Available online on 15.08.2022 at http://ajprd.com

Asian Journal of Pharmaceutical Research and Development

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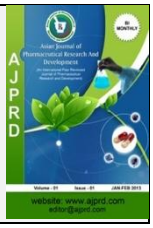

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Review Article

A Short Review on Cefuroxime Axetil Tablet

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A B S T R A C T

Cefuroxime axetil is a broad-spectrum antibiotic with a simple pharmacokinetic profile. The medicine treats otitis media, pharyngitis, sinusitis, CAP, and acute exacerbations of chronic bronchitis effectively and well. Cefuroxime axetil was beneficial in intravenous/oral sequential therapy for CAP, but dosage recommendations are not accessible in some countries. Cefuroxime axetil may be used to treat community-acquired infections, including those caused by -lactamase-producing respiratory bacteria. In an era of rapidly growing bacterial resistance, empirical treatment with cefuroxime axetil may assure the proper use of newer antibacterial medicines, reducing bacterial resistance to these drugs.

Keywords: Cefuroxime axetil, Administration, Bacterial Disease, Pharmacokinetics

A R T I C L E I N F O: Received; 20 May 2022; Review Complete; 15 June 2022 Accepted; 25 July 2022 Available online 15 August 2022

Cite this article as:

Kumar S, Jeet K, Devi A, Kumar P, Kumar N, A Short Review on Cefuroxime Axetil Tablet, Asian Journal of Pharmaceutical Research and Development. 2022; 10(4):93-96.

DOI: http://dx.doi.org/10.22270/ajprd.v10i4.1148

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INTRODUCTION

Although a variety of delivery systems are being developed for different routes of administration like the oral, parenteral, nasal, and transdermal, the oral route remains attractive for drug delivery because this mode of administration is an easy, convenient, noninvasive and familiar method of drug delivery.[1]The common oral dosage forms include: liquid mixtures like solutions, suspensions, solid dosage forms like tablets and capsules and liquid filled capsules etc. However, patients at the extremes of age, such as children and the elderly, often experience difficulty in swallowing solid oral dosage forms. For these patients the drugs are mostly provided in liquid dosage forms such as emulsions and suspensions.[2] These dosage forms usually lead to perceptible exposure of the active drug ingredient to taste buds and this is a very serious problem when the drug has an extremely unpleasant or bitter taste. [3] The bitter taste of the drugs, which are orally administered, is disadvantageous in several aspects. Taste is an important parameter governing the compliance. [4] "The worse the taste of the medication, the better the cure" was once the prevailing attitude. A change in patient attitude and development of taste masking technique has reversed this opinion. Patients now expect and demand formulations that are pleasantly, or at least tolerably, flavoured.[5] The disagreeable taste of drugs causes difficulties in swallowing (dysphagia) or causes patients to avoid their medication thereby resulting in low compliance of patients. Conventional taste masking techniques such as use of sweetener, amino acids, flavouring agents are often unsuccessful in masking the taste of the highly bitter drugs like quinine, barberin, antibiotics like levofloxacin, ofloxacin, sparfloxacin, ciprofloxacin, cefuroxime axetil, erythromycin, and clarithromycin. Thus taste masking technologies are considered important and developed by many researchers. [6-9] The current work is concerned with pharmaceutical compositions containing the 1- acetoxyethyl ester of cefuroxime, which has the approved name Cefuroxime axetil. The presence of 1-acetoxyethyl esterifying group results in significant absorption of the compound from the gastro-intestinal tract, whereupon the esterifying group is hydrolysed by enzymes present to yield the antibiotically active acid. Cefuroxime axetil has therefore extended the valuable therapeutic potential of cefuroxime by making available a form of antibiotic which may be administered orally. [10,11] A convenient means of presenting antibiotics for oral administration is in the form

of granules which may be administered as a solution or suspension.[12] Syrups are particularly convenient for oral administration of antibiotics to children. They are particularly aimed at patients with nausea, vomiting, motion sickness and institutionalised patients. However Cefuroxime axetil has an extremely bitter taste which is long lasting and this remains a challenge[13]

Cefueoxime Axetil Tablet

Cefuroxime axetil, a cephalosporin antibacterial medication, restricts bacterial growth by blocking penicillin-binding protein [14] causing elongation, leakage, and cell death. In vitro, the medication is active against a wide range of Gram-positive and Gram-negative bacteria, including those associated with respiratory tract infections [e.g. Streptococcus pneumoniae, Haemophilus influenzae, Moraxella catarrhalis, S. pyogenes, and MSSA].[15]

Cefuroxime is active against penicillin-susceptible S. pneumoniae (MIC90 range 0.06 to 0.25 mg/L), shows some activity against intermediately susceptible S. pneumoniae (MIC90 range 2 to 4 mg/L), but has no activity against penicillin-resistant S. pneumoniae (MIC90 2 to 8 mg/L). [16] In a recent study, cefuroxime's bactericidal activity (mean MIC900.25 mg/L) was equivalent to other cephalosporins.[17] Cefuroxime axetil's MIC90 against MSSA was 2 to 4 mg/L globally. Cefuroxime is ineffective against methicillin-resistant Staphylococcus (including MRSA).[18]

Cefuroxime is active against -lactamase-positive and -negative strains of H. influenzae (mean MIC90 range 1 to 2 and 2 to 4 mg/L), M. catarrhalis (mean MIC90 2 and 0.5 mg/L), and Neisseria gonorrhoeae (mean MIC90 0.125 and 0.06 mg/L). [19] Recent studies shown cefuroxime to be effective against 95% of H. influenzae and 99% of M. catarrhalis. In 2 recent studies, the drug's MIC90 against Escherichia coli was 4 and 8 mg/L.[20] In a recent international survey, E. coli (4509 isolates) susceptibility to cefuroxime was lower than this and showed more variance, with mean MIC90 values ranging from 8 to 32 mg/L (median MIC90 16 mg/L). Cefuroxime was ineffective against Klebsiella pneumoniae (MIC90 16 to >16 mg/L). Cefuroxime is also ineffective against Citrobacter spp., Serratia marcescens, Pseudomonas aeruginosa, and Acinetobacter spp.[21] Some nosocomial Enterobacteriaceae (particularly K. pneumoniae and E. coli) have developed resistance to cefuroxime and other cephalosporins by generating TEM and SHV -lactamases. Cefuroxime is stable against E. coli TEM-1, TEM-2, OXA-1, and OXA-2 and SHV-1-producing K. pneumoniae. Pharmacodynamic/pharmacokinetic analyses suggest that the time cefuroxime concentrations are above the MIC90 for relevant pathogens (e.g., penicillin-susceptible S. pneumoniae isolates and -lactamase-positive and -negative H. influenzae isolates) [22] exceeds 50% of the dosage interval in most situations.

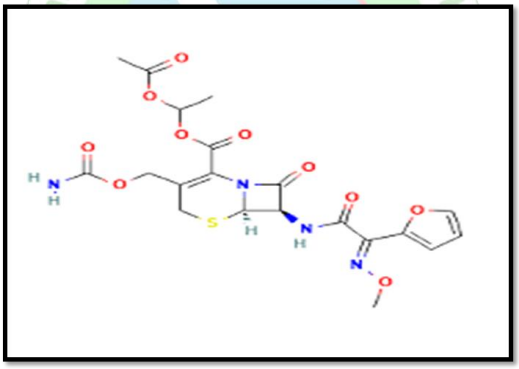

Figure: 1 Structure of Cefueoxime Axetil

Mechanism of Action

Penicillin and cefuroxime both kill bacteria. [23]. Peptidoglycan stabilises the cell wall. Gram-negative bacteria have thicker cell walls (50 to 100 molecules) than gram-positive bacteria (1 or 2 molecules). The peptidoglycan includes alternating N-acetylglucosamine and N-acetylmuramic amino sugars. [24] Cytoplasm creates peptiddoglycan precursors. A dipeptide completes the UDP-acetylmuramyl-pentapeptide synthesis (formed by racemization and condensation of L-alanine). UDP-acetylmuramyl-pentapeptide and UDP-acetylglucosamine release uridine nucleotides to form a polymer. Cross-linking requires extracellular transpeptidation. -Lactam antibiotics decrease peptididoglycan synthesis by breaking the lactamine –CO–N link and acylating transpeptidase. -lactams target penicillin-binding proteins. Penicillin-binding proteins synthesise peptididoglycan. [25] Penicillin kills bacteria lytically and nonlytically. H. influenzae, Neisseria meningitides, Streptococcus pneumoniae-effective. Small-scale activity targets Escherichia coli and Klebsiella. First-generation cephalosporins are weaker against staphylococci. Cefuroxime doesn't kill Bacillus fragilis, unlike cefoxitin, cefotetan, and cefmetazole. Cefuroxime can be given orally, intravenously, or intramuscularly to children and adults. [26] This medicine can cure meningitis caused by susceptible organisms, however cerebrospinal fluid concentrations are barely 10% of plasma. The most usually prescribed antibiotic, ceftriaxone, is better.

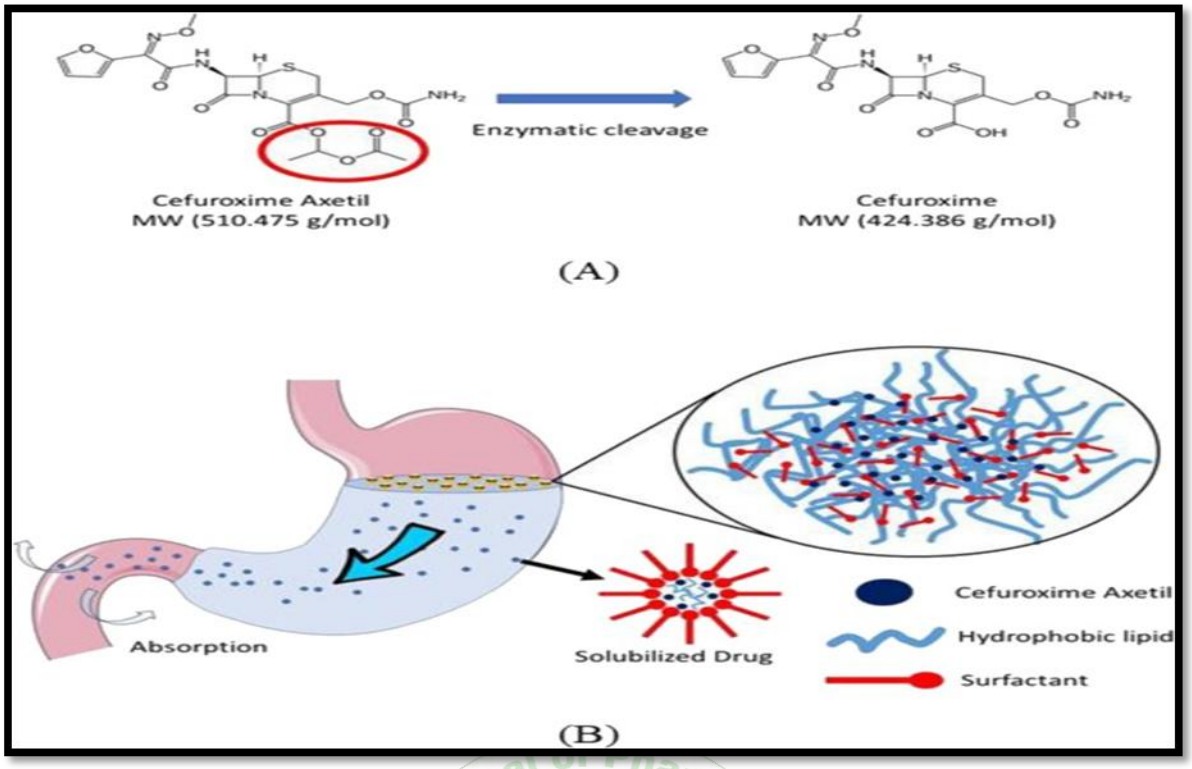

Figure: 2 Mechanism of Action

Pharmacokinetics of Cefueoxime Axetil

Children's pharmacokinetics of cefuroxime axetil suspension are similar to tablets. Cefuroxime axetil solution is less bioavailable than the tablet formulation, although the Cmax in paediatric patients receiving a 10- or 15-mg/kg dose is equivalent to the Cmax obtained for adults receiving a single 250-mg tablet. 20 mg/kg of cefuroxime axetil suspension is similar to a 500 mg tablet for adults. Our kids on 15 or 20 mg/kg cefuroxime axetil suspension had a Cmax similar to those on broken tablets in 85% sucrose [(27)]. Cmax and AUC rose correspondingly over 10-20 mg/kg. This is like adult cefuroxime axetil tablets. Twelve healthy people took 125, 250, 500, and 1,000 mg of cefuroxime axetil after a meal (3). Cefuroxime axetil dose affects Cmax linearly. Finn et al. (3) found that meals improved cefuroxime axetil absorption [28][29] Based on this facts, we chose to give cefuroxime axetil with milk or formula. Cefuroxime's MIC for 90% of 3-lactamase-positive Haemophilus influenzae and Moraxella (Branhamella) catarrhalis strains is 1.0 g/ml, while 90% of tested respiratory strains are below this dosage. [30]. Serum cefuroxime concentrations exceeding 1 ug/ml rose with dosage. Regardless of dose, cefuroxime's t1/2 was 1.4 to 1.9 h. This is longer than the t1/2s of cefaclor (42.5 min), cephalexin (0.98 h), and cephradine (1.0 h) in paediatric patients and the mean tl2 (1.1 to 1.4 h) for children receiving crushed cefuroxime axetil tablets[31]. Infants and children with otitis media and group A streptococcal pharyngitis take cefuroxime axetil twice daily. 10- or 15-mg/kg doses of cefuroxime axetil suspension yield serum cefuroxime concentrations similar to a 250-mg tablet, hence it may be useful twice day. Clinical studies show that twice-daily cefuroxime axetil suspension is helpful in healthy adults with mild to moderate infections caused by sensitive microorganisms [32]. Infants and children's blood lacked complete cefuroxime axetil. Cefuroxime axetil is hydrolyzed to cefuroxime quickly. Four kids' urine had intact cefuroxime axetil, although less than 0.1% of the dose. In children, cefuroxime axetil hydrolysis is fast, with little prodrug excreted unchanged. Unlike cefuroxime axetil, some antibiotic prodrugs are removed by the kidneys. In newborns and toddlers, chloramphenicol bioavailability after intravenous succinate varied.[33] 7 to 42% of the dose was unaltered chloramphenicol succinate.

Dosage and admistration

Upper and lower respiratory infections produced by susceptible bacteria last 7 to 10 days. Cefuroxime axetil is food-absorbable. Cefuroxime axetil needs greater CAP (usually 500mg twice daily). [34] US prescribing information lacks intravenous/oral cefuroxime axetil dosage. AECB patients in the UK receive intravenous or intramuscular cefuroxime 750mg twice daily for 2 to 3 days, then oral cefuroxime axetil 500mg twice daily for 7 days.[35] 1.5g twice-daily cefuroxime is followed by 500mg cefuroxime axetil for 7 days. 1g cefuroxime cures gonorrhoea. 500 mg twice a day for 20 days is recommended for early Lyme. In the UK, the recommended dosage of cefuroxime axetil tablet and suspension formulations for children aged 3 months with upper respiratory tract infections r impetigo is 125mg and 10 mg/kg twice daily, respectively; patients aged 2years with acute otitis media may require a higher dosage (usually 250mg and 15 mg/kg twice daily, respectively).[36] In the US, the recommended dosage for children >3 months with pharyngitis/tonsillitis is 125mg and 10 mg/kg twice daily in tablet and suspension forms; for acute otitis media, acute maxillary sinusitis, or impetigo, it's 250mg and 15 mg/kg twice daily. No treatment guidelines exist for Cefuroxime axetil in 3-month-olds.[37]

Clinical Applications

Even with the advent of advanced surgical procedures, SSIs remain a major postoperative complication. In this article, the evidence supporting use of cefuroxime is restricted to general surgery and limited to gastrointestinal, abdominal and urological surgeries.

Gastro-intestinal Surgery

A randomized study evaluating antibiotic effect of cefuroxime in 150 patients undergoing elective gastrointestinal surgery showed that a single preoperative dose of cefuroxime without addition of metronidazole can significantly reduce wound sepsis after surgeries involving the upper gastrointestinal tract.[38] However, the microbiological flora in the large bowel is predominantly anaerobic and in recto-colonic surgery metronidazole is undeniably more effective compared to cefuroxime. In line with the above study, a prospective randomized controlled trial (RCT) in patients undergoing gastric surgery compared single- dose systemic cefuroxime or intra-incisional cefuroxime versus a control group.[39] In this study, approximately 7% of the patients who received systemic cefuroxime developed wound sepsis with no cases of abscess or septicemia compared to those with intra-incisional cefuroxime (4% wound sepsis, 19% abscess and 4% septicemia) and control (35% wound sepsis, 29% abscess and 21% septicemia). Another randomized study demonstrated that administration of 1.5 g cefuroxime i.v. was effective in reducing wound sepsis following biliary surgery.[40] Further, a randomized, controlled, double-blind multicenter trial compared the prophylactic effect of a two-dose regimen of cefuroxime in patients undergoing biliary surgery who had a high risk of infection. No significant difference was found between one- and three-dose cefuroxime regimens in preventing postoperative wound infection.[41] Overall, data showed that one dose of short-acting agent preoperatively is as effective as a three-dose regimen to prevent major wound infections after biliary surgery. A prospective, randomized, double-blind study was undertaken to compare the prophylactic efficacy of ciprofloxacin and cefuroxime in 155 patients undergoing elective cholecystectomy. In this study, patients were randomly assigned to prophylactic cefuroxime, no antibiotic, prophylactic ciprofloxacin, or postoperative ciprofloxacin. [42,43,44]

Abdominal surgery

In a double-blind, placebo-controlled, RCT, the efficacy of a pre-operative single dose of cefuroxime (1.5 g) was assessed in 1234 patients for the prevention of SSIs after surgery for herniated disc over a 6-month period. Eight (1.3%) patients in the cefuroxime group and 18 patients (2.8%) in the placebo group developed SSIs (p=0.073). A diagnosis of spondylodiscitis or epidural abscess was made in 9 patients in the placebo group, but none in the cefuroxime group.[45][46]

Urological surgery

Prophylactic antibacterial therapy is recommended for urethral catheterization, endoscopy of the urinary tract, prostate biopsy, transurethral surgery, and selected open urologic procedures. 48 Most often, broad-spectrum cephalosporins and penicillins are used in these surgeries.[47] A systematic review including 28 trials comprising 4694 patients showed that prophylactic antibiotics significantly reduced the incidence of bacteriuria post-transurethral resection of prostate (RR: -0.17 [95% CI -0.20, -0.15]), high fever (-0.11 [-0.15, -0.06]), bacteremia (-0.02 [-0.04, 0.00]) and additional antibiotic treatment (-0.20 [-0.28, -0.11]). A RCT compared sulbactam-ampicillin and cefuroxime for prophylaxis of percutaneous nephrolithotomy and assessing optimal regimen for antibiotic maintenance to prevent systemic inflammatory response syndrome (SIRS). Incidence of SIRS was similar in sulbactumampicillin and cefuroxime groups (43.3% vs. 56.7%; p=0.44). [48] Further, a prospective randomized study in patients starting peritoneal dialysis showed no microbial growth in dialysis fluid during the postoperative period in patients who received prophylactic treatment of 1.5 g i.v. pre- and 250 mg i.p. perioperative cefuroxime compared to the control (no prophylactic antibiotic) group (30%, p=0.021). [49,50]

CONCLUSIONS

Cefuroxime axetil is a broad spectrum 13-1actam antibiotic. It has many approved indications, however, it is considered a second-line alternative. It is not the drug of choice for any infection, particularly those encountered in the field of obstetrics and gynecology. It is safe to use in pregnancy and has a low adverse effect profile, but due to its excessive acquisition cost and better therapeutic alternatives, it should be reserved for select cases.

REFERENCES

1. Harding MS, Williams PO, Ayrton J: Pharmacology of cefuroxime as the 1-acetoxyethyl ester in volunteers. Antimicrob Agents Chemother, 1984; 25:78-82.
2. Mandell GL, Petri WA: Antimicrobial agents: Penicillin, cephalosporins, and other]3-1actam antibiotics. In Hardman JG, Limbird LE (eds): Goodman and Gilman's The Pharmacological Basis of Therapeutics. 9th ed. New York: McGraw-Hill, 1996, pp 1074-1076.
3. Kees F, Lukassck U, Naber KG, Grobccker H: Com parative investigations on the bioavailability of cefuroxime axetil. Arzneim Forsch, 1999; 41:843-846.
4. Ginsburg CM, McCracken GH, Petruska M, Olson K: Pharmacokinetics and bactericidal activity of cefuroxime axetil. Antimicrob Agents Chemother,1985; 28:504-507.
5. Finn A, Straughn A, Meyer M, Chubb J: Effect of dose and food on the bioavailability of cefuroxime axetil. Biopharm Drug Dispos 1987; 8:519-526.
6. Mackay J, Mackie AE, Palmer JL, et al.: Investigations into the mechanism for the improved oral systemic bioavailability of cefuroxime from cefuroxime axetil when taken after food. Br J Clin Pharm 1992; 33:226 P-227P.
7. Foord RD: Cefuroxime: Human pharmacokinetics. Antimicrob Agents Chemother 1976; 9:741-747.
8. Perry CM, Brogden RN: Cefuroxime axetilmA review of its antibacterial activity, pharmacokinetic properties and therapeutic efficacy. Drugs 1996; 52:125-158.
9. Konishi K, Suzuki H, Hayashi M, Saruta T: Pharmacokinetics of cefuroxime axetil in patients with normal and impaired renal function. J Antimicrob Chemother 199331:413-420.
10. Glaxo Wellcome, Inc.: Cefuroxime Axetil. Package Insert. Research Triangle Park, NC: Glaxo Wellcome, Inc., 1995.
11. McEvoy GK, Litvak K, Welsh OH (eds): Cefuroxime axetil (monograph). In: American Hospital Formulary Service Drug Information. Bethesda, MD: American Society of Health System Pharmacist, 1997 pp 173-181
12. Neu HC, Fu KP: Cefuroxime, a [3-1actamase resistance cephalosporin with a broad spectrum of gram positive and negative activity. Antimicrob Agents Chemother 1978; 13:657-664,

13. Bradley JS, Kaplan SL, Klugman KP, Leggiadro RJ: Consensus: Management of infections in children caused by Streptococcus pneumoniae with decreased susceptibility to penicillin. Pediatr Infect Dis J,1995; 14:1037- 1041,.
14. Sweet RL, Gibbs RS: Antimicrobial agents. In: Infectious Diseases of Female Genital Tract. 3rd ed. Baltimore: Williams & Wilkins, 1995, pp 680-689
15. Vogel F, Droszcz W, Vondra V, Reisenberg K, Marr C, Staley H. Sequential therapy with cefuroxime followed by cefuroxime axetil in acute exacerbations of chronic bronchitis. J Antimicrob Chemother 1997;40(6):863-7
16. Awuchi, Chinaza Godswill, Ikechukwu Otuosorochi Amagwula, Priyanka Priya, Roshan Kumar, Umama Yezdani, and Mohammad Gayoor Khan. "Aflatoxins in foods and feeds: A review on health implications, detection, and control." *Bull. Environ. Pharmacol. Life Sci* 2020; 9:149-155.
17. Umama, Yezdani, G. Venkatajah, Rav Shourabh, Roshan Kumar, Arvind Verma, Ayush Kumar, and Md Khan Gayoor. "Topic-The scenario of pharmaceuticals and development of microwave as; sisted extraction technique." *World J Pharm Pharm Sci*,2019: 8(7):1260-1271.
18. Kumar, Roshan, Purabi Saha, Priya Lokare, Kunal Datta, P. Selvakumar, and Anurag Chourasia. "A Systemic Review of Ocimum sanctum (Tulsi): Morphological Characteristics, Phytoconstituents and Therapeutic Applications." *International Journal for Research in Applied Sciences and Biotechnology*, 2022; 9(2):221-226.
19. Roshan, Kumar. "Priya damwani, Shivam kumar, Adarsh suman, Suthar Usha. An overview on health benefits and risk factor associated with coffee." *International Journal Research and Analytical Review*, 2020; 7(2):237-249.
20. Sahana, Soumitra. "Purabi saha, Roshan kumar, Pradipta das, Indranil Chatterjee, Prasit Roy, Sk Abdur Rahamat." *A Review of the 2019 Corona virus (COVID-19) World Journal of Pharmacy and Pharmaceutical science*, 2020 ;(9):2367-2381.
21. Bind, Amit, Saumya Das, Veena D. Singh, Roshan Kumar, Anurag Chourasia, and Purabi Saha. "Natural Bioactives For The Potential Management Of Gastric Ulceration." *Turkish Journal of Physiotherapy and Rehabilitation* 32, no. 3.
22. Dubey, Anubhav, Priyanka Yadav, Preeti Verma, and Roshan Kumar. "Investigation of Proapoptotic Potential of Ipomoea carnea Leaf Extract on Breast Cancer Cell Line." *Journal of Drug Delivery and Therapeutics* 12, no. 1 (2022): 51-55.
23. Nyarko, Richard Owusu, Amit Prakash, Nayan Kumar, Purabi Saha, and Roshan Kumar. "Tuberculosis a globalized disease." *Asian Journal of Pharmaceutical Research and Development*, 2021; 9(1):198-201.
24. Raj, A., S. Tyagi, R. Kumar, A. Dubey, and A. C. Hourasia. "Effect of isoproterenol and thyroxine in herbal drug used as cardiac hypertrophy." *Journal of Cardiovascular Disease Research* (2021): 204-217.
25. Singh, Mukesh Kr, Ajay Kumar, Roshan Kumar, P. Satheesh Kumar, P. Selvakumar, and Anurag Chourasia. "Effects of Repeated Deep Frying on Refractive Index and Peroxide Value of Selected Vegetable Oils." *International Journal for Research in Applied Sciences and Biotechnology* (2022) ;93:28-31.
26. Sahana, Soumitra. "Roshan kumar, Sourav nag, Reshmi paul, Nilayan guha, Indranil Chatterjee. A Review on Alzheimer disease and future prospects." *World Journal of Pharmacy and Pharmaceutical science*,(2020) ;9(9): 1276-1285.
27. Sahana, Soumitra, Roshan Kumar, Sourav Nag, Reshmi Paul, Indranil Chatterjee, and Nilayan Guha. "A Review On Alzheimer Disease And Future Prospects." (2020).
28. Nyarko, R. O., P. Saha, R. Kumar, I. Kahwa, E. A. Boateng, P. O. Boateng, A. Christian, and A. Bertram. "Role of Cytokines and Vaccines in Break through COVID 19 Infections." *Journal of Pharmaceutical Research International*, (2021); 33:2544-2549.
29. Nyarko, Richard Owusu, Edward Boateng, Ivan Kahwa, and Paul Owusu Boateng. "A comparison analysis on remdesivir, favipiravir, hydroxychloroquine, chloroquine and azithromycin in the treatment of corona virus disease 2019 (COVID-19)-A Review." *World J. Pharm. Pharm. Sci* (2020); 9:121-133.
30. Kumar, Roshan, Purabi Saha, Priyatosh Pathak, Ramayani Mukherjee, Abhishek Kumar, and Rakesh Kumar Arya. "Evolution of Tolbutamide In The Treatment Of Diabetes Mellitus." *Jour. of Med. P'ceutical & Alli. Sci* 9.
31. Kumar, Roshan, Purabi Saha, Yogendra Kumar, Soumitra Sahana, Anubhav Dubey, and Om Prakash. "A Review on Diabetes Mellitus: Type1 & Type2." *World Journal of Pharmacy and Pharmaceutical Sciences* 9, no. 10 (2020): 838-850.
32. Daharia, Anju, Vinod Kumar Jaiswal, Kabya Pratap Royal, Himanshu Sharma, Anuj Kumar Joginath, Roshan Kumar, and Purabi Saha. "A Comparative review on ginger and garlic with their pharmacological Action." *Asian Journal of Pharmaceutical Research and Development* (2022) ; 10(3):65-69.
33. Kumar R, Jain A, Tripathi AK, Tyagi S. Covid-19 outbreak: An epidemic analysis using time series prediction model. In2021 11th international conference on cloud computing, data science & engineering (Confluence) 2021; 28:1090-1094). IEEE.
34. Kumar, Ayush. "The Scenario of Pharmaceuticals and Development of Microwave Assisted Extraction Techniques." (2019).
35. Saha, Purabi, Richard Owusu Nyarko, Priya Lokare, Ivan Kahwa, Paul Owusu Boateng, and Christian Asum. "Effect of Covid-19 in Management of Lung Cancer Disease: A Review." *Asian Journal of Pharmaceutical Research and Development*, (2022) ;10(3):58-64.
36. Kumar, Roshan, and Purabi Saha. "A Review on Artificial Intelligence and Machine Learning to Improve Cancer Management and Drug Discovery." *International Journal for Research in Applied Sciences and Biotechnology*,(2022) ; 9(3):149-156.
37. Kumar, S., S. P. Yadav, G. Chandra, D. S. Sahu, R. Kumar, P. S. Maurya, D. K. Yadav, V. JaiswaL, and K. Ranjan. "Effect of dietary supplementation of yeast (Saccharomyces cerevisiae) on performance and hemato-biochemical status of broilers." (2019): 15-19.
38. Mukkamala, Ramesh, Roshan Kumar, Sanjay K. Banerjee, and Indrapal Singh Aidhen. "Synthesis of Benzyl C-Analogues of Dapagliflozin as Potential SGLT2 Inhibitors." *European Journal of Organic Chemistry*, (2020); 9(3):1828-1839.
39. Anubhav, Saha Purabi Dubey, Kumar Dr Sanjay, and Kumar Roshan. "Evaluation of Enzyme Producing K. Pneumoniae and Their Susceptibility to Other Anti-Biotics." *International Journal of Innovative Science and Research Technology,2022;* 7(5):351-353.
40. Saha, P., Kumar, A., Bhanja, J., Shaik, R., Kawale, A. L., & Kumar, R. A Review of Immune Blockade Safety and Antitumor Activity of Dostarlimab Therapy in Endometrial Cancer. *International Journal for Research in Applied Sciences and Biotechnology*, 2022; *9*(3):201-209.
41. Kumar, Roshan, E. Keshamma, Shravan Kumar Paswan, Purabi Saha, Utkarsh Trivedi, Anurag Chourasia, and Mihir Otia. "Alkaloid Based Chemical Constituents of Ocimum santum & Cinchona Bark: A Meta Analysis." *Journal for Research in Applied Sciences and Biotechnology* ,(2022) ; 1(2):35-42.
42. Singh, Yogendra, Shravan Kumar Paswan, Roshan Kumar, Mihir Kedarbhai Otia, Smita Acharya, Devinder Kumar, and E. Keshamma. "Plant & Its Derivative Shows Therapeutic Activity on Neuroprotective Effect." *Journal for Research in Applied Sciences and Biotechnology*, (2022) ;1(2):10-24.