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Single dose oral pharmacokinetics of sparfloxacin in rats

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Abstract
A sensitive and simple reverse phase - high performance liquid chromatographic method has been developed for quantitative analysis of sparfloxacin in rat plasma. The method validation was done with respect to linearity, precision, accuracy and sensitivity. The analysis of sparfloxacin was done on reversed phase C_{18}- column [Luna C18 (2), 5µ, 250 X 4.60 mm] using the mobile phase of 1% aqueous acetic acid: acetonitrile at the ratio of 71: 29% (v/v) with a flow rate of 0.7 mL/min and the oven temperature of 30^0C and was detected at 280 nm. The method showed the linear response with the correlation coefficient of 0.9992. The mean recovery percentage of 3 different concentration (0.1, 0.5 and 1µg/ml) were found to be more than 87±1.547 %. The precision and accuracy was 2.474 to 8.218 % and 0.0035 to 0.0512. The lower limit of detection and quantification of the method was 0.01 µg/ml and 0.025 µg/ml respectively for sparfloxacin in rat plasma. This method was used analyse the plasma concentration of sparfloxacin, following a single oral administration at the dose rate of 200 mg/kg. The pharmacokinetic analysis of sparfloxacin in rats was fitted well in to two compartment model. The maximum plasma concentration attained by sparfloxacin in rats were 7.351±0.884 µg/ml at 0.755±0.049 h. The half-life, apparent volume of distribution, apparent clearance were 8.379±0.962 h, 13.745±1.576 L/kg, and 3.864±0.195 ml/kg/hr respectively. AUC $_{0\text{-}t}$ and MRT were 45.873±2.082 µg/ml*h and 10.964±1.093 h. sparfloxacin is rapidly absorbed from intestine after oral administration and attained good plasma concentration.

Keywords: sparfloxacin, Pharmacokinetics, two compartment model, rat, HPLC

1. Introduction
Quinolones are structurally derived from heterobicyclic aromatic compound known as quinoline. This oily quinoline was obtained from alkaline distillation of quinine (Gerhardt, 1842) [5]. After quinine was isolated from *cinchona* bark in 1811, many other quinolone derivatives were isolated from natural source like plant, animal and bacteria (Heeb *et al*., 2011) [6].

The first quinolone, 7-chloro-1-ethyl-1, 4-dihydro-4-oxoquinoline-3-carboxylic acid which was a by-product of cloroquine was isolated in early1960. This 7-chloro-1-ethyl-1, 4-dihydro-4-oxoquinoline-3-carboxylic acid was modified subsequently to produce nalidixic acid (Sheehan and Chew, 2003) [13]. In 1976 first mono - fluoroquinolone was developed with fluro group at position 6 which had improved activity against gram positive organism also. Hence the quinolone containing fluro group came to know as fluoroquinolone (Emmerson and Jones, 2003) [4].

Sarkozy (2001) [12] reported that Quinolones are amphoteric and considered as zwitterionic due to the presence of carboxylic acid and one or more basic functional group. Bergogne-Bérézin, (2002) [1] reported that the plasma protein binding of fluoroquinolones was found to be lower approximately 20 - 40 percent in plasma, they are bound mainly to albumin. Uivarosi (2013) [16] reported that pKa is between 5.33-6.53 for carboxyl group and 7.57-9.33 for nitrogen of piperazine group and hence they are highly lipid soluble and can penetrate tissue. Water solubility at physiological pH varies depending on the substitution on the quinolone nucleus, salts of fluoroquinolones are soluble freely and stable in aqueous solution.

Hooper (2001) [7] reviewed that quinolone produce bactericidal activity by direct inhibiting DNA synthesis. This inhibition occurs by interaction of the drug with DNA and gyrase enzyme complex or with DNA and topoisomerase 4 enzyme complex. The GyrA and GyrB subunit of DNA gyrase is are structurally homologous with ParC and ParE subunits of topoisomerase IV. Mammalian topoisomerase is fundamentally different from bacterial gyrase,

hence mammals are not susceptible to quinolones. The enzyme will equally break both strands of DNA and will cause passing of another strand of DNA through the break and then will reseal it. Gyrase enzyme will introduce negative supercoiling and Topoisomerase IV will cause separation of daughter strand during replication DNA replication. Quinolones will interfere with either of the enzymes (DNA gyrase and topoisomerase IV) and act as physical barrier in the movement of replication fork, DNA helicase and RNA polymerase, causing ultimate bacterial cell death.

Sparfloxacin is a third generation fluoroquinolone antimicrobial agent had activity against wide range of gram-negative, gram-positive, anaerobic, glucose non fermenters, *mycoplasma* spp, *legionella* spp, *mycobacterium* spp, *chlamydia* spp. Methicillin-resistance *Staphylococcus aureus* (MRSA) was also sensitive to sparfloxacin (Shimada *et al*., 1993) [14].

According to literature survey there are few reports regarding pharmacokinetic analysis of sparfloxacin in rats. Different methods were used to analyse sparfloxacin which include luminescence spectrophotometry, UV- Vis spectrophotometric methods (Kumar *et al*., 2000) [9], Reverse Phase High Pressure Liquid Chromatography (Ravisankar *et al*., 2014) [11]. Most of RP-HPLC method for detection of sparfloxacin has limitation like low sensitivity, long retention time, uneconomic because buffer used as mobile phase should be freshly prepared everyday especially phosphate buffer which is favourable for growth of fungus and bacteria. It should be filtered before use, when organic compound comes in contact with mobile phase when chromatography is off it may cause crystallization which will block column and cause corrosion of stainless steel lines and will damage the pump. To overcome the usage of buffer, we have prepared simple, accurate analysis method for detection of sparfloxacin by following the guidelines of ICH (ICH, 2005) [8].

2. Materials and methods

2.1 Experimental animals

Pharmacokinetic study was conducted on 18 adult Sprague Dawley rats of either sex weighing 250-350 grams (g) body weight. The experiment was approved in the Institutional Animal Ethics Committee (IAEC) of College of Veterinary and Animal Sciences, Wayanad vide order no. IAEC/COVAS/PKD/4/2019. The Sprague Dawley rats were procured from Small Animal Breeding Station, College of Veterinary and Animal Sciences, Mannuthy. All the animals were maintained in well ventilated cages at 24ºC temperature and relative humidity ranging at 50-60% and fed on standard laboratory rat feed and reverse osmoses drinking water. The animals are kept under standard management conditions for one week, to get acclimatized to new laboratory environment, before the commencement of the experimental setup. The experiment was carried out for a period of 2 months.

2.2 Solvents and chemicals

All the chemicals used in the research were of analytical grade procured from M/s Sigma Aldrich India Pvt Ltd, Merck Specialities Pvt. Ltd, All the solvents used for high performance liquid chromatography were of HPLC grade Lichrosolv® and procured from M/s Merck Specialities Pvt Ltd. Water for HPLC was obtained from Milli-Q® water system from M/s Millipore (Bedford, MA, USA).

2.3 Instruments and conditions

High Performance Liquid Chromatography system- HPLC (M/s Shimadzu Corporation, Tokyo, Japan) equipped with a DGU-20A3 degasser, LC-10AT quaternary gradient pump, a Rheodyne manual loop injector 20 µL, a column oven CTO-10AS VP, a SIL-20A HT autosampler, a diode array detector SPD-M20A a RF-10A XL fluorescence detector, and a CBM-20A bus module and a Lab-solutions version software for data analysis was used for the analysis of sparfloxacin. Analytical reversed phase C18- column [Luna C18 (2), 5µ, 250 X 4.60 mm, Phenomenex, Inc.] was used for separation. A mixture of 1% acetic acid and acetonitrile (80: 20) was used as mobile phase which gave better system for the standardization of the analytical methodology by reverse phase HPLC as described by Sultan *et al*. (2012) [15] with slight modification. All analyses were done at oven temperature of 30^0C under isocratic condition. The mobile phase consists of aqueous solution of 1% acetic acid: acetonitrile at 80: 20 (V/V) and the flow rate was 0.7ml/min, the injection volume was 20 µL and the detection wavelength was 280nm. All the samples and standards were filtered with PDVF hydrophilic syringe driven membrane filters of 0.22µm. Composite working standard solutions of 0.01, 0.025, 0.05, 0.075, 0.1, 0.25, 0.5, 0.75, 1 µg/ml were prepared by diluting the stock solutions with suitable quantities of 10% acetic acid and were stored at 4ºC until analysis by HPLC.

2.4 Recovery of sparfloxacin from plasma

Three different concentration of sparfloxacin 0.1, 0.5 and 1µg/ml was spiked into 450 µl of plasma. 50 µl of concentrated sulphuric acid, 450 µl of 9:1 acetonitrile: glacial acetic acid was added to precipitate the protein and it was vortexed for 4 minutes, centrifuged at 14000 rpm for 15 minutes. The supernatant was transferred to clean 1.5 ml micro centrifuge tube. To the sediment, again 250 µl of 9:1 acetonitrile : glacial acetic acid was added to precipitate the remaining protein, vortexed for 2 minutes and centrifuged at 14000 rpm for 15 minutes. The total supernatant collected was made to evaporate and final volume was made up to 1ml. All the samples were filtered using PVDF hydrophilic syringe driven membrane filters of 0.22µm and were injected using manual injector to RP-HPLC. The chromatographic view of recovered sample is given in fig.3. along with control and mobile phase peaks. There was shift in the peak of sparfloxacin from 6.5 minutes to 8.5 minutes which may be due to the decrease in pH, occurred during extraction procedure with glacial acetic acid and concentrated sulphuric acid. The mean recovery percentage was calculated from the spiked concentrations.

2.5 Method validation

2.5.1 Linearity

Ascending standards of sparfloxacin that is of 0.01, 0.025, 0.05, 0.075, 0.1, 0.25, 0.5, 0.75 and 1 µg/ml in 1% aqueous acetic acid were prepared and was injected into the HPLC and the analyses was done at 280 nm and repeated three times. Linear regression analysis was done to find out the relations of concentration and area.

2.5.2 Precision and accuracy of method

Precision and accuracy was calculated using intraday and interday variations in spiked sample. In intraday variation, the plasma sample were spiked with 0.1, 0.5 and 1µg/ml of sparfloxacin and recovery was done above mentioned

extraction procedure. The experiment was repeated four times a day and results was expressed in co-efficient of variation percentage. Accuracy of the method was determined by interday variation, the plasma sample were spiked with 0.1, 0.5 and 1µg/ml of sparfloxacin and the recovery was done using extraction procedure. Extraction was repeated for six day and error mean was calculated.

2.5.3 Sensitivity
The limit of detection (LOD) and quantification (LOQ) were determined by signal-to-noise ratio evaluations of samples spiked from 0.01 to 10 µg/ml. The LOQ is defined as the lowest concentration with a signal to noise ratio of at least 3. LOQ is defined as the lowest concentration of analyse with a signal-to-noise ratio of at least 10 and can be determined with acceptable accuracy and precision. The LOQ was established by determining the concentrations of spiked calibration standards from 0.1 to 10 µg/ml.

2.5.4 Experimental design
Eighteen adult healthy normal rats were taken to study the pharmacokinetics of sparfloxacin which were divided in to three groups. Animals were kept in uniform laboratory condition for 2 months. After 2 months animals were fasted overnight and sparfloxacin was administered at the dose rate of 200 mg/kg body weight orally in 1 per cent carboxy-methyl cellulose in water. Water was given *ad libitum* during the experiment. Blood was collected by retro-orbital puncture method (approximately 1ml) of alternate sets of animal at 15, 30, 45 min and 1, 2, 4, 6, 8, 10, 12 and 24 h into heparinized containers and plasma was separated by centrifugation at 5000 rpm for 15 min and stored at -20° C till analysis. Pharmacokinetic variables were determined using computerized curve fitting program PK solver® software Zang *et al. (*2010) [18]. This computerized curve fitting program was based on a compartment model.

3. Results and discussion
A modified RP-HPLC method has been developed and validated by using the mobile phase comprising aqueous solution of 1% aqueous acetic acid and acetonitrile in the ratio of 80% and 20% (v/v) at ambient temperature at flow rate of 0.7 mL/min with UV detection at 280 nm. The injection volume was kept at 20 µL for standard and all samples. The retention time of sparfloxacin was obtained at 8.5min.

When peak area (y) was plotted against ascending standards of sparfloxacin that is of 0.01, 0.025, 0.05, 0.075, 0.1, 0.25, 0.5, 0.75 and µg/ml, a good correlation co-efficient was obtained with R^2 of 0.9992 which was within the accepted range and showed good linear relationship, slope (m) and intercept (c) of the calibration curve as 65196.1 and -113.77 respectively.

The accuracy was evaluated at three different concentrations with spikes which were conducted in six days (n = 6) using the proposed method and the value was expressed as mean error which ranged from 0.0035 to 0.0512 indicating better accuracy of method.

The precision was evaluated at three different concentrations with spikes which were conducted four times a day days (n = 4) using the proposed method and the value was expressed as co-efficient of variation which ranged from 2.474 to 8.218 %

The LOQ was established by determining the concentrations of spiked calibration standards from 0.1 to 10 µg/ml. The LOD and LOQ of the method was 0.01 µg/ml and 0.025 µg/ml respectively for sparfloxacin in rat plasma, with acceptable accuracy and precision.

Mobile phase used for the detection of sparfloxacin consisted of a mixture of 1% aqueous acetic acid and acetonitrile (20:80) with a flow rate of 0.7 ml/minute with an optimum wavelength of 280 nm which gave better system for the detection by RP-HPLC. This methodology was as described by Sultan *et al*. (2012) [15] with slight modification. Response linearity of sparfloxacin was measured from 0.01ppm to 1ppm and the linear correlation was found to be (R^2) 0.992, as similar to correlation coefficient reported by Sultan *et al*. (2012) [15] which was 0.998. Mean recovery percentage with standard deviation was found to be 98.73 ± 3.91. Precision and accuracy were also good. All these results were comparable to the reports of Sultan *et al*. (2012) [15].

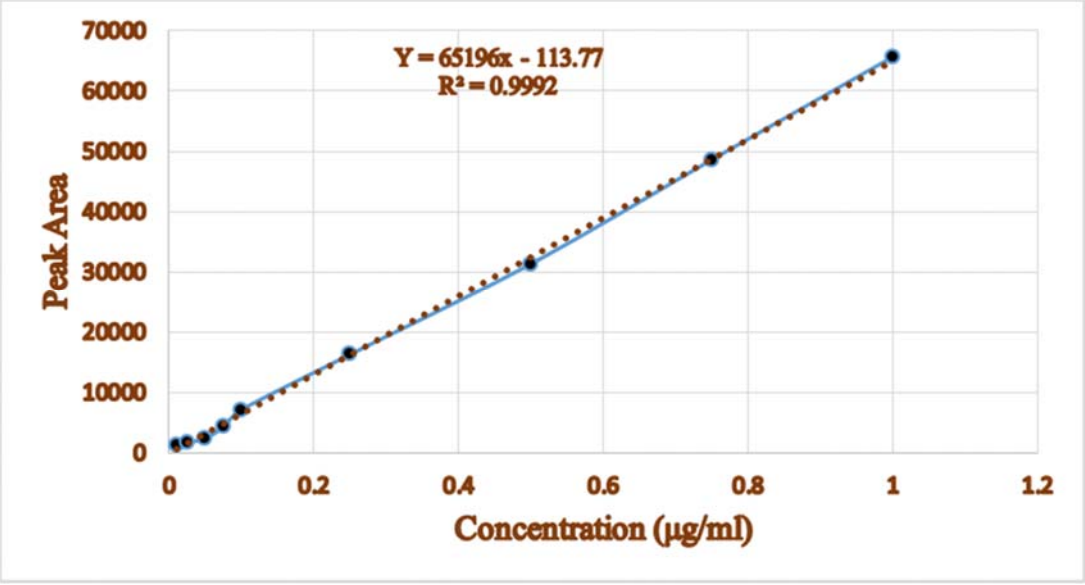

Fig. 1: Response linearity of sparfloxacin in 1% acetic acid: acetonitrile at 80:20

Table 1: Concentration versus area curve of chromatogram of sparfloxacin in different days

ppm	Day1	Day2	Day3	Mean ± SEM
0.01	1254	1253	1254.4	1253.8±0.24
0.025	1749.8	1744	1744.1	1745.9±1.107
0.05	2423.3	2419.1	2418	2420.1±0.932
0.075	4344.9	4344.5	4347.1	4345.5±0.467
0.1	7157.4	7162.2	7158.7	7159.4±0.828
0.25	16290.8	16294.2	16293.7	16292.9±0.612
0.5	31338.5	31341.2	31342.4	31340.7±0.666
0.75	48657.9	48655.2	48654.9	48656±0.551
1	65702.5	65705.3	65701.2	65703±0.698

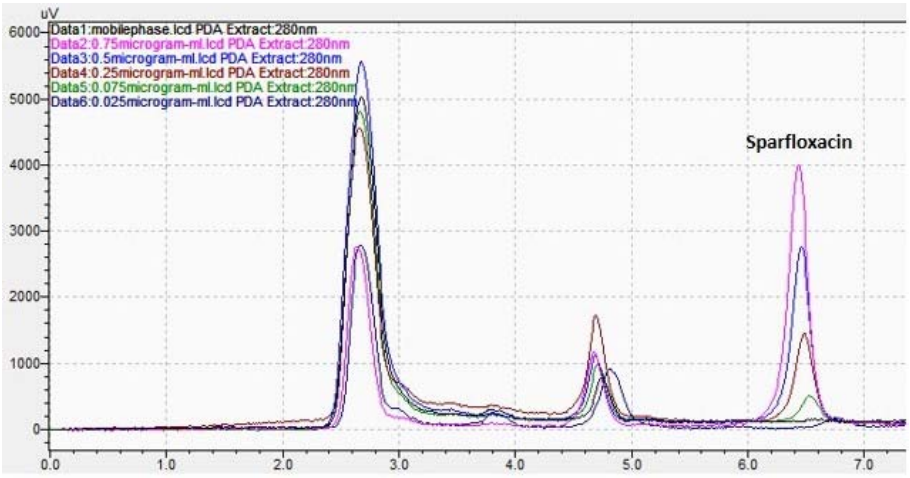

Fig. 2: Chromatogram of different concentration of standard standard injection in HPLC along with mobile phase

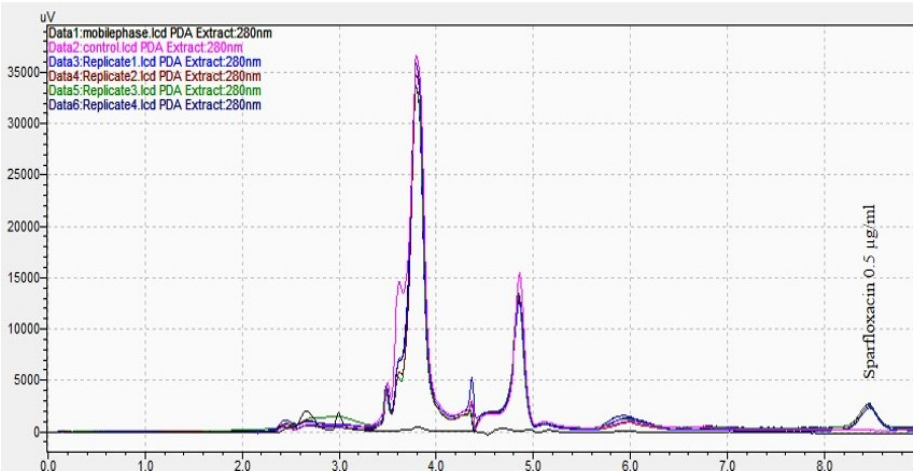

Fig. 3: Recovery of 0.5 µg/ml of sparfloxacin from plasma, along with control and mobile phase peaks

Table 2: Intra-day variation of 0.5, 1, 0.1 µg/ml of sparfloxacin

Concentrations	10.00pm	4.00am	10.00pm	4.00am	Mean Recovery %	Standard deviation	Co-eff of Variation
0.5 µg/ml	99.22	97.18	94.79	100.28	97.868	2.422	2.474
1 µg/ml	90.56	83.47	89.27	88.27	87.893	3.094	3.52
0.1 µg/ml	98.75	85.06	85.67	98.11	91.898	7.552	8.218

Table 3: Inter-day variation of 0.5, 1, 0.1 µg/ml of sparfloxacin

	Detected concentration of sparfloxacin from spiked sample												
Spiked Conc of sparfloxacin	Day1	Day2	Day3	Day4	Day5	Day6	Day1	Day2	Day3	Day4	Day5	Day6	Mean Error
0.1 µg/ml	0.095	0.097	0.099	0.1	0.094	0.094	0.005	0.003	0.001	0	0.006	0.006	0.0035
0.5 µg/ml	0.469	0.457	0.441	0.444	0.427	0.455	0.031	0.043	0.059	0.056	0.073	0.045	0.0512
1 µg/ml	0.98	0.958	0.979	0.991	0.914	0.917	0.02	0.042	0.021	0.009	0.086	0.083	0.0435

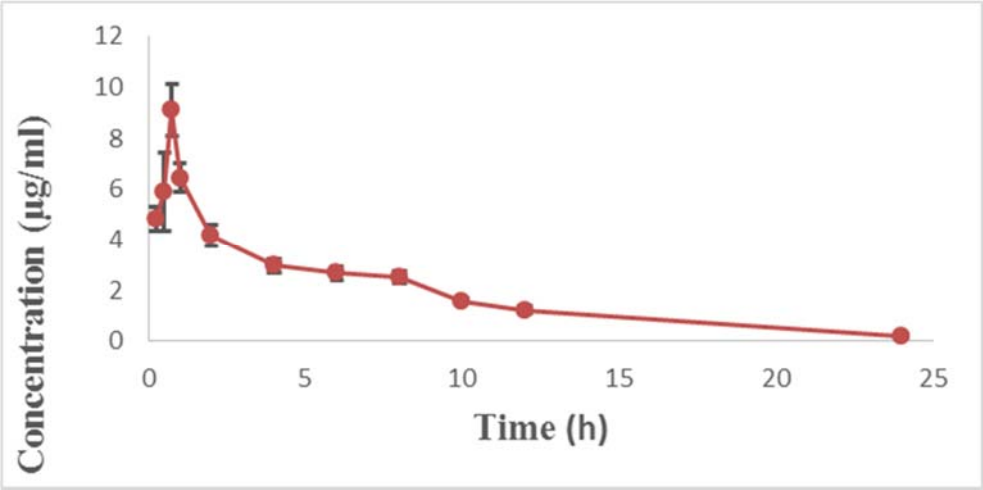

Fig. 4: Mean (±SEM) plasma concentration of sparfloxacin at 200mg/kg orally in rats. (n=6)

Table 4: Pharmacokinetic parameters of two compartment analysis of sparfloxacin given 200mg/kg orally in rats (n=6)

Parameters	unit	Animal						Mean± SEM
		A1	A2	A3	A4	A5	A6	
A	µg/ml	28.552	271.038	272.869	403.288	146.784	126.034	208.094±54.463
α	1/h	1.634	1.85	1.296	1.64	1.723	1.9	1.674±0.088
B	µg/ml	3.187	5.689	3.066	3.052	4.968	5.103	4.178±0.492
β	1/h	0.068	0.101	0.062	0.069	0.116	0.115	0.089±0.01
k_a	1/h	2.464	1.934	1.347	1.749	1.834	1.998	1.888±0.148
K_{10}	1/h	0.247	0.287	0.242	0.486	0.299	0.244	0.301±0.038
k_{12}	1/h	1.006	1.013	0.784	0.99	0.871	0.874	0.923±0.038
k_{21}	1/h	0.449	0.651	0.332	0.233	0.669	0.897	0.539±0.1
$t_{1/2\alpha}$	h	0.424	0.375	0.535	0.423	0.402	0.365	0.421±0.025
$t_{1/2\beta}$	h	10.225	6.855	11.188	10.03	5.967	6.01	8.379±0.962
$t_{1/2ka}$	h	0.281	0.358	0.514	0.396	0.378	0.347	0.379±0.031
V/F	L/kg	15.718	11.66	14.957	7.135	14.781	18.218	13.745±1.576
CL/F	ml/kg/hr	3.875	3.351	3.618	3.465	4.424	4.45	3.864±0.195
V2/F	L/kg	35.187	18.144	35.331	30.267	19.255	17.75	25.989±3.488
CL2/F	ml/kg/hr	15.807	11.808	11.725	7.064	12.875	15.921	12.533±1.334
T_{max}	h	0.608	0.728	0.94	0.651	0.79	0.813	0.755±0.049
C_{max}	µg/ml	6.54	8.071	5.849	11.425	6.523	5.696	7.351±0.884
AUC $_{0-t}$	µg/ml*h	42.378	54.712	44.09	49.316	42.578	42.165	45.873±2.082
AUC $_{0-\infty}$	µg/ml*h	51.619	59.681	55.278	57.724	45.211	44.943	52.409±2.566
AUMC	µg/ml*h^2	699.136	561.66	809.332	656.134	372.493	385.762	580.753±71.578
MRT	h	13.544	9.411	14.641	11.367	8.239	8.583	10.964±1.093

The concentration of sparfloxacin in the plasma of each animal at 0.25, 0.5, 0.75 min and 1, 2, 4, 6, 8, 10, 12 and 24 hours are given in the fig. 4. The concentration and time data was analysed using PK solver® software and found that pharmacokinetics of rats fit well into two compartment analysis.

The mean pharmacokinetics data analysis of two compartment in the table 4. From the data it can be concluded that the value of A, B were 208.094 µg/ml and 4.178 µg/ml respectively and α, β are 1.674 /h and 0.089 /h respectively. Hence the two compartmental kinetics equation is

$$C_t = 208.094e^{-1.674t} + 4.178e^{-0.089t}$$

Non compartment model was obtained for single dose of 400 mg sparfloxacin administration orally in humans (Montay, 1996) [10]. One compartmental model fitting of sparfloxacin was obtained for intravenous administration of sparfloxacin in healthy chicken (Bhar *et al*., 2009) [2]. Two compartmental model was reported by Zeng *et al*. (2012) [17] in rats after oral administration of sparfloxacin at the dose rate of 5 mg/kg.

From the table 4 given above mean absorption rate constant, rate of movement of the drug from central compartment to the second compartment, rate of movement of the drug from second compartment to the central compartment and the rate of movement of the drug from central compartment to elimination compartment was (1.888±0.148/ h), (0.923±0.038/ h), (0.539±0.1/ h) and (0.301±0.038/ h) respectively. The C_{max} and T_{max} was found to be (7.351±0.884 µg/ml) and (0.755±0.049 h) respectively. From the fig. 4. it is clear that the peak plasma concentration attained by sparfloxacin was rapid. The mean half-life of absorption, distribution and elimination was 0.379±0.031 h, 0.421±0.025 h, 8.379±0.962 h respectively. The mean residence time (MRT), mean volume of distribution, total body clearance, volume of distribution in second compartment was (10.964±1.093h), (13.745±1.576 L/kg), (3.864±0.195 ml/kg/h), (25.989±3.488 L/kg), (12.533±1.334 ml/kg/h) respectively. Sparfloxacin is lipid soluble in nature, the volume of distribution of is higher (Decre and Bergogne-Berezin, 1993) [3]. The AUC $_{0-t}$, AUC $_{0-\infty}$ were 45.873±2.082 µg/ml*h and 52.409±2.566 µg/ml*h respectively. K_{12}/K_{21} is

1.72, indicate that sparfloxacin is rapidly distributed from central compartment to second compartment. In rats the volume of distribution higher in our study compared to humans. The MRT of sparfloxacin in healthy, hepatopathic, nephropathic birds after intravenous administration of 40 mg/kg sparfloxacin was 4.71±0.46 h, 20.69±0.56 h and 31.27±0.77 h respectively (Bhar *et al*., 2009) [2]. The AUC_{0-t} - in oral administration of sparfloxacin at the dose rate of 5 mg/kg in rat was 1.96 mg/h*L.

Montay *et al*. (1996) [10] reported the pharmacokinetic parameters of sparfloxacin after administering 200mg orally in humans. The peak plasma concentration C_{max} was 705 ng/ml which was attained in 4 h, AUC was 18749 ng/ml*h, $t_{1/2\,\beta}$ was 20.79 h, MRT was 29.25 h and clearance was 11 L/h. He also reported that $t_{1/2\beta}$ and clearance of the drug doesn't depend on dose of drug but in this study there was decreased in $t_{1/2\beta}$ and clearance.

Goa *et al*. (1997) reported in his review different pharmacokinetics parameters sparfloxacin in humans. The peak plasma concentration of drug after administering 200 mg sparfloxacin orally was 0.62- 0.71 mg/L which was attained in 3.5- 4 h. $t_{1/2\beta}$ of sparfloxacin was 15.8- 20.8 h. AUC was 14.7-18.8 mg/L*h. Volume of distribution was 5.5 L/kg and clearance was 11.0-15.3 L/kg. Volume of distribution higher in our study compared to humans.

4. Conclusion

The method validation for sparfloxacin was simpler, effective, accurate precise, less time consuming, effective and can be used for analysis of more biological samples. From the pharmacokinetic result it can be concluded that sparfloxacin is rapidly absorbed from intestine after oral administration and attained good plasma concentration. Sparfloxacin is distributed well into tissue as evident by the rapid movement of drug from central compartment to second compartment. Good concentration is achieved in tissue, hence it can be used in urinary, respiratory infection treatment.

5. Acknowledgement

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6. Conflicts of interest

The authors declare that there are not any conflicts of interests

7. References

1. Bergogne-Bérézin E. Clinical role of protein binding of quinolones. Clin. Pharmacokinet. 2002; 41(10):741-750.
2. Bhar MK, Khargharia S, Chakraborty AK, Mandal TK. Disposition kinetics of sparfloxacin in healthy, hepatopathic, and nephropathic conditions in chicken after single intravenous administration. Indian. J. Pharmacol. 2009; 41:106.
3. Decre D, Bergogne-Berezin E. Pharmacokinetics of quinolones with special reference to the respiratory tree. J. Antimicrob. Chemother. 1993; 31:331-343.
4. Emmerson AM, Jones AM. The quinolones: decades of development and use. J. Antimicrob. Chemother. 2003; 51:13-20.
5. Gerhardt C. Untersuchungen ber die organischen Basen. *Justus Liebigs Annalen der Chemie.* 1842; 42(3):310-313.
6. Heeb S, Fletcher MP, Chhabra SR, Diggle SP, Williams P, Cámara M. Quinolones: from antibiotics to autoinducers. FEMS microbiology reviews. 2011; 35(2):247-274.
7. Hooper DC. Emerging mechanisms of fluoroquinolone resistance. Emerging infect. Dis. 2001; 7:337.
8. ICH. Validation of analytical procedures: text and methodology. In International Conference on Harmonization, Geneva, 2005.
9. Kumar KG, Chowdary KR, Rao GD. Spectrophotometric methods for the determination of sparfloxacin in pharmaceutical forms. Indian J. Pharm. Sci. 2000; 62(3):230.
10. Montay G. Pharmacokinetics of sparfloxacin in healthy volunteers and patients: a review. J. Antimicrob. Chemother. 1996; 37:27-39.
11. Ravisankar P, Devadasu C, Rao GD, Rao MN. A validated RP-HPLC Method for the Determination of Sparfloxacin in Bulk and Pharmaceutical Dosage Form. Asian J Pharm Clin Res. 2014; 7(1):135-140.
12. Sarkozy G. Quinolones: a class of antimicrobial agents. Veterinary medicina-praha. 200; 46(10):257-274.
13. Sheehan G, Chew NS. The history of quinolones. In Fluoroquinolone Antibiotics, 2003, 1-10
14. Shimada J, Nogita T, Ishibashi Y. Clinical pharmacokinetics of sparfloxacin. Clin. Pharmacokinet. 1993; 25:358-369.
15. Sultan Z, Zia-Ul-Huda G, Hossain A, Mazid A, Rashid A. Development and validation of a RP-HPLC method for the quantification of sparfloxacin in pharmaceutical dosage forms. Ars Pharm. 2012; 53:11-16
16. Uivarosi V. Metal complexes of quinolone antibiotics and their applications: an update. Molecules. 2013; 18(9):11153-11197.
17. Zeng HJ, Yang R, Liu B, Lei LF, Li JJ, Qu LB. Simple and sensitive determination of sparfloxacin in pharmaceuticals and biological samples by immunoassay. J. Pharm. Anal. 2012; 2:214-219.
18. Zhang Y, Huo M, Zhou J, Xie S. PK Solver: An add-in program for pharmacokinetic and pharmacodynamic data analysis in Microsoft Excel. Comput. Methods Programs Biomed. 2010; 99:306-314.