Research

Analytical Method Development and Validation of Drugs in the Management of Hospital-Acquired Bacterial Pneumonia

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Abstract

A basic, Exact, exact strategy was created for the concurrent assessment of the Ceftolozane and Tazobactam in drug dose structure. Chromatogram was gone through XTerra C18 (4.6 x 150mm, 5 μm molecule size). Portable stage containing Phosphate cradle and Acetonitrile in the proportion of 55:45 was siphoned through segment at a stream pace of 1ml/min. Support utilized at pH 4.6. Temperature was kept up with at Encompassing. Upgraded frequency for Ceftolozane and Tazobactam was 260 nm. Maintenance season of Ceftolozane and Tazobactam were viewed as 2.28 min and 3.62 min. The % virtue of Ceftolozane and Tazobactam was viewed as 100.5% and 101.2% individually. The framework appropriateness boundaries for Ceftolozane and Tazobactam, for example, hypothetical plates and following element were viewed as 2589.3, 5419.7, 1.11 and 1.34. The goal was viewed as 8.0. The linearity study for Ceftolozane and Tazobactam connection coefficient (r2) was viewed as 0.999 and 0.999, % mean recuperation was viewed as 100.1% and 100.4%, %RSD for repeatability was 1.2 and 0.60, % RSD for moderate accuracy was 1.48 and 0.82 separately. The accuracy study was exact, strong and repeatable. LOD esteem was 0.63 and 0.09, and LOQ esteem was 1.88 and 0.26respectively. The consequences of study showed that the proposed RP-HPLC strategy is a basic, exact, exact, tough, strong, quick and reproducible, which might be helpful for the normal assessment of Ceftolozane and Tazobactam in drug measurements structure.

Keywords: Ceftolozane, Tazobactam, RP-HPLC, Simultaneous estimation.

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INTRODUCTION

Ceftolozane is a cephalosporin anti-toxin used to treat convoluted intra-stomach contaminations in blend with metronidazole, confounded urinary plot diseases, and clinic gained pneumonia.1 Ceftolozane has a place with the cephalosporin class of antibacterial medications. Ceftolozane applies antibacterial impacts, forestalling the development of cell walls that shield microbes from injury and give protection from certain anti-toxins. Its antibacterial action is likewise intervened through ceftolozane restricting to penicillin-restricting proteins (PBPs), which are expected for peptidoglycan cross-connecting for bacterial cell wall blend. Because of cell wall amalgamation restraint, bacterial cells are killed, treating different infections.2 IUPAC Name is 5-amino-2-{[(6R,7R)- 7-[(2Z)- 2-(5-amino-1,2,4-thiadiazol-3-yl)- 2-[(1-carboxy-1-methylethoxy) imino] acetamido]-2-carboxylato-8-oxo-5-thia-1-azabicyclo [4.2.0] oct-2-en-3-yl] methyl}-4-{[(2- aminoethyl) carbamoyl] amino}-1-methyl-1H-pyrazol-2-ium. Substance Recipe is $C_{23}H_{30}N_{12}O_8S_2$. Atomic weight is 666.69. Dissolvable in water (50mg/ml); somewhat solvent in methanol and 100 percent ethanol; insoluble in CH3)2CO, chloroform and benzene.

Tazobactam is a beta lactamase inhibitor controlled with anti-toxins like piperacillin and ceftolozane to forestall their debasement, coming about in expanded efficacy.3 Tazobactam widens the range of piperacillin and ceftolozan by making them compelling against life forms that express beta-lactamase and would regularly corrupt them. This happens through the irreversible restraint of beta-lactamase chemicals. Likewise, tazobactam may tie covalently to plasmid-intervened and chromosome- interceded beta-lactamase catalysts. Tazobactam is overwhelmingly compelling against the OHIO-1, SHV-1, and TEM gatherings of beta-lactamases, however may likewise repress other beta- lactamases.4 IUPAC Name is (2S,3S,5R)- 3-methyl-4,4,7-trioxo-3-(1H-1,2,3-triazol-1-ylmethyl)- $4\lambda^6$-thia-1-azabicyclo [3.2.0] heptane-2-carboxylic corrosive. Synthetic Recipe is $C_{10}H_{12}N_4O_5S$. Sub-atomic weight is 300.29. Tazobactam is marginally dissolvable in watery arrangement (9.59 mg/mL). Tazobactam sodium is unreservedly dissolvable in watery arrangement.
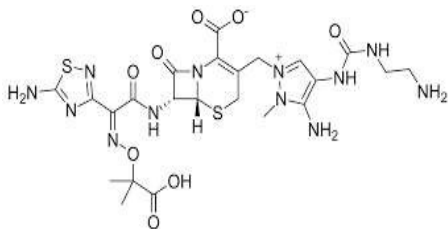

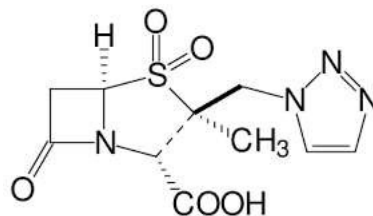**Figure 1: Structure of Ceftolozane**   **Figure 2: Structure of Tazobactam**

The writing study uncovered that There are Different scientific techniques were completed for the assessment of Ceftolozane and Tazobactum as a solitary or joined with different medications in drug measurements Writing review uncovers that the maintenance time for the concurrent assessment of Ceftolozane and Tazobactum is more. Subsequently the current review, we had made an endeavor to foster basic, exact, exact, less tedious and with less maintenance time involving RP-HPLC for the synchronous assessment of Ceftolozane and Tazobactum in mass and drug measurement structure by RP-HPLC.5-11 To approve the created strategy as per ICH rules for the expected scientific application i.e., to apply the proposed technique for examination of the medication in its dose structure.

MATERIALS AND METHODS

Chemicals and Reagents: Ceftolozane and Tazobactum were Bought from market. NaH2PO4 was scientific grade provided by Finerchem restricted, Orthophosphoric corrosive (Merck), and Water and Methanol for HPLC (Lichrosolv (Merck).

Hardware and Chromatographic Circumstances: The chromatography was performed on a Waters 2695 HPLC framework, outfitted with an auto sampler, UV indicator and Enable 2 programming. Examination was completed at 260 nm with section XTerra C18 (4.6 x 150mm, 5 µm molecule size), aspects at 250C temperature. The improved portable stage comprises of Phosphate cushion and Acetonitril in the proportion of 55:45. Stream rate was kept up with at 1 ml/min.

Preparation of solutions 0.1% OPAbuffer
0.1ml of ortho phosphoric corrosive was taken in a 1000ml volumetric carafe and arrangement was sifted by

utilizing 0.45-micron layer channel and sonicated for 10 min.

Mobile phase
550 ml (55%) of OPA cradle and 450 ml of Acetonitrile (45%) were blended and degassed in a ultrasonic water shower for 10 minutes and afterward separated through 0.45 μ channel under vacuum filtration.
Diluent: Versatile stage was utilized as diluents

Planning of stock standard arrangements
Precisely gauged and transfer25mg&12.5mg of Ceftolozane and Tazobactam working guidelines into a 25ml clean dry volumetric cup individually, sonicated for 30 minutes and make up to the last volume with diluents. The above standard stock arrangement appropriately weakened with diluents to get different convergences of Ceftolozane and Tazobactam.
Readiness of working standard arrangements: Working standard arrangements were ready by taking 1ml of stock arrangements of Ceftolozane and Tazobactam in to clean dry 10ml volumetric cup and make up volume with diluent to get a grouping of 100µg/ml of Ceftolozane and 50µg/ml Tazobactam.

Planning of Test Arrangements of Ceftolozane and Tazobactam
One vial powder was gauged and powder identical to 850 mg of ceftolozane and tazobactam was taken into 100 ml clean dry volumetric carafe, diluent was added and sonicated to break down totally and volume was made up with the diluent. The above example arrangement was sifted, 1ml of filtrate was pipette out into a 10 ml volumetric carafe and made up to 10ml with diluent

System
20µL of the norm, test are infused into the chromatographic framework and the regions for ceftolozane and tazobactam tops are estimated and the %Assay are determined by utilizing the formulae.

METHOD

The created chromatographic strategy was approved for framework appropriateness, linearity exactness, accuracy, toughness and strength according to ICH rules.

Framework reasonableness boundaries: To assess framework appropriateness boundaries, for example, maintenance time, following variable and USP hypothetical plate count, the versatile stage was permitted to course through the section at a stream pace of 1.0 ml/min to equilibrate the segment at surrounding temperature. Chromatographic division was accomplished by infusing a volume of 20 µL of standard into XTerra C18 (4.6 x 150mm, 5 µm molecule size), the versatile period of structure Phosphate cushion and Acetonitril in the proportion of 55:45 was permitted to move through the section at a stream pace of 1.0 ml each moment. Maintenance time, following variable and USP hypothetical plate count of the created technique are displayed in table 1.

Assay of pharmaceutical formulation: The proposed approved technique was effectively applied to decide ceftolozane and tazobactam in their tablet dose structure. The outcome acquired for was tantamount with the relating marked sums and they were displayed in Table-2.

Validation of Analytical method
Linearity: The linearity study was performed for the convergence of 25 ppm to 150 ppm and 12.5 ppm to 75ppm level. Each level was infused into chromatographic framework. The region of each level was utilized for estimation of relationship coefficient. Infuse each level into the chromatographic framework and measure the pinnacle region. Plot a chart of pinnacle region versus fixation (on X-hub focus and on Y-pivot Pinnacle region) and work out the connection coefficient. The resulte are displayed in table 3.

Precision studies: The not entirely set in stone by help of recuperation study. The recuperation strategy completed at three level half, 100 percent, 150% and 25%, half, 75% Infuse the standard arrangements into chromatographic framework. Compute the Sum found and Sum added for ceftolozane and tazobactam and work out the singular recuperation and mean recuperation values. The outcomes are displayed in table 4,5.

Accuracy Studies: accuracy was caliculated from Coefficient of change for six duplicate infusions of the norm. The standard arrangement was infused for multiple times and estimated the region for every one of the six Infusions in HPLC. The %RSD for the area of six recreate infusions was found. The resulte are displayed in table 6.

Ruggedness: To assess the halfway accuracy of the strategy, Accuracy was performed on various day. The standard arrangement was infused for multiple times and estimated the region for every one of the five infusions in HPLC. The %RSD for the area of five duplicate infusions was found. The resulte are displayed in table 7,8.

Robustness: As a feature of the Vigor, purposeful change in the Stream rate, Versatile Stage sythesis, Temperature Variety was had to assess the effect on the technique. The stream rate was shifted at 0.8 ml/min to 1.2 ml/min. The resulte are displayed in table 9,10,11.

LOD and LOQ: The responsiveness of RP not set in stone from LOD and LOQ. Which were determined from the alignment bend involving the accompanying conditions according to ICH rules. The resulte are displayed in table 12.

LOD = 3.3σ/S and LOQ = 10 σ/S, where
σ= Standard deviation of y intercept of regression line, S = Slope of the calibration curve
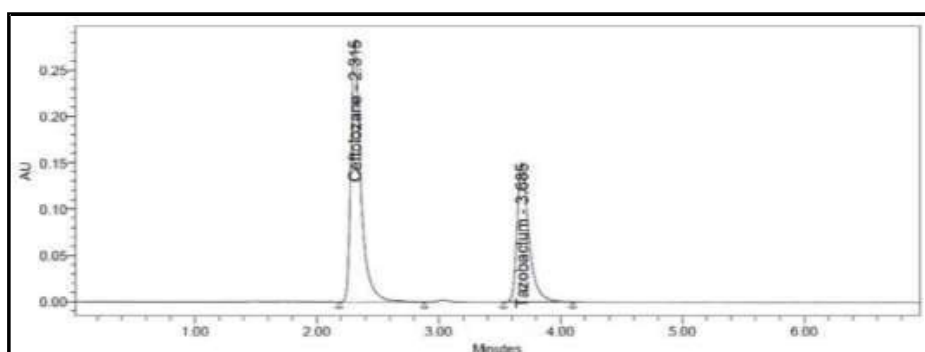
RESULTS AND DISCUSSION

Figure 3: Standard chromatogram
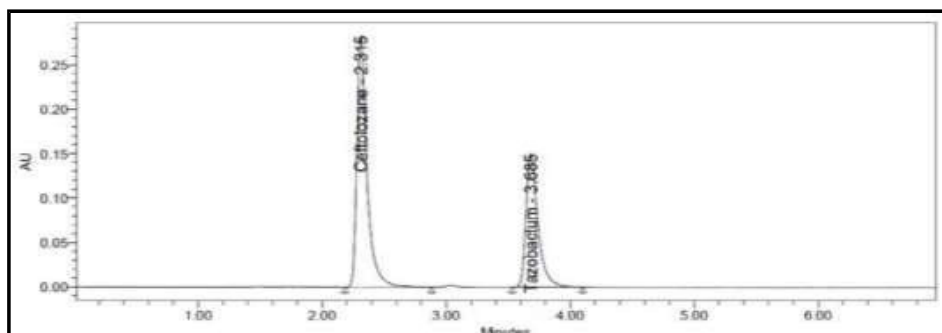
Figure 4: Sample chromatogram
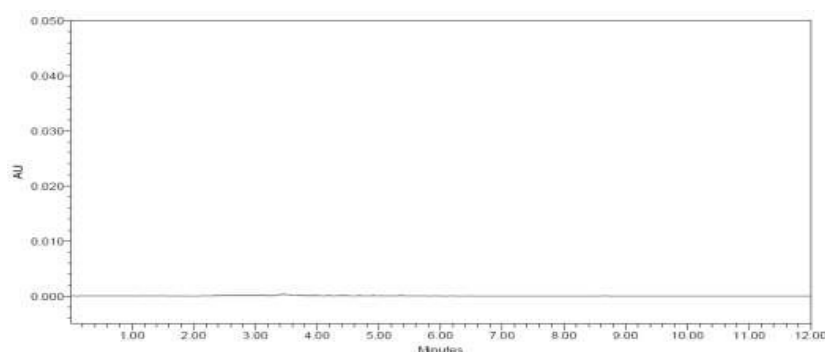
Figure 5: Blank chromatogram

Table 1: System suitability parameters

Parameter	Ceftolazone	Tazobactam
Peak area	924081	22127
Theoretical plates	2589.3	5419.72
Retention time	2.28	3.62
Tailing factor	1.11	1.34

Table 2: Assay results for Ceftolazone and Tazobactam

	Label Claim (mg)	% Assay
Ceftolazone	25	100.3
Tazobactam	12.5	101.6

Table 3: Linearity results of Ceftolazone and Tazobactam

Level	Concentration of Ceftolazone (μg/ml)	Peak area	Concentration of Tazobactam (μg/ml)	Peak area
1	25	365031	12.5	7362
2	50	590445	25	14723
3	75	824680	37.5	22084
4	100	938891	50	29512
5	125	1262631	62.5	36368
6	150	1482624	75	44237

Figure 6: Linearity graph for Ceftolozane

Figure 7: Linearity graph for Tazobactam

Table 4: Showing accuracy results for Ceftolazone

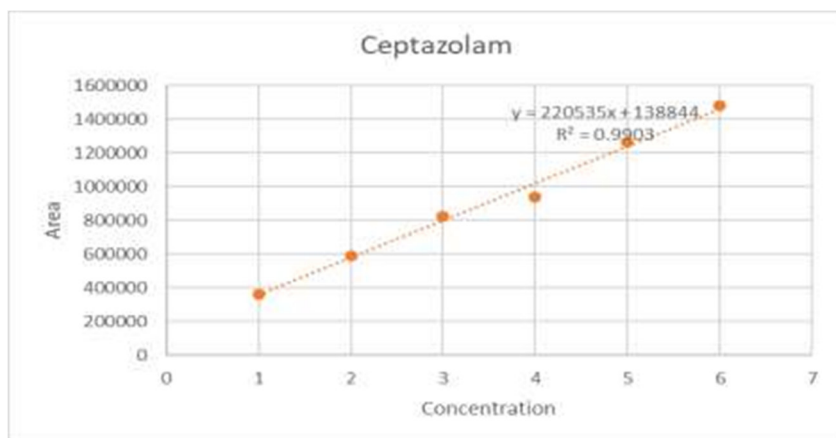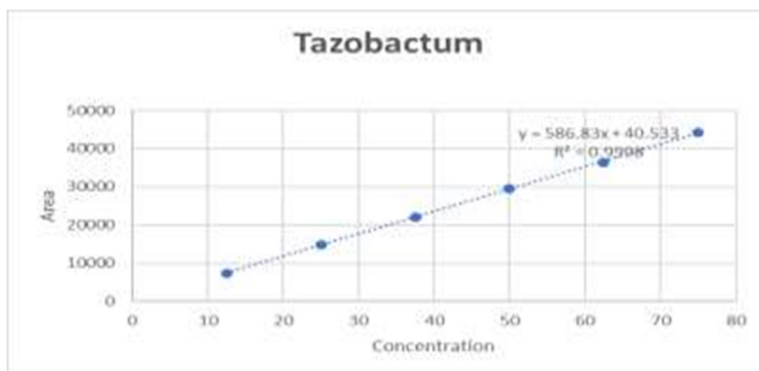| Sample name	Amount added (µg/ml)	Amount found (µg/ml)	%Recovery	Statistical Analysis
S1:50%	50	49.8	99.6	Mean=100.12%(n=3)
S2:50%	50	49.6	99.2	S.D=1.031
S3:50%	50	50.78	101.56	%RSD=1.030
S4:100%	100	100.56	100.56	Mean=100.53%(n=3)
S5:100%	100	100.45	100.45	S.D=0.060
S6:100%	100	100.59	100.59	%RSD=0.060
S7:150%	150	150.55	100.36	Mean=99.59%(n=3)
S8:150%	150	148.36	98.90	S.D=0.598
S9 :150%	150	149.29	99.52	%RSD=0.601

Table 5: Showing accuracy results for Tazobactam

Sample name	Amount added (µg/ml)	Amount found (µg/ml)	%Recovery	Statistical Analysis
S1:50%	25	25.65	102.6	Mean=101.11%(n=3)
S2:50%	25	24.77	99.08	S.D=1.48
S3:50%	25	25.41	101.64	%RSD=1.46
S4:100%	50	50.18	100.36	Mean=100.43%(n=3)
S5:100%	50	49.71	99.42	S.D=0.85
S6:100%	50	50.76	101.52	%RSD=0.85
S7:150%	75	76.25	101.66	Mean=100.40%(n=3)
S8:150%	75	75.44	100.58	S.D=1.11
S9 :150%	75	74.22	98.96	%RSD=1.10

Table 6: Precision results for Ceftolazone and Tazobactam

	Ceftolazone			Tazobactam		
S. No	Concentration (µg/ml)	Peak Area	% Assay	Concentration (µg/ml)	Peak Area	% Assay
1	100	911508	99.3	50	22376	98.4
2	100	939016	100.2	50	21765	101.45
3	100	908096	100.4	50	21597	99.38
4	100	940019	99.4	50	21572	101.92
5	100	924217	100.9	50	21733	100.9
6	100	921693	99.6	50	22476	99.6
Average		924091.5	99.97		21919.8	100.28
SD		13389.5	0.63		400.4	1.36
%RSD		1.4	0.63		1.8	1.36

Table 7: Ruggedness results of Ceftolozane

Concentration (µg/ml)	Laboratory-1 (% Assay)-HPLC-1				Laboratory-2 (% Assay)-HPLC-2			
	Analyst-1		Analyst-2		Analyst-1		Analyst-2	
	Day-1	Day-2	Day-1	Day-2	Day-1	Day-2	Day-1	Day-2
100	99.45	97.25	98.25	99.47	102.08	101.08	102.38	101.51
100	98.50	99.27	101.27	100.30	101.87	100.26	100.18	100.18
100	97.09	96.91	99.22	99.19	99.38	100.71	101.61	100.51
100	99.48	98.18	99.40	98.42	101.90	99.78	100.39	101.81
100	99.34	100.13	97.08	99.28	100.20	99.23	101.82	101.47
100	100.24	98.09	100.24	101.08	100.29	100.78	101.27	101.29
Average	99.02	98.31	99.24	99.62	100.95	100.31	101.28	101.13
SD	1.09	1.22	1.47	0.93	1.14	0.70	0.85	0.64
%RSD	1.10	1.24	1.48	0.94	1.13	0.69	0.84	0.63

Table 8. Ruggedness results of Tazobactam

Concentration (µg/ml)	Laboratory-1 (% Assay)-HPLC-1				Laboratory-2 (% Assay)-HPLC-2			
	Analyst-1		Analyst-2		Analyst-1		Analyst-2	
	Day-1	Day-2	Day-1	Day-2	Day-1	Day-2	Day-1	Day-2
100	101.83	102.54	100.21	101.34	100.21	98.37	100.21	98.35
100	100.18	101.29	99.81	100.65	100.61	101.67	99.47	100.52
100	100.38	100.51	101.3	99.78	99.4	98.02	101.82	102.78
100	100.39	101.81	100.61	101.81	100.39	98.42	100.74	99.58
100	100.65	101.72	100.8	101.72	97.56	99.28	101.47	102.55
100	101.27	101.29	99.79	100.27	101.27	100.69	102.27	99.79
Average	101	101.53	100	100.93	100	99	101	101
SD	0.6	0.68	0.6	0.82	1.3	1.5	1.1	1.8
%RSD	0.6	0.67	0.6	0.82	1.3	1.5	1.0	1.7

Robustness results

Table 9: Flow variation results for Ceftolozane and Tazobactam

Drug	Change in Flowrate (ml/min)	Change in flow Rate (0.8ml/min to 1.2 ml/min)		
		%Assay	SD	% RSD
Ceftolazone	0.8	98.2	1.2	1.34
	1	101.41	1.14	1.2
	1.2	99.26	1.6	1.64
Tazobactam	0.8	100.12	1.7	1.8
	1	98.46	0.79	0.8
	1.2	101.12	1.43	1.5

Table 10: Change in Mobile phase composition results for Ceftolozane and Tazobactam

Drug	Change in mobile phase	Change in Mobile phase (0.8ml/min to 1.2 ml/min)		
		%Assay	SD	% RSD
Ceftolazone	10% less organic phase	101.21	0.95	1.1
	Actual	99.42	1.28	1.3
	10% more organic phase	100.61	1.26	1.3
Tazobactam	10% less organic phase	100.81	1.43	1.5
	Actual	101.21	0.58	0.6
	10%more organic phase	99.41	1.4	1.5

Table 11: Change in column Temparature for Ceftolazone and Tazobactam

Drug	Change in column temperature	Change in column temperature		
		%Assay	SD	% RSD
Ceftolazone	25°C	98.34	1.56	1.6
	30°C	101.42	1.26	1.3
	35°C	101.39	1.40	1.5
Tazobactam	25°C	101.45	1.58	1.6
	30°C	99.45	0.49	0.5
	35°C	99.81	0.61	0.7

Table 12: LOD, LOQ of Ceftolozane and Sitagliptin

Drug	LOD	LOQ
Ceftolozane	0.63	1.88
Sitagliptin	0.09	0.27

CONCLUSION

The Created HPLC strategy was approved and it was viewed as basic, exact, precise and delicate for the synchronous assessment of Ceftolozane and Tazobactam in its unadulterated structure and in its drug dose structures. Subsequently, this technique can undoubtedly and advantageously embrace for routine quality control examination of Ceftolozane and Tazobactam in unadulterated and its drug measurement structures.

REFERENCES

1. Sorbera M, Chung E, Ho CW, Marzella N: Ceftolozane/Tazobactam: a new option in the treatment of complicated gram-negative infections. P T. 2014 Dec;39(12):825-32.
2. Zhanel GG, Chung P, Adam H, Zelenitsky S, Denisuik A, Schweizer F, Lagace-Wiens PR, Rubinstein E, Gin AS, Walkty A, Hoban DJ, Lynch JP 3rd, Karlowsky JA: Ceftolozane/tazobactam: a novel cephalosporin/beta-lactamase inhibitor combination with activity against multidrug-resistant gram-negative bacilli. Drugs. 2014 Jan;74(1):31-51.
3. Gin A, Dilay L, Karlowsky JA, Walkty A, Rubinstein E, Zhanel GG: Piperacillin- tazobactam: a beta-lactam/beta-lactamase inhibitor combination. Expert Rev Anti Infect Ther. 2007 Jun;5(3):365-83. doi: 10.1586/14787210.5.3.365. [Article]
4. Zhanel GG, Chung P, Adam H, Zelenitsky S, Denisuik A, Schweizer F, Lagace-Wiens PR, Rubinstein E, Gin AS, Walkty A, Hoban DJ, Lynch JP 3rd, Karlowsky JA: Ceftolozane/tazobactam: a novel cephalosporin/beta-lactamase inhibitor combination with activity against multidrug-resistant gram-negative bacilli. Drugs. 2014 Jan;74(1):31-51.
5. Bhavana M, Reddy RT, Sandhya M, Umea V, Rao M. RP-HPLC Method Development and Validation for Simultaneous Estimation of Cefepime and Tazobactam in Marketed Formulation. Int J of Pharmacy 2013;3(4):837-42.
6. Tamboli SR, Patil DD. RP-HPLC Method for Simultaneous Estimation of Cefepime Hydrochloride and Tazobactam Sodium in Bulk and Pharmaceuticals. J of Chemistry 2013;1- 6.
7. Lalitha N, Pawar V, Puranik SB, Pai PN, Rao GK. Estimation of Cefoperazone in Marketed formulation By RP-HPLC. Oriental J of Chemistry 2008;24(2):737-40.
8. Lalitha N, Puranik SB, Pai PN. A Stability-Indicating HPLC Method for Cefoperazone. Eur J Anaytical Chemistry 2009;4(1):110-8.
9. Kumar Vinod K, Dharuman J, Karuna A. RP-HPLC Method Development and Validation for Simultaneous Estimation of Sulbactam and Cefoperazone in Dosage form and in Plasma. Int J of Pharm and Bio Sci 2010;4(1):87-92.
10. Abdullah NA, Ayad MF, El-Kosasy AM. HPLC and Densitometric TLC Methods for Simultaneous Determination of Pazufloxacin with Some Co-administered Drugs in human Plasma. J Chromatography Séparation Techniques 2012;3(8):1-8.
11. Rao LA, Sai KK, Kiran Kumar CH, Raja T. Simultaneous determination of Piperacillin and Tazobactum in bulk and Pharmaceutical dosage forms by RPHPLC. Int J of Pharmacy and Pharm Sci 2011;3(2):134-6.
12. Kumar PK, Nilewar SS, Bonthu MG, Dudhe SP, Dudhe PB. Computational Drug Design and Docking Studies of Thiazole Derivatives Targeting Bacterial DNA Gyrase. Indian Journal of Pharmaceutical Chemistry and Analytical Techniques. 2025 Aug 7:40-53.
13. Bandaru N, Noor SM, Kammili ML, Bonthu MG, Gayatri AP, Kumar PK. Methionine restriction for cancer therapy: From preclinical studies to clinical trials. Cancer Pathogenesis and Therapy. 2025 Jan 6.
14. Bandaru N, Bonthu MG, Gayatri AP, Metri S, Kumar PK, Addanki A, Nallapaty S, Priya KS, Nadhreddy DT, Gowravi PN. Review on Exploring Role of Vitamin D on Alzheimer's Disease: Mechanistic Insights and Implications. Journal of Pharmacology and Pharmacotherapeutics. 2025 Jun;16(2):164-71.
15. Bandaru N, Noor SM, Kammili ML, Bonthu MG, Gayatri AP, Kumar PK. Cancer Pathogenesis and Therapy.
16. Kumar PK, Dhulipalla NL, Gadicherla V, Dasari V. International Journal of Pharmacy and Analytical Research (IJPAR).
17. Bharadwaj N, Das AB, Sunil R, Devi S, Kumar PK, Bhadkariya S, Kakkar S, IA C. asPotentialDPP-4InhibitorsforDiabetesManagement. Journal of Neonatal Surgery. 2025;14(12s):955.

18. Rekha NV, Kumar PK, Dasari V. Quantification And Phytochemical Examination Of Acacia Catechu Willd By HPTLC. Journal of Engineering Sciences. 2023;14(1):670-6.
19. Dudhe SP, Dudhe PB, Mundhe SM, Rojin RG, Vijukumar A, Cherian IV, Das S, Perli KK. The Digital Revolution in Education: Historical Perspectives and Future Directions. Revolutionizing Education With Remote Experimentation and Learning Analytics. 2025:489-508.
20. Behera A, Joshi V, Mohapatra R, Vishwakarma D, Sarkar S, Das S, Begum T, Kumar PK. Empagliflozin-Loaded Floating Density-Modulated Drug Delivery System as a Novel Approach for Sustained Therapy in Type 2 Diabetes Mellitus with Sodium-Glucose Co-Transporter-2 Inhibition. Cuestiones de Fisioterapia. 2025 Feb 19;54(3):4357-68.
21. Madhuri VD, Aparna TN, Dasari V, Kumar PK. A prospective of primary and novel approaches to the colon targeted drug delivery system.
22. Dhulipalla NL, Gadicherla V, Dasari V, Kumar PK. International Journal of Pharmacology and Clinical Research (IJPCR).
23. Uplanchiwar VP, Sarma KN, Mujawar T, Mythily V, Kranti P. Chronotherapeutic Circadian-Based Pulsatile Drug Delivery of Etodolac for Morning Stiffness in Rheumatoid Arthritis. Journal of Neonatal Surgery. 2025;14(4s):833.
24. Bandaru N, Shamim N, Nagalakshmi SB, Sunanda T, Hanisha C, Gambhire MS. Preparation of Platinum Nanoparticles of Biophytum reinwardtii and Evaluation of Neuroprotective Activity of MPTP-induced Parkinson's Disease in Zebra Fish. Biomedical and Pharmacology Journal. 2024 Sep 30;17(3):1635-45.
25. Krantikumar P, Godasu SK, Raju P, Vuyyala G, Dasari V. A study on method development and validation of drugs used in hospital acquired bacterial pneumonia. J Eng Sci. 2022;12:278-90.