofloxacin @ 5 mg/kg b. wt. once daily, orally for 28 days.
III	Enrofloxacin @ 10 mg/kg b. wt. once daily, orally for 28 days.

Collection of blood sample

Blood was collected on day 0 and day 28 from the retro-orbital plexus with the help of capillary tube as described by Archer and Riley (1981). Blood was collected in heparinised vials and used for biochemical and oxidative stress parameter study.

Biochemical studies

Plasma was separated from heparinised blood samples and refrigerated at 4°C for biochemical studies. The following biochemical markers of liver and kidney function were estimated by using Semi-auto analyzer with respective commercially available kits of ERBA, manufactured by Transasia Bio-Medicals Ltd., Daman.

1. Aspartate aminotransferase (AST) (IU/L).
2. Alanine transaminase (ALT) (IU/L).
3. Alkaline phosphatase (ALP) (IU/L).
4. Bilirubin (mg/dl).
5. GGT-Gamma glutamyl transpeptidase (U/L).
6. Albumin (g/dl).
7. Creatinine (mg/dl).
8. Blood urea nitrogen (BUN) (mg/dl).

Assessment of oxidative stress indices

After blood collection the samples were centrifuged at 2000 rpm for 15 min to separate plasma. The layer of white blood cells above the packed erythrocytes was discarded. Erythrocyte pellet was washed three times with 0.15 M NaCl, diluted (33 per cent) in phosphate buffer saline (mM: NaCl, 136.9, KCl, 2.68; KH_2PO_4 , 1.47 and Na_2HPO_4 , 6.62; pH 7.4) and kept at 4°C until further analysis. The 33 per cent packed erythrocytes were used for the estimation of LPO, GSH, Glutathione reductase, Catalase and Superoxide dismutase activity by using Helios double beam spectrophotometer. LPO and GSH were measured on the day of blood collection (Prins and Loos, 1969).

Lipid peroxidation

Membrane peroxidative damage in erythrocytes was determined in terms of malondialdehyde (MDA) production as method suggested by Rehman (1984).

Reagents

- 1) **Trichloroacetic acid (TCA) (10 per cent solution):** 10 gm of TCA was dissolved in distilled water and the volume was made up to 100 ml with distilled water.
- 2) **Thiobarbituric acid (TBA) (0.67 percent solution):** 0.67 gm of TBA in 100 ml of distilled water and warm up for dissolving TBA.

Procedure

One ml of 33 per cent of erythrocyte was incubated at 37°C for 2 hrs. To each sample, 1 ml of 10 per cent w/v TCA was added. After thorough mixing, the reaction mixture was centrifuged at 2000 rpm for 10 minutes. Then 1 ml of 0.67 per cent w/v of TBA was added in 1 ml of supernatant and kept in boiling water bath for 10 minutes. Reaction was cooled and diluted with 1ml of distilled water. Blank was made by adding all the reagents except the packed erythrocyte. The absorbance of these samples was read at wavelength 535 nm.

Calculation

Calculation was done by using molar extinction coefficient (EC) of MDA-TBA complex at 535 nm, i.e., 1.56×10^8 /M/cm. The amount of LPO expressed as nano mole (nM) of MDA formed per ml of packed RBCs.

LPO level nM MDA/g blood) =

$$\frac{\text{OD of test}}{\text{EC}} \times \frac{\text{Total volume of reaction mixture}}{\text{Volume of sample taken}} \times 10^9 \times \text{DF} \times \text{Time of incubation}$$

OD = Optical density

DF = Dilution factor

Reduced glutathione (GSH)

GSH was estimated by the 5, 5' dithiobis (2- nitrobenzoic acid) (DNTB) method suggested by Prins and Loos (1969).

Reagents

- 1) H_2SO_4 0.08 N in distilled water.
- 2) Tungstate solution, containing 0.3 M Na_2WO_4 and 0.1 M ethylene diamine tetra acetic acid.
- 3) TRIS buffer, pH 8.0, a solution containing 1M tris hydroxymethyl amino methane and adjusted with HCl to pH 8.0.
- 4) DNTB reagent, a solution containing 0.14 M NaCl, 0.009M Na_2HPO_4 , 0.000013 M, NaH_2PO_4 and 40 mg/100 ml DNTB (prepared fresh).

Procedure

RBCs pack (0.2 ml) (33 per cent dilution in PBS) was added to 4 ml of 0.08 N H_2SO_4 and mixed carefully. After 10 minutes

of standing at room temperature, 0.5 ml of Tungstate solution was added to clear haemolysate. The tube was stoppered and mixture was shaken vigorously for 5 minutes. The stopper was removed and suspension was allowed to stand for 5 minutes in order to avoid bubble formation on top of the supernatant. The suspension was then centrifuged for 15 minutes at 2000 rpm at room temperature. After centrifugation, 2 ml of supernatant was added to 2.5 ml of tris-buffer, 0.2 ml of DNTB reagent was added and mixed well. Within a minute, absorbance was measured at 412 nm against blank by using Spectrophotometer in which 2 ml of distilled water was substituted for supernatant.

Calculation

Calculation was done by using the following formula and results were expressed as micromole (μM) of GSH per ml of packed RBCs.

GSH level (μmol /ml of blood) =

$$\frac{\text{OD of test}}{\text{EC}} \times \frac{\text{Total volume of reaction mixture}}{\text{Volume of sample taken}} \times \frac{1}{\text{mg of Haemoglobin}}$$

EC = Extinction coefficient *i.e.*, 13100/M/cm.

OD = Optical density.

Superoxide dismutase

Superoxide dismutase (SOD) activity was determined in the blood supernatant according to the method of Madesh and Balasubramanian (1998). A calorimetric assay involving generation of superoxide by pyrogallol auto-oxidation and the inhibition of superoxide dependent reduction of tetrazolium dye (MTT) [3-(4-5 dimethyl thiazol-2-4) 2, 5-diphenyl tetrazolium bromide]. One unit of SOD was that which caused a 50 per cent inhibition of reduction rate of MTT.

Reagent

- 1) Sample: 1:20 haemolysate.
- 2) Phosphate buffer saline.
- 3) MTT(1.25 mM) fresh 12.61 mg/10 ml.
- 4) Pyrogallol(100 mM) fresh 12.61 mg/100 ml distilled water.
- 5) DMSO (Dimethyl sulfoxide).

Procedure

In a set of tubes 0.65 ml PBS (pH 7.4) was taken. To this 30 μl (MTT) was added. Then, 75 μl of pyrogallol was added to both the tubes. This mixture was incubated for 5 min at room temperature and the reaction was stopped by adding 0.75 ml of dimethyl sulfoxide and finally 10 μl of sample was added to second tube to find out the percentage of reduction of MTT formation. The absorbance was read at 570 nm and the activity has been expressed as Unit. One unit of SOD was defined as the micrograms of haemoglobin causing 50 per cent inhibition in the MTT reduction.

Catalase

Catalase activity in erythrocytes was assayed by the spectrophotometric method of Aebi (1983).

Reagents

- 1) Phosphate buffer saline
- 2) Haemolysate (10 per cent)
- 3) Hydrogen peroxide (10 mM)

Procedure

Two ml of phosphate buffer (50 mM, pH 7.0) and 10 μl hemolysate (10per cent) were taken in a cuvette. Reaction was started by adding 1 ml H_2O_2 (10 mM) and the absorbance was recorded at every 10 sec for 1 min at 240 nm against water blank. The activity of catalase has been expressed as mmol H_2O_2 utilized/min/mg haemoglobin.

Statistical analysis

Means and standard error were obtained as per standard procedure. Parameters were analyzed by using the method of complete randomized design with seven treatments allotted to groups of six animals each. The difference between treatments was tested statistically for their significance (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

Biochemical studies

In the present research work, biochemical study was carried out to study the alterations in biochemical markers of liver and kidney function on sub-acute exposure of enrofloxacin in albino rats.

Biochemical markers of liver function

The mean values of biochemical markers of liver function *viz.* Alanine aminotransferase (ALT), Aspartate aminotransferase (AST), Gamma-glutamyl transferase (GGT), Alkaline phosphatase (ALP), albumin and bilirubin in rats treated with enrofloxacin have been presented in table (01).

ALT (SGPT) and AST (SGOT)

The concentration of ALT in control was 79.75 ± 7.50 IU/L. Enrofloxacin, significantly increased the concentration of ALT and this increase was 91.38 ± 0.22 IU/L at the dose rate of 5 mg/kg b.wt. orally for 28 days. In higher doses *i.e.* 10 mg/kg b.wt. orally for 28 days, enrofloxacin further increased the concentration of ALT to 106.32 ± 0.10 . The concentration of AST in control was 159.98 ± 6.27 IU/L. Enrofloxacin, significantly increased the concentration of AST and this increase was 177.33 ± 0.49 IU/L at the dose rate of 5 mg/kg b.wt., orally for 28 days. In higher doses *i.e.* 10 mg/kg b.wt., orally for 28 days, enrofloxacin further increased the concentration of AST to 180.53 ± 0.09 IU/L. In the present investigation, elevated level of serum ALT and AST after subacute exposure of enrofloxacin are in agreement with the result of Guo *et al.* (2018). ALT and AST are liver enzyme markers used as an indicator of enrofloxacin induced hepatic

changes in albino rats (Jiang *et al.*, 2014). Corum *et al.* (2014) suggested that enrofloxacin administration in rats significantly increased levels of liver enzymes AST and ALT after sub- acute treatment.

GGT (Gamma glutamyl transferase)

The concentration of GGT (Gamma glutamyl transferase) in control was 7.07 ± 0.03 IU/L. Enrofloxacin, significantly increased the concentration of GGT and this increase was 7.40 ± 0.04 IU/L after the subacute exposure of enrofloxacin at the dose rate of 5 mg/kg b.wt., orally for 28 days. In higher doses *i.e.* 10 mg/kg b. wt., orally for 28 days enrofloxacin further increased the concentration of GGT to 7.70 ± 0.05 IU/L. Serum GGT is sensitive, highly specific and indicative enzyme for liver function. Sureshkumar *et al.* (2013) suggested that enrofloxacin after the sub- acute administration increased the level of enzyme GGT in serum. Ellakany *et al.* (2007) found the elevation in serum GGT level after the administration of enrofloxacin in chickens.

ALP (Alkaline phosphatase)

The concentration of alkaline phosphatase in control was 449.50 ± 2.54 . Enrofloxacin significantly increased the concentration of ALP and this increase was 532.50 ± 0.96 IU/L after the subacute exposure of enrofloxacin at the dose rate of 5 mg/kg b.wt. orally for 28 days. In higher doses *i.e.* 10 mg/kg b.wt. orally for 28 days, enrofloxacin further increased the concentration of ALP to 545.17 ± 3.71 IU/L. Alkaline phosphatase is used to detect liver disease and is also indicative enzyme for liver function. Elkholy *et al.* (2009)

showed that administration of enrofloxacin @ 10 mg/kg body weight daily for five successive days caused elevation of serum ALP when given orally. Davoren and Mainstone (1993) and Moustafa *et al.* (1998) showed that oral administration of enrofloxacin for 15 consecutive days caused elevation in serum ALP level in dogs.

Albumin and bilirubin

The concentration of albumin in control was 4.05 ± 0.03 . Enrofloxacin, significantly increased the concentration of albumin and this increase was 4.33 ± 0.03 g/dl after the administration of enrofloxacin at the dose rate of 5 mg/kg b.wt., orally for 28 days. In higher doses *i.e.* 10 mg/kg b.wt., orally for 28 days, enrofloxacin further increased the concentration of albumin to 4.50 ± 0.05 g/dl. The concentration of Bilirubin in control was 0.107 ± 0.003 mg/dl. Enrofloxacin, significantly increased the concentration of bilirubin and this increase was 0.127 ± 0.003 mg/dl after the administration of enrofloxacin at the dose rate of 5 mg/kg b.wt. orally for 28 days. In higher doses *i.e.* 10 mg/kg b.wt. orally for 28 days, enrofloxacin further increased the concentration of bilirubin to 0.137 ± 0.002 mg/dl. Kock *et al.* (1987) also suggested that enrofloxacin, after the sub- acute administration increased the level of albumin and bilirubin. Kaneko *et al.* (1997) and Jain (1986) also reported the elevation in serum albumin and bilirubin level after the administration of enrofloxacin. Enrofloxacin induced oxidative stress contributes to liver injury and elevates concentration of albumin and bilirubin.

Table 1: Effect of enrofloxacin on biochemical markers of liver function after sub-acute exposure in albino rats.

Group	Treatment	ALT (IU/L)	AST (IU/L)	GGT (IU/L)	ALP (IU/L)	ALBUMIN (g/dl)	BILIRUBIN (mg/dl)
I	Control	$79.75^c \pm 7.50$	$159.98^b \pm 6.27$	$7.07^d \pm 0.03$	$449.50^d \pm 2.54$	$4.05^c \pm 0.03$	$0.107^d \pm 0.003$
II	Enrofloxacin @ 5 mg/kg b. wt. once daily, orally for 28 days.	$91.38^b \pm 0.10$	$177.33^a \pm 0.09$	$7.40^b \pm 0.05$	$532.50^b \pm 3.71$	$4.33^b \pm 0.05$	$0.127^b \pm 0.002$
III	Enrofloxacin @ 10 mg/kg b. wt. once daily, orally for 28 days.	$106.32^{a\pm}$	$180.53^a \pm 0.10$	$7.70^a \pm 0.05$	$545.17^{a\pm}$	$4.50^a \pm 0.05$	$0.137^{a\pm}$

Values are mean $\pm$ SE (n=6).

Values in rows with different superscript differ significantly ($p < 0.01$).

Table 2: Effect enrofloxacin on biochemical markers of kidney function after sub-acute exposure in albino rats.

Group	Treatment	CREATININE (mg/dl)	BLOOD UREA NITROGEN (mg/dl)
I	Control	$0.640^d \pm 0.021$	$14.35^d \pm 0.23$
II	Enrofloxacin @ 5 mg/kg b. wt. once daily, orally for 28 days.	$0.847^c \pm 0.013$	$14.62^d \pm 0.03$
III	Enrofloxacin @ 10 mg/kg b. wt. once daily, orally for 28 days.	$1.052^a \pm 0.023$	$23.84^a \pm 0.02$

Values are mean $\pm$ SE (n=6).

Values in rows with different superscript differ significantly ($p < 0.01$).

Biochemical markers of kidney function

The mean values of biochemical markers of kidney function viz. blood urea nitrogen and creatinine in rats treated with enrofloxacin have been presented in (Table 2).

Creatinine and blood urea nitrogen

The concentration of creatinine in control was 0.640 ± 0.021 mg/dl. Enrofloxacin, significantly increased the concentration of creatinine and this increase was 0.847 ± 0.013 mg/dl after the administration of enrofloxacin at the dose rate of 5 mg/kg b.wt. In higher doses i.e. 10 mg/kg b.wt enrofloxacin further increased the concentration of creatinine to 1.052 ± 0.023 mg/dl. The concentration of blood urea nitrogen in control was 14.35 ± 0.23 mg/dl. Enrofloxacin, at the dose rate of 5 mg/kg b.wt., orally for 28 days did not affect the BUN level in serum significantly and the mean value was 14.62 ± 0.03 . However, enrofloxacin in higher doses i.e. 10 mg/kg b.wt., orally for 28 days, significantly increased the concentration of BUN to 23.84 ± 0.02 mg/dl. Creatinin and blood urea nitrogen are potent indicators of renal impairment. In this study enrofloxacin administration significantly increased the concentration of creatinine and BUN in serum as compared to control. Khan and Rampal (2014) indicated that sub-acute exposure of enrofloxacin increased the concentration of creatinine and BUN level. Sureshkumar *et al.* (2013) mentioned enrofloxacin induced changes in biomarkers of kidney function and found increased concentration of creatinine and blood urea nitrogen.

Oxidative stress indices

The mean values of oxidative stress indices viz. lipid peroxidation (MDA), Superoxide dismutase (SOD), reduced glutathione (GSH) and catalase in rats treated with enrofloxacin have been presented in Table 3.

Lipid peroxidation (MDA)

Lipid peroxidation was calculated in terms of nM MDA/gm of blood on day 28 of experiment in albino rats. The concentration of LPO in control was 4.63 ± 0.02 nM MDA/gm of blood, however, enrofloxacin at dose of 5 mg/kg b.wt and 10 mg/kg b.wt. significantly increased the concentration of LPO and the mean values were 5.20 ± 0.03 and 5.78 ± 0.03 nM MDA/gm of blood, respectively. MDA is the end product of lipid

peroxidation, due to oxidation of polyunsaturated fatty acids by free radicals. The increase in its concentrations in the kidney tissue revealed an enhanced lipid peroxidation leading to tissue damage as well as the failure of the antioxidants to prevent excessive production of free radicals (Karadeniz *et al.*, 2008). Dhuley, (1999) observed that enrofloxacin after administration, increased concentration of malondialdehyde in blood. In the present study, the concentration of LPO was increased significantly in enrofloxacin treated group as compared to control group. Sarban *et al.* (2005) reported an increase in MDA levels in the plasma associated with enrofloxacin administration as indicated by the onset of lipid hydroperoxide.

SOD (Superoxide dismutase)

Superoxide dismutase was calculated in terms of U/g of Hb on day 28 of experiment in albino rats. The concentration of SOD in control was 1.22 ± 0.01 U/g of Hb, however enrofloxacin at dose of 5 mg/kg b.wt and 10 mg/kg b.wt. significantly decreased the concentration of SOD and the mean values were 0.88 ± 0.01 and 0.84 ± 0.02 U/g respectively.



Plate 1: ERBA EM-200 Auto-analyzer



Plate 2: Spectrophotometer

Table 3: Effect of enrofloxacin in oxidative stress indices after sub-acute exposure in albino rat.

Group	Treatment	Oxidative Stress Indices (Mean $\pm$ SE)			
		MDA (nM MDA /gm)	SOD (U/g of Hb)	GSH (μ mol /ml of blood)	CATALASE (μ mol H ₂ O ₂ decompose/ min/gm Hb)
I	Control	$4.63^a \pm 0.02$	$1.22^a \pm 0.01$	$340.67^a \pm 0.21$	$235.08^a \pm 0.38$
II	Enrofloxacin @ 5 mg/kg b. wt. once daily, orally for 28 days.	$5.20^b \pm 0.03$	$0.88^c \pm 0.01$	$332.57^b \pm 0.24$	$157.83^d \pm 0.48$
III	Enrofloxacin @ 10 mg/kg b. wt. once daily, orally for 28 days.	$5.78^a \pm 0.03$	$0.84^c \pm 0.02$	$330.42^c \pm 0.44$	$131.57^e \pm 0.20$

Values are mean $\pm$ SE (n=6).

Values in rows with different superscript differ significantly ($p < 0.01$).

SOD activity contributes to increasing the level of superoxide radicals, thus increased oxidative stress. Suresh *et al.* (2013) indicated that enrofloxacin administration reduced superoxide dismutase (SOD). Sakaguchi and Furusawa (2006) indicated that enrofloxacin administration caused formation of reactive oxygen species and reduced the level of superoxide dismutase. The findings of present study are in agreement with the findings of Suresh *et al.* (2013) and Sakaguchi and Furusawa (2006).

GSH (Reduced glutathione)

Reduced glutathione was calculated in terms of $\mu\text{mol/ml}$ of blood on day 28 of experiment in albino rats. The concentration of GSH in control was $340.67 \pm 0.21 \mu\text{mol/ml}$ of blood, however, enrofloxacin at dose of 5 mg/kg b.wt and 10 mg/kg b.wt. Significantly decreased the concentration of GSH and the mean values were 332.57 ± 0.24 and $330.42 \pm 0.44 \mu\text{mol/ml}$ of blood respectively. Glutathione peroxidase reduces H_2O_2 to H_2O by oxidizing reduced glutathione. A decrease in glutathione peroxidase would increase the concentration of H_2O_2 , thus signaling an increase in further oxidative stress. The decreased renal antioxidant capacity due to excessive ROS production could aggravate oxidative damage in rats. GSH is an essential compound for maintaining cellular integrity and metabolism. It has been proposed that antioxidants maintain the concentration of reduced GSH. Cerreras *et al.* (2005) suggested that metabolism of enrofloxacin residues, generate free radicals and contribute to an increase in oxidative stress, promoting inhibition of cellular enzymes by the reduction in glutathione peroxidase (GSHPx). In agreement with that GSH concentration was significantly reduced after enrofloxacin treatment compared to control group in present study. Keskin *et al.* (2005) and Gurbay *et al.* (2006) indicated that administration of enrofloxacin in rats produced reactive oxygen species and increased oxidative stress. In agreement with that GSH concentration was significantly lowered after enrofloxacin treatment compared to control group in present study.

Catalase

Catalase was calculated in terms of $\mu\text{mol H}_2\text{O}_2$ decomposed/min/gm Hb on day 28 of experiment in albino rats. The concentration of CAT in control was $235.08 \pm 0.38 \mu\text{mol H}_2\text{O}_2$ decomposed. However, enrofloxacin at dose of 5 mg/kg b.wt and 10 mg/kg b.wt. significantly decreased the concentration of CAT and the mean values were 157.83 ± 0.48 and $131.57 \pm 0.20 \mu\text{mol H}_2\text{O}_2$ decomposed, respectively. Decrease in catalase activity would increase H_2O_2 concentration in the cell, leading to increased oxidative stress (Chelikani *et al.*, 2004). Yazar and Tras (2001) suggested that metabolism of enrofloxacin residues, generate free radicals and contribute to an increase in oxidative stress, promoting inhibition of cellular enzymes by the reduction in catalase (CAT). The findings of present study are in agreement with Yazar and Tras, as in the

present research, CAT concentration was significantly lower in enrofloxacin treated group as compared to control group.

CONCLUSION

Enrofloxacin at the doses of 5 mg/kg body wt. and 10 mg/kg body wt., administered orally, daily for 28 days in albino rats induced the liver impairment as indicated by increased concentration of biochemical markers of liver function *viz.* ALT, AST, GGT, ALP, albumin and bilirubin and at the doses of 5 mg/kg body wt. and 10 mg/kg body wt., orally, daily for 28 days in albino rats induced the renal impairment as indicated by increased concentration of biochemical markers of kidney function *viz.* BUN and creatinine. Enrofloxacin at the doses of 5 mg/kg body wt. and 10 mg/kg body wt., orally, daily for 28 days in albino rats induced oxidative stress as indicated by altered oxidative stress indices *viz.* catalase, superoxide dismutase, reduced glutathione and lipid peroxidation in blood.

Conflict of interest

All authors declare that they have no conflict of interest.

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