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DEVELOPMENT OF SUSTAINED RELEASE MATRIX TABLET USING NATURAL POLYMER: A COMPREHENSIVE REVIEW

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ABSTRACT

By releasing medications over an extended period of time, sustained release drug delivery systems (SRDDS) improve therapeutic efficacy and minimize side effects and frequent dosing. These systems work well for medications with short half-lives or low solubility, offering continuous therapeutic advantages. Drug solubility, molecular size, rate of absorption, and metabolism all play a role in their design. Diffusion-based release, dissolution control, pH-sensitive systems, and osmotic pressure systems are common tactics that often make use of polymers. These systems are formed via production methods like granulation and extrusion. Constant medication levels, decreased patient compliance, and fewer adverse effects are benefits. Problems include sudden drug release (dose dumping), patient variability, and performance differences between the lab and the real world continue to exist. SRDDS keeps pushing for safer drug delivery methods in spite of all these challenges

KEYWORDS: Sustained release, Polymers, Formulation approaches.

INTRODUCTION

With sustained-release drug delivery systems, fewer dosages are given because the medication is released gradually. This improves the drug's efficacy, reduces adverse effects, and yields a predictable result. Because they make use of innovative methods and technology like polymers, these systems are safer and more effective, especially for medications with short half-lives or poor solubility.[1,2,3]

Long-acting medications reduce medication side effects and provide benefits to the patient under the pretense of comfort, convenience, and reduced discomfort and are beneficial to the medical community. Conventional dose forms are progressively being replaced by more modern drug delivery methods including sustained and controlled-release dosing. The matrix system is a controlled, prolonged-release medication dispersion or dissolution method. The oral route is the most widely used drug delivery mechanism since it is the most practical and affordable.[4, 5, 6]

The goals of extended-release drug delivery systems are to maximize a medicine's biopharmaceutical, pharmacokinetic, and pharmacodynamic qualities, minimize adverse effects, and administer the least amount of a medication to the body for maximal benefit. They distribute medications equally, deliver them to the site of action, minimize dosages, and regulate their release without requiring complex production procedures. Oral sustained-release dose forms include membrane-controlled systems, osmotic systems, and various matrices including water-soluble or insoluble polymers or waxes.[7,8,9,10]

Ideal characteristics of a drug delivery system[11]

1. It need to be economical.
2. It needs to be dependable and safe.
3. The patient must find it easy to administer.
4. It must improve the medication's bioavailability.
5. It should avoid the healthy host tissue and deliver the medication intact to the action site.

Rationale for development for the development of SRDDS[19]

1. To reduce the frequency of dosing.
2. Reduce fluctuations in plasma levels.
3. Use drugs more frequently.
4. Extend the medication's duration of effect.
5. Less negative effects.

Factors governing the design of sustained release dosage form

There are two factors involved

1. Physiochemical factors

a) Aqueous solubility

Even though most drugs are weak acids or bases, it can be challenging to incorporate them into continuous-release systems. High drug concentrations in blood may be caused by the easy solubility of highly soluble drugs in water or gastrointestinal fluid, which causes the release of their dosage form in a burst. It is difficult to incorporate such drugs into the dosage form and retard drug release, especially at high doses. Because pH fluctuates during the formulation, pH-dependent solubility increases the difficulty of continuous-release formulations, particularly in the physiological pH range.

B) Partition coefficient

The partition coefficient (P (o/w)) measures the drug's bioavailability in an oil phase in comparison to an adjacent aqueous phase. It displays the extent to which the medication can cross the biological membrane that is lipophilic. medications with lower partition coefficients cannot be used with oral CR drug delivery systems, whereas medications with larger partition coefficients cannot be used with oral SR drug delivery systems.[21]

c) Drug pKa and ionisation

Drugs that are mostly administered in ionized form are not appropriate for systemic sustained-release drug delivery systems. Unionized drug absorption is excellent, but ionized medicine penetration is poor since the plasma drug's absorption rate is roughly three to four times lower than that of the unionized drug. The pKa range for acidic medications with pH-sensitive ionization is roughly 3.0–7.5 for optimal positive absorption, whereas the pKa range for basic drugs with pH-sensitive ionization is roughly 7.0–11.0. There will be 0.1% to 5.0% unionization of medications at the site.[21]

d) Diffusion and molecular size

Diffusivity is influenced by the membrane's shape and pore size. The diffusion coefficient of a flexible polymer is 10-6 10-9 cm2/sec, while that of an intermediate molecular weight medication ranges from 100 to 400 Daltons. Drugs with molecular weights more than 500 Daltons typically have a diffusion coefficient of less than 10-12 cm2/sec in most polymers. Among the medications whose release rate from the dosage form is difficult to regulate are proteins and peptides.[21]

2. Biological factors

a) Absorption

Maintaining a steady drug concentration can be aided by even continuous release and absorption of oral sustained release systems (SR). Fully absorbed drugs having a maximum half-life of three to four hours should be released by the ideal system. Water solubility, a small partition coefficient, protein binding, acid hydrolysis, and metabolism could all contribute to this, although substances with lower absorption rate constants are not preferred choices. Additionally, drugs involving substantial metabolism and those with a high visual volume of distribution are not appropriate for SR DDS. Drugs that undergo metabolic prior to absorption may exhibit decreased bioavailability from sustained-release systems.[22]

b)Distribution

Since this may limit drug equilibrium with extravascular tissue and blood and lower drug concentration in the blood, drug clearance kinetics are the distribution of drug molecules within cells and tissue. Due to their biological inactivity, protein-bound medications have long-lasting positive effects. The idea of volume of distribution is a crucial proportionality constant used in the creation of continuous release products.[23,25]

c)Metabolism

Numerous enzymes are used in the metabolism of drugs in various tissues. If drugs with delayed dose forms go through a lot of processing in the lumen or gut before being absorbed, their bioavailability may be lower. Enzyme-sensitive compounds can be employed as prodrugs. Drugs that encourage or inhibit the creation of enzymes are not recommended because the SR delivery system keeps blood levels steady. Drugs whose bioavailability vary because of intestinal metabolism should not be used.[23,24]

d) Side effects

Changes in plasma concentrations are the primary cause of drug adverse effects. Controlling concentration within the therapeutic range is one way to lessen these effects. SR drug administration, which includes controlled release techniques, is commonly employed for local gastrointestinal side effects.[23]

The ideal medication characteristics for SRDDS [26]

1. It must be steadily and effectively absorbed orally in the gastrointestinal tract's fluid.
2. Drugs having short half-lives (2-4 hours), including captopril and salbutamol sulphate, are the ideal candidates for formulation into SR dosage forms.
3. The minimum dose should not be less than 0.5 g, and the maximum drug dosage for producing SRDDS is 1.0 g, such as metronidazole.
4. The therapeutic range of the drug should be sufficiently wide, according to SRDDS, to guarantee that variations in release do not cause concentrations to rise over the minimally dangerous thresholds.

Challenges of SRDDS[27,28]

- **Dose dumping**

It might significantly raise a drug's levels in the body, which could result in toxicity from an overdose or negative side effects. Dose dumping occurs when a sustained-release formulation gradually delivers an abnormally large amount of medication. Dumping doses can be fatal for a medication that works well but has a low therapeutic index, such as phenobarbital. Limited ability to choose the unit's optimal dosage.

- **Limited capacityto select the ,ost suitable Dosage for the unit**

Dosage changes are quicker for conventional dose forms, like pills, which can be divided into two equal halves. However, with sustained release dose formulations, this can seem like a far more difficult problem. In a scattered dose form, the sustained-release characteristics can be lost.

- **A poor link between in vivo in vitro**

The rate of drug release is constantly decreased in sustained-release dosage forms in order to achieve drug release, possibly over a wide region of the gastrointestinal system. As a result, the so-called "Absorption window" becomes significant and leads to inadequate drug absorption in vivo, even if it has outstanding in-vitro release qualities.

- **Individual difference among patients**

Individual differences may exist in the amount of time needed for the drug released from the dose form to be absorbed. Each patient is unique in terms of how long they remain in the gastrointestinal tract, whether they eat or not, and whether they take other medications concurrently.

This also affects the patient's clinical reaction.

Criteria for selection of SRDDS[29,30]

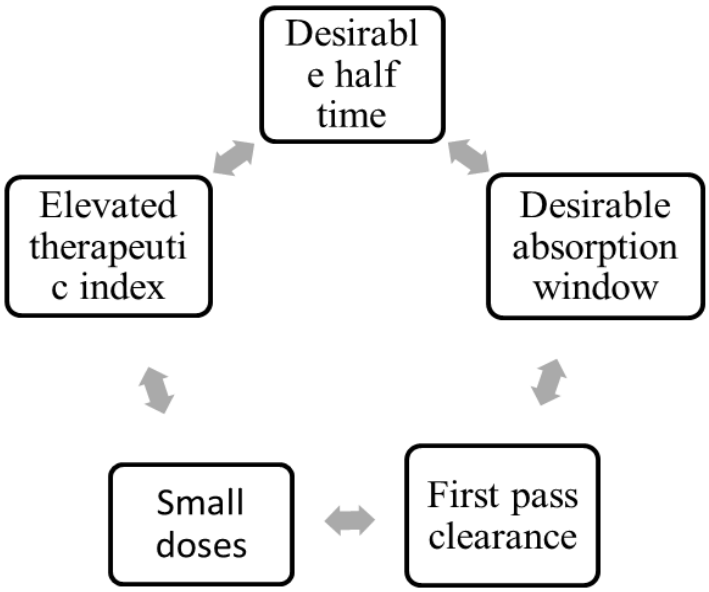
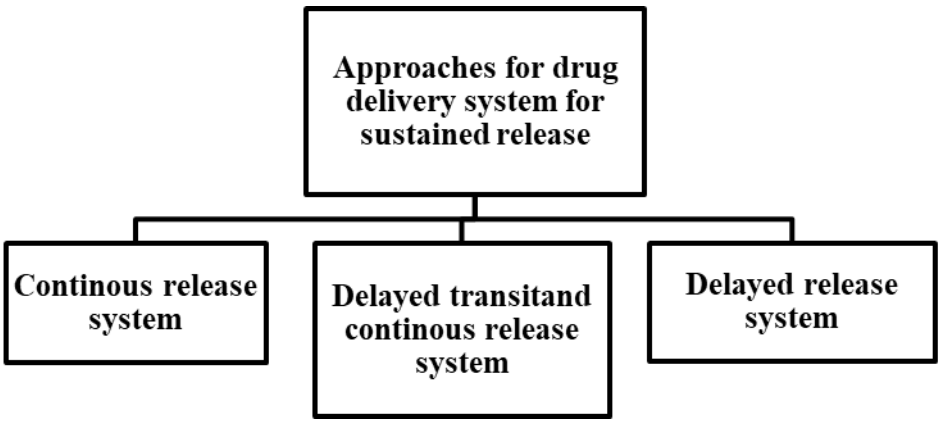


Table 1. Poymers used in a sustained release drug delivery system.[31,32]

Sr no.	Polymers	Examples
1.	Natural polymers	Guar gum, Tragacanth, Gum Arabic
2.	Hydrogels	Polyhydroxy ethyl methyl acrylate (PHEMA), Polyethylene oxide (PEO)
3.	Soluble polymers	Polyethylene glycol (PEG), Polyvinyl pyrrolidone (PVP)
4.	Bio degradable	Polyvinyl chloride (PVC), polyglycolic acid (PGA)
5.	Non biodegradable	Polylactic acid (PLA), Polyglycolic acid (PGA)
6.	Mucoadhesive polymers	Ethyl cellulose, sodium carboxymethyl cellulo

Approaches for sustained release drug dlivery system[33-39]



1. Continous release System:

The various systems that fall under this category include: [40] Dissolution-controlled release systems; Diffusion-controlled release systems; Dissolution and diffusion-controlled release

systems; Ion exchange resin drug complexes; pH-dependent formulations; and Osmotic pressure-controlled systems. The continuous release system releases the medication for a prolonged period of time along the entire length of the gastrointestinal tract by normal transportation of the dosage type.

Dissolution-controlled release systems

- Diffusion-controlled release systems.
- Dissolution and diffusion-controlled release system
- Ion exchange resin drug complexes
- pH-dependent formulation
- Osmotic pressure-controlled system.

a) Diffusion-controlled release systems.

Dissolution-controlled release systems are easy to build and can be classified as either matrix or reservoir. Matrix systems, which are made of waxes like beeswax, carnauba wax, and hydrogenated castor oil, regulate the release of medications by changing the fluid penetration into the matrix. They have first-order kinetics. Reservoir systems use microencapsulation techniques to encapsulate drug particles with slowly dissolving materials including cellulose, waxes, and polyethylene glycol. These units can be enclosed in capsules or crushed into tablets. The rate of medication degradation is significantly influenced by the thickness and solubility of the coating.[34]

b) Diffusion-controlled release system

Systems for diffusion-controlled release In diffusion release models, the diffusion of a dissolved drug across a polymeric membrane is a rate-limiting stage. The drug release rate in this system does not follow zero-order kinetics, even if the diffusional channel lengthens over time as the insoluble matrix gets drug-depleted.[35]]

Drug molecules travel from areas with greater concentrations to those with lower concentrations during the diffusion process. Fick's law, J = -Ddc/dx, defines the drug's flow across a membrane in decreasing concentration. The medication must permeate through water-insoluble membranes. The formula for calculating the drug release rate is dm/dt=ADKΔ C/L, where A stands for area, K for partition coefficient, L for diffusion route length, and ΔC for concentration differential across the membrane.[36]

c) Dissolution and diffusion-controlled release system

In this kind of gadget, the medication is membrane-coated and somewhat soluble in water. The membrane dissolves, creating pores that allow aqueous media to pass through. This phenomenon leads to drug dissolution in the membrane and subsequent drug diffusion out of the system. One example of this kind of coating is combining ethyl cellulose with PVP or methyl cellulose.[37]

d) Ion exchange resin drug

Complex resins are compounds with cationic and anionic groups that are insoluble in water. When there is an excess of Na+ and Cl- in the gastrointestinal tract, a drug-resin complex that was previously formed by prolonged drug exposure is released. Medication is released from the resin-resin complex using this system's water-insoluble cross-linked molecules of polymer.[38]

e)ph-dependent formulation

Dosage forms are created with a sufficient amount of a buffering agent, such as phosphoric, citric, or tartaric acid salt, because some drugs change the pH of the gastrointestinal tract during absorption and dissolution in the GIT. These salts lower the pH to the proper level while the dosage form moves through the digestive system. Permeable coating agents are applied to the medication and buffer in the dosage form, allowing the aqueous medium to enter and preventing the tablets from spreading.

f)Osmotic pressure controlled-release system

These devices, also known as Oros, use the osmotic pressure mechanism to release the medication at a steady zero-order pace. A reservoir is created by covering the medication and osmotic agent, like mannitol or KCl, with a semipermeable membrane. A tiny hole in the dosage form that allows water to enter the reservoir causes the dissolved medication to pump out at a specific rate due to osmotic pressure. The drug's release from the reservoir is unaffected by conditions in the GIT. The amount of drug released depends on the stability of the drug, the osmotic properties of the core, the membrane's permeability, the semipermeable membrane's thickness, and the size of the aperture.[34, 41]

2. Delayed transit and continuous release system

These mechanisms develop to extend their stay in the GI tract along with their release. Since the pH of the stomach tends to remain there, the drug contained in the dosage form should be able to adjust to it. This group of systems includes mucoadhesive and size-based systems.

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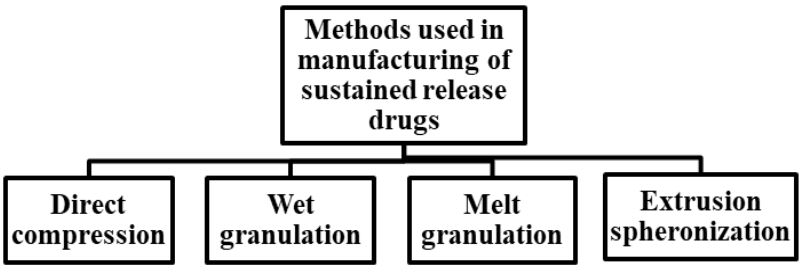
Methods of Formulation of Sustained Release Drugs[43-56]



1. Direct compression

This technique directly compresses powdered materials without altering the chemical or physical properties of the medication.

2. Melt granulation

In a porcelain dish, melt the drug, add the excipient, separate, run through 22 meshes, and then resift. During grinding, 15% to 20% of the weight is removed. Particles are mixed with talc and magnesium stearate to create a mixture of fines and granules.

3. Extrusion spheronisation

Materials such as food preparation ingredients, Ayurvedic remedies, or medications are spheronized and extruded into pellets using a spheronizer. The extrudate turns into cylinders after the particles are eventually coated into spheres. After that, the pellets are dried for 24 hours at 40±2°C. Powdered lubricant, filler, and the medical field are all used in the process.

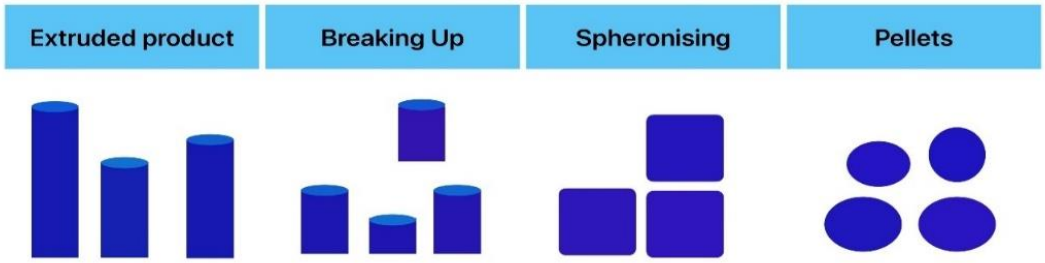


Fig.2: Different Steps Involved in The Extrusion-SpheronizationProcess [70]

14.Marketed Formulations Available

Table no.3 Marketed Formulations Available. [71]

Brand name	Drug	Manufacture
A-Fenac SR	Diclofenac sodium	ACME Laboratories Ltd.
Anafelx SR	Naproxen sodium	ACILimited
Anril SR	Nitro-glycerine	Square PharmaceuticalLtd.
ArofilSR	Theophylline	InceptPharmaceuticals Ltd.
Bucod SR	Butamiratecitrate	SharifPharmaceuticals Ltd.
CardizemmSR	DiltiazemHCl	Drug InternationalLtd.
DiaMSR	MetforminHCl	Medimet PharmaceuticalsLtd.
LithinSR	Lithium Carbonate	Albion Laboratories Ltd.
SultionSR	Salbutamol	SquarePharmaceutical Ltd.

CONCLUSION

Significant improvements in drug delivery, stable therapeutic levels, less side effects, and patient compliance are offered by sustained release drug delivery systems (SRDDS). Low solubility and short half-lives are addressed by new paradigms such as polymer-based models and controlled-release methods. Despite shortcomings like dose dumping, SRDDS is improving as research advances. These systems revolutionize drug delivery for focused, safer, and more effective therapies addressing a variety of medical requirements by optimizing absorption, metabolism, and physiochemical characteristics. They also provide dependable and affordable options.

REFERENCES

1. Kumar KS, Bhowmik D, Srivastava S, Paswan S, Dutta AS. Sustained release drug delivery system potential. The pharma innovation, 2012 Apr 1; 1(2).
2. VHL L. Controlled Drug Delivery-Fundamentals and Applications. New York, NY, Marcel Dekker, Incorporated, 1987.
3. Wagner JG. A modern view of pharmacokinetics. Journal of pharmacokinetics and biopharmaceutics, 1973 Oct; 1(5): 363-401.

4. Parashar T, Soniya SV, Singh G, Tyagi S, Patel C, Gupta A. Novel oral sustained release technology: A concise review. Int J Res Dev Pharm Life Sci., 2013 Feb; 2(2): 262-9.
5. Agarwal G, Agarwal S, Karar PK, Goyal S. Oral sustained release tablets: an overview with a special emphasis on matrix tablet. American journal of advanced drug delivery, 2017; 5(2): 64-76.
6. Alli PR, Bargaje PB, Nilesh SM. Sustained Release Drug Delivery System: A Modern Formulation Approach. Asian journal of pharmaceutical technology and innovation, 2016; 4(17): 108-18.
7. Kumar KS, Bhowmik D, Dutta A, Paswan S, Deb L. Recent trends in scope and opportunities of controlled release oral drug delivery systems. Crit Rev Pharm Sci., 2012; 1: 20-33.
8. Vamsy KA, Srinath KR, Chowdary PC, Palanisami P, Vijayasanker GR. Formulation development and evaluation of Divalproex sodium extended-release tablet. International Journal of Research Pharmaceutical and Biomedical Science, 2011; 2(1): 809-32.
9. Patel H, Panchal DR, Patel U, Brahmbhatt T, Suthar M. Matrix type drug delivery system: A review. J Pharm Sci Biosci Res., 2011 Nov; 1(3): 143-51.
10. Kumar KS, Bhowmik D, Srivastava S, Paswan S, Dutta AS. Sustained release drug delivery system potential. The pharma innovation, 2012 Apr 1; 1(2).
11. Misal R, Atish W, Aqueel S. Matrix tablet: A Promising Technique for Controlled drug delivery. Indo American Journal of Pharmaceutical Research, 2013; 3.
12. Patel KK, Patel MS, Bhatt NM, Patel LD, Pathak NL, Patel KJ. An overview: extended release matrix technology. Int J Pharm Chem Sci., 2012; 1(2): 828-43.
13. Patel Chirag J, Satyanand T. Novel sustained release drug delivery: A modern review. International Journal of Applied Pharmaceutics, 2014; 1: 115-9.
14. Ghorab MA, Khafagy EL, Kamel MA, Gad SH. Formulation, characterization, and comparative in vitro and in vivo evaluation of sustained release theophylline tablets. International Journal of Pharmacy and Pharmaceutical Sciences, 2012; 4(3): 721-8.
15. Wadher SJ, Mehtre SB, Kalyankar TM, Tiprale PS. Recent (Aspects) trend on sustained drug delivery systems. System, 2013; 7: 9.
16. Bose S, Kaur A, Sharma SK. A Review on Sustained Release Drug Delivery System. International Research Journal of pharmacy, 2013; 149-515.
17. Kumar Sampath KP, Bhowmik D, Srivastava S. Sustained release drug delivery system potentials. International Journal of Pharmaceutics, 2010; 2: 751-4.

18. Parashar T, Soniya SV, Singh G, Tyagi S, Patel C, Gupta A. Novel oral sustained release technology: A concise review. Int J Res Dev Pharm Life Sci., 2013 Feb; 2(2): 262-9.
19. Pundir S, Badola A, Sharma D. Sustained release matrix technology and recent advances in matrix drug delivery system: a review. Int J Drug Res Tech., 2013; 3(1): 12-20.
20. Garg C, Saluja V. Once-daily sustained-release matrix tablets of metformin hydrochloride based on an enteric polymer and chitosan. Journal of pharmaceutical education and research, 2013 Jun 1; 4(1): 92.
21. Dm B, Sb J. Biopharmaceutics and Pharmacokinetics, Vallabh Prakashan.
22. Ratnaparkhi MP, Gupta Jyoti P. Sustained release oral drug delivery system-an overview. Terminology, 2013; 3(4): 10-22270.
23. Khar RK, Vyas SP. Controlled drug delivery concept and advances. Ist Edition, 2002; 442-3. 24. Khalane L, Alkunte A, Birajdar A. Sustained release drug delivery system: a concise review. Pharma tutor: pharmacy infopedia, 2016.
24. Ankit B, Rathore RP, Tanwar YS, Gupta S, Bhaduka G. Oral sustained release dosage form: an opportunity to prolong the release of drug. IJARPB., 2013 Jan 1; 3(1): 7-14.
25. Misal R, Atish W, Aqueel S. Matrix tablet: A Promising Technique for Controlled drug delivery. Indo American Journal of Pharmaceutical Research, 2013; 3.
26. Deore R, Kavitha K, Tamizhmani T. Preparation and evaluation of sustained release matrix tablets of tramadol hydrochloride using glyceryl palmitostearate. Tropical Journal of Pharmaceutical Research, 2010; 9(3).
27. John C., Chris M., Modified–Release Oral Dosage Form. In: M.E. Aluton's Pharmaceutics – The Science of Dosage Form Design, International Journal of Pharmaceutics, 2003; 296-298.
28. Jun C, Haesun P, Kinam P. Super Porous Hydrogels as a Platform for Oral Controlled Drug Delivery. Handbook of Pharmaceutical Controlled Release Technology, 2000; 211-6.
29. Dash S, Murthy PN, Nath L, Chowdhury P. Kinetic modelling on drug release from controlled drug delivery systems. Acta Pol Pharm., 2010 May 1; 67(3): 217-23.
30. Jain S, Yadav SK, Patil UK. Preparation and evaluation of sustained release matrix tablet of furosemide using natural polymers. Research journal of pharmacy and technology, 2008; 1(4): 374-6.
31. Marroum PJ. Bioavailability/Bioequivalence for Oral controlled release products, Controlled release drug delivery systems: Scientific and Regulatory Issues. Fifth www.wjpps.com | Vol 14, Issue 5, 2025. | ISO 9001:2015 Certified Journal |

15International Symposium on Drug Development, East Brunswick, NJ., 1997 May 15; pp. 15-25.

32. Modi SA, Gaikwad PD, Bankar VH, Pawar SP. Sustained release drug delivery system: a review. International Journal of Pharma Research and Development, 2011 Feb; 2(12): 147-60.
33. Brahmankar DM, Jaiswal SB. Biopharmaceutics and pharmacokinetics. Vallabh Prakashan, 2019 May 24.
34. Kumar AR, Aeila AS. Sustained release matrix type drug delivery system: An overview. World J. Pharm. Pharm. Sci., 2019 Oct 24; 9: 470-80.
35. Wise DL. Handbook of Pharmaceutical Controlled Release Technology. CRC Press, 2000 Aug 24.
36. Kumar S, Kumar A, Gupta V, Melodia K, Rakha P. Oral extended-release drug delivery system: A promising approach. Asian Journal of Pharmacy and Technology, 2012; 2(2): 38-43.
37. Lee VH. Controlled drug delivery: fundamentals and applications. CRC Press, 1987 Jan 30.
38. Ratnaparkhi MP, Gupta Jyoti P. Sustained release oral drug delivery system-an overview. Terminology, 2013; 3(4): 10-22270.
39. Pasha SS. Pharmacoeconomic Analysis of Antihypertensive Drugs and Evaluation of Quality of Life of Patients on Antihypertensive Drug Therapy (Doctoral dissertation, Rajiv Gandhi University of Health Sciences (India)).
40. Pogula M, Nazeer S. Extended-release formulation. Int J Pharm Tech., 2010 Dec; 2(4): 625-84.
41. Harsh M. The kidney and lower urinary tract. Textbook of Pathology, 6th edition, Jaypee Brothers Medical Publishers, 2000; 2: 649-54.
42. Ratnaparkhi MP, Gupta Jyoti P. Sustained release oral drug delivery system-an overview. Terminology, 2013; 3(4): 10-22270.
43. Dash TR, Verma P. Matrix tablets: An approach towards oral extended-release drug delivery. International Journal of Pharma Research & Review, 2013 Feb; 2(2): 12-24.
44. Patel H, Panchal DR, Patel U, Brahmbhatt T, Suthar M. Matrix type drug delivery system: A review. J Pharm Sci Biosci Res., 2011 Nov; 1(3): 143-51.
45. Manish J, Abhay K. Sustained release matrix type drugdelivery system: a review. Journal of Drug Delivery & Therapeutics, 2012; 2(6): 142-8.

46. Alli PR, Bargaje PB, Nilesh SM. Sustained Release Drug Delivery System: A Modern Formulation Approach. Asian journal of pharmaceutical technology and innovation, 2016; 4(17): 108-18.
47. Mishra S. Sustained release oral drug delivery system: a concise review. Int J Pharm Sci Rev Res., 2019; 54: 5-15.
48. Karvekar M, Khan AB. A brief review of sustained release matrix-type drug delivery systems. Journal of Pharmaceutical Research, 2017 Jul; 16(3): 282-9.
49. Gupta MM, Ray B. A review on: sustained release technology. International Journal of Therapeutic Applications, 2012; 8(1): 18-23.
50. Nikita J. Thakar, Dr. Mukesh R. Patel, Dr. Kanu. R. Patel, Dr. Alpesh D. Patel, A Review on Sustained Release Technology Drug Delivery System; International Journal of Pharmaceutical Research and Bio-Science, Apr 2017; 6(2): 75-92.
51. Brahmankar DM, Jaiswal SB. Biopharmaceutics and pharmacokinetics. Vallabh Prakashan, 2019 May 24.
52. Lee VH. Controlled drug delivery: fundamentals and applications. CRC Press, 1987 Jan 30.
53. Bansal BK, Shakya V, Rewar S. A New Trend in Oral Sustained Release Technology. Asian Journal of Pharmaceutical Research and Development, 2014 Mar 1; 91-5.
54. Robinson J, Lee VH. Controlled drug delivery: fundamentals and applications. CRC Press, 1987 Jan 30.
55. Bajdik J, Pintye-Hódi K, Planinšek O, Regdon Jr G, Srčič S, Erős I. Film coating as a method to enhance the preparation of tablets from dimenhydrinate crystals. International journal of pharmaceutics, 2004 Jan 28; 269(2): 393-401
56. Yadav N, Verma A. Pharmaceutical pellets: a versatile carrier for oral controlled delivery of drugs. Indian J. Pharm. Educ. Res., 2016 Jul 1; 50(3): S146-60. 58. Pachori, A., Joshi, A., Kumar, K., Ikram, I., & Rajput, V. (2023).