INTERNATIONAL JOURNAL OF PHARMACEUTICAL SCIENCES
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: https://www.ijpsjournal.com

OPEN ACCESS

Review Article

A Comprehensive Review of Matrix Tablets and Assessment Techniques

Chetan Patil*[1], Rohini Patil[2], Ajit Patil[3]

[1,2] Department of Pharmaceutics, SNJB's SSDJ College of Pharmacy, Chandwad 423101
[3]Department of Pharmaceutics, Prof. Ravindra Nikam College of Pharmacy, Gondur, Dhule 424001.

ARTICLE INFO

Published: 13 Mar. 2025
Keywords:
Sustained release tablets, Polymer, Systems, Bioavailability
DOI:
10.5281/zenodo.15014891

ABSTRACT

Matrix with sustained release tablets have changed the way of drug delivery by exhibiting controlled release of drugs, increasing therapeutic effect, and improving compliance of the patient. The systems decrease frequency of dosing, reduce side effects, and provide stable drug levels in the body, which are a mainstay of contemporary pharmaceutical science. This review provides an overview of the matrix tablets with regard to their classification into hydrophobic, hydrophilic, lipid, and biodegradable matrices, as well as mechanisms of drug release, viz diffusion, dissolution, and erosion. Various polymers such as cellulose derivatives, hydrogels, and biodegradable materials are examined critically with respect to how they can shape release profiles. Evaluation methods of sustained released tablets such as dissolution testing, assay, stability tests, and bioavailability studies are outlined to guarantee the safety and efficacy of these formulations. Although matrix tablets have many positive factors, e.g., cost effective and flexibility, drawbacks such as dose dumping and formulation complexity exist. It also describes the physicochemical and biological factors controlling drug release, as well as the criteria for the selection of perfect drugs for sustained-release systems. Combination of advances in polymer science and hybrid technologies, matrix tablets are continually enhancing as a patient-focused drug delivery system. The purpose of this review is a guidance for learners, researchers and industry experts in developing matrix-based drug delivery systems.

INTRODUCTION

Long-acting drug delivery systems have revolutionized the realm of pharmaceutical science, leading to enhanced therapeutic efficacy, minimized side effects and elevated patient compliance. These provide a sustained systemic supply of the drug, keeping the concentration in the body at a constant level for extended periods and decreasing dosing frequency, allowing for better disease control. In the past few decades, sustained release formulations have attracted a lot of attention due to the high cost of developing new drugs, expiration of existing patents, the discovery of new polymer materials that can help to control the release of drugs, and the improvement in the

***Corresponding Author:** Chetan Patil
Address: *Department of Pharmaceutics, SNJB's SSDJ College of Pharmacy, Chandwad 423101*
Email ✉: cchetanppatil91@gmail.com
Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

therapeutic efficiency and safety of these formulations.

There are many different types of sustained release formulations, and among the most common are matrix tablets, owing to their simplicity, straightforward manufacture and moderate expense, as well as the ability to achieve high drug loads. These types of tablets can release drugs (hydrophilic or hydrophobic matrix systems) through diffusion or polymer dissolution (e.g. biodegradable polymers like HPMC). The oral route still dominates the market for sustained release formulations with maintenance of plasma drug levels to alleviate unwanted side effects in comparison to a conventional dosage form. The advancement in polymer science also further increases the technological viability of these systems at the expense of high costs in new drug development and patenting issues. [1,2]

Classification of Matrix Tablets [3,1]

Depending on the types of retardant materials used for matrix tablets production they are classified into:

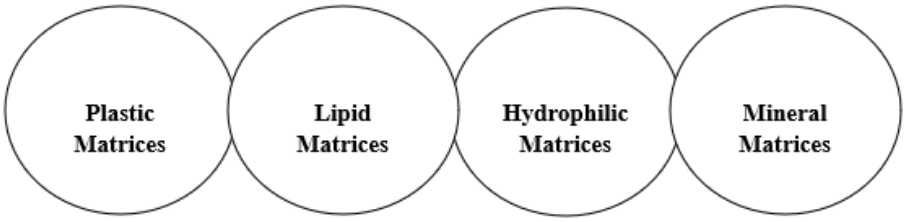

Figure 1: Classification of Matrix Tablets

1. Plastic (Hydrophobic) Matrices

Sustained-release system: hydrophobic matrices comprising drug and inert, water-insoluble polymers. viz polyethylene, polyvinyl chloride (PVC), and acrylate copolymers, which do not dissolve in aqueous solutions. This matrix of microscopic pores develops as fluid migrates in the polymer structure and diffusion occurs to drug release. The matrix should be able to absorb fluid and enable diffusion for controlling the rate of the drug release. These matrices show resistant to degradation in gastric fluids.

2. Lipid Matrices

Waxes and other lipid-based materials comprise lipid matrices. Drug is released via the simultaneous processes of diffusion through the pores along with erosion of the lipid material. The composition of the digestive juices determines the release characteristics, which makes these matrices very suitable for gastric sensitive drugs.

3. Hydrophilic Matrices [2,5]

Hydrophilic matrices incorporate the drug into water-loving polymers (also called gelling agents), which swell in the presence of water. These matrices are commonly explored for oral controlled drug delivery because of being economical, regulatory acceptance, and can attain the preferable release rate. Hydrophilic matrices can be classified into three subtypes depending upon the type of polymers used:

Cellulose Derivatives: Common polymers include hydroxypropyl methylcellulose or HPMC, hydroxyethyl cellulose and sodium carboxymethyl cellulose (SCMC)

4. Mineral Matrices

Depending on the pore structure and actuation dynamics, these matrices, derived from seaweed (e.g. alginate) or mineral (e.g. cellulose)-based polymers, supply unique drug release mechanisms:

Microporous Systems: Less dense, with larger pore sizes (0.1–1 μm) which allow drug molecules to diffuse readily.

Microporous Systems: Having small pores (50–200 nm) specific for molecular diffusion.

Non-Porous Systems: Lacking pore structures and relying on the molecular diffusion within the polymer network [3,6]

Advantages of Sustained-Release Matrix Systems:

1. conventional processes
2. Versatile, effective and low cost

3. Huge molecular weight compounds can also be made to release
4. Unlike reservoir and osmotic systems, product based on matrix design can be manufactured using conventional processes and equipment. [7]
5. It decreases dosing frequency; hence compliance is enhanced in a patient.
6. Decreases fluctuation in plasma drug levels for stable therapeutic effects.
7. Improves drug utilization by maintaining consistent drug release.
8. Reduce the side effects of peak plasma drug concentrations.
9. Physicochemical drug selection parameters: Molecular size: < 1000 Daltons Aqueous solubility: > 0.1 mg/mL (pH 1–7.8)
10. Partition Coefficient: High
11. Absorption mechanism: Diffusion
12. Absorbability: Throughout GI tract
13. Release: Independent of pH and enzymes [8,9,10,11]

Disadvantages of Sustained-Release Matrix Systems:

1. Risk of Dose Dumping: Incorrect preparation can result in too rapid release of the drug, which may be toxic.
2. Less Flexibility to Adjust Dose Level: Difficult to modify once prepared
3. Higher First-Pass Metabolism: This can lead to greater breakdown of the drug within the liver.
4. Patient Education is Required: They should understand the proper use.
5. Lower Systemic Bioavailability: May lead to reduced levels of drugs in the blood
6. Poor In Vitro-In Vivo Correlation: It may become challenging to predict the performance in the body. [8,12,13,14]
7. Remaining matrix needs to be removed once the drug has been released
8. The release rate is proportional to square root of time
9. Matrix tablet have poor flexibility [7]

Table 1: Criteria for Inclusion of Drugs in Controlled-Release Preparations [8,15,16,14]

Criteria	Requirements
Physicochemical Attributes	
Molecular Weight	≤ 1000 Daltons
Solubility in Water	> 0.1 mg/mL (pH 1-7.8)
Partition Coefficient	High (for good membrane permeability)
Absorption Mechanism	Diffusion-based
Absorbability	Uniform across the GI tract
Release Characteristics	Should not be affected by pH or enzymatic action
Pharmacokinetic Parameters	
Elimination Half-Life	2 - 8 hours
Absolute Bioavailability	≥ 75%
Absorption Rate Constant (Ka)	Ka > drug release rate
Apparent Volume of Distribution (Vd)	Higher Vd with lower MEC requires a higher dose
Total Clearance	Dose-independent
Elimination Rate Constant	Important for designing a release profile
Steady-State Concentration (Css)	Lower Css with smaller Vd reduces dose requirement
Toxic Concentration	A wider gap between MTC and MEC ensures safety

Matrix Tablets

Matrix tablets are one of the most simple and effective techniques used to prep

are sustained-release dosage forms. A blend of the drug, retardant material, and additives are directly compressed to form a tablet where the drug gets embedded within the matrix core or the drug and retardant could be granulated before compression. Both hydrophilic and hydrophobic polymers are used in matrix tablets for controlled drug release.

Hydrophilic Matrix Tablets

Hydrophilic matrices are commonly used in the regulation of drug release rate. Hydrophilic matrices are either compressed directly from a blend of the drug and hydrophilic carriers or through wet granulation with hydrophilic excipients. Water serves as an activator to release mechanism; therefore, hydration of polymer is crucial in making the formulation successful.

Low hydration can lead to drug diffusion or tablet breaking prior to the end of the desired time interval. Examples of hydrophilic materials: Cellulose derivatives: Hydroxypropyl methylcellulose (HPMC), sodium carboxymethylcellulose, methylcellulose.

Non-cellulose polymers: Agar, alginates, chitosan, and modified starches. Acrylic acid polymers: Carbopol 934.

Fat-Wax Matrix Tablets

These matrices having lipids or waxes to control drug release through erosion and pore diffusion. The drug is entrapped in the wax or fat granules using techniques such as spray congealing, bulk congealing, or granulation with melted fats. It is released through hydrolysis, enzymatic activity, and dissolution of the matrix in the GI tract. Surfactants can be added into it to modify release profile and increase drug loading.

Plastic Matrix Tablets (Hydrophobic Matrices)

The matrices for these consist of inert polymers, creating a network of compact particles. There is drug release through diffusion within these capillaries. Prepared by direct compression of the drug with plastic materials or by granulation techniques using binding agents, organic solvents, or latex.

Examples of materials: Polyvinyl chloride, ethyl cellulose, cellulose acetate, and polystyrene.

Biodegradable Matrices

Composed of polymers with unstable linkages in their backbone, which degrade into oligomers and monomers through enzymatic or non-enzymatic processes.

These materials are metabolized or excreted, thus clean up the environment

Examples: Proteins, polysaccharides, aliphatic polyesters, and poly anhydrides.

Mineral Matrices

Derived from natural sources like seaweeds, these matrices include hydrophilic carbohydrates such as alginic acid, extracted from brown seaweed species.

Classification Based on Matrix Porosity

Macro-porous Systems

It contains comparatively large pores (0.1–1 μm) through which drug molecules diffuse.

Micro-porous Systems

It contains comparatively smaller pores (50–200 Å) for drug diffusion, slightly larger than drug molecules.

Non-porous Systems

It does not have pores; the diffusion of drug occurs through the polymeric network.

Hybrid Systems

Use a composite of release-retardant material in conjunction with an overcoat of a polymer membrane to control release.

Polymers Used in Matrix Tablets

Polymers play a pivotal role in matrix tablets, offering structural integrity and enabling controlled drug release. They can be classified based on their properties and functions as follows:

1. Hydrogels

Hydrogels are cross-linked, water-absorbing polymers that swell upon hydration, releasing the drug gradually through diffusion. Several polymers are commonly used, viz.,Polyhydroxyethyl methacrylate (PHEMA), Cross-linked polyvinyl alcohol (PVA), Cross-linked polyvinylpyrrolidone (PVP), Polyethylene oxide (PEO), Polyacrylamide (PA).

2. Soluble Polymers

These polymers dissolve in aqueous environments, enabling drug release by erosion or dissolution. Several polymers are commonly used, viz., Polyethylene glycol (PEG), Polyvinyl alcohol (PVA), Polyvinylpyrrolidone (PVP), Hydroxypropyl methylcellulose (HPMC).

3. Biodegradable Polymers

Biodegradable polymers are designed to degrade into biocompatible by-products, making them ideal for sustained or long-term drug delivery. Several polymers are commonly used, viz., Polylactic acid (PLA), Polyglycolic acid (PGA), Polycaprolactone (PCL), Polyanhydrides, Polyorthoesters.

4. Non-Biodegradable Polymers

These polymers do not degrade in the body but allow sustained drug release by diffusion.

Several polymers are commonly used, viz., Polyethylene vinyl acetate (PVA), Polydimethylsiloxane (PDS), Cellulose acetate (CA), Ethyl cellulose (EC)

5. Mucoadhesive Polymers

Mucoadhesive polymers adhere to mucosal surfaces, prolonging drug residence time at the site of action or absorption. Several polymers are commonly used, viz.,Polycarbophil, Sodium carboxymethylcellulose, Xanthan gum, Guar gum, Karaya gum [8,12,3,17]

Drug Release Mechanism from Matrix Devices

1. Controlled Release by Dissolution

Dissolution is the most straightforward approach as it is usually the rate-limiting step in sustained-release oral formulations. In this process, the drug dissolves in a carrier with a slower dissolution rate. The drug's release rate is controlled by its diffusion through an unstirred fluid layer surrounding the solid particle and is described by the Noyes-Whitney equation:

dc/dt = KDA (Cs -C) ---------- (1)

Matrix Dissolution Control

The drug is incorporated in a matrix containing a carrier that leaches over time. Leaching fluid penetrates into the matrix, and this depends on factors such as; Matrix porosity Availability of hydrophilic molecules. Tablet and particle wetting surface. Subclasses are;

Matrix Systems: The drug is evenly distributed in the leachable matrix.

Coated/Encapsulated Systems: Drug is controlled by a leaching or partially leaching out-layer.

2. Diffusion-Controlled Release Systems

In diffusion-based systems, a drug is released by diffusion through a polymeric barrier or matrix.

There are two types:

a. Encapsulation Diffusion Control

Core of drug is encapsulated in an insoluble polymeric membrane. Release of drug occurs due to partitioning into the polymer membrane and subsequently diffuses to the exterior medium. Release of drug follows Fick's diffusion law and can be explained according to the same.

b. Matrix Diffusion Control

A drug dispersed throughout a polymeric matrix. As the drug diffuses out, its release is regulated by the following factors: The characteristics of the polymer. Concentration gradients of the drug. Porosity and tortuosity of the matrix structure. This delivery mechanism provides a controlled and predictable release of the drug and is widely employed in controlled-release formulations. [18, 19, 20]

Biological Factors Influencing Release From Matrix Tablet [21,22,23,24]

1. Biological half-life:

The major goal of an oral sustained-release (SR) drug is to provide therapeutic blood levels of the drug for an extended duration. To do so, the drug should be released at a rate equivalent to its elimination. The rate of drug elimination is characterized by its biological half-life ($t_{1/2}$), the time it takes for its blood concentration to decrease by half. This rate is affected by multiple elimination processes, such as excretion and metabolism.

Short-half-life drugs are generally good candidates for SR dosage forms, because controlled release has the potential to decrease dosing intervals and achieve constant plasma concentrations. Drugs that have a half-life of less than two hours, like levodopa and furosemide, tend to be bad candidates for SR dosage forms since they are quickly cleared. In contrast, long-half-life drugs (more than eight hours) like digoxin and phenytoin are usually not necessary in sustained-release forms because they already last for a longer duration.[25]

2. Absorption:

To be optimally formulated as a sustained-release (SR) product, the absorption of a drug must be at a fairly even rate over the small intestine. This is not always true, though, as some drugs depend on active transport or absorption only in a certain region of the intestines. In these situations, SR formulations can be at a disadvantage since they could release the drug past its point of maximum absorption, resulting in lower bioavailability.

In order to facilitate greater retention and absorption of the drug, some SR drug delivery systems also target longer residence times in the stomach. With the drug in the stomach, there is controlled release possible where gradual progression can occur towards absorptive locations within the intestine. To ensure efficacy, however, of an SR preparation, a substantially lower rate of drug release is necessary as compared to absorption. Since the normal GI transit time in absorptive areas is about 8–12 hours, the optimal absorption half-life would be about 3–4 hours. If the absorption is too slow, the drug will be eliminated before full release, diminishing its therapeutic effect. This is equivalent to a minimum apparent absorption rate constant of 0.17–0.23 h^{-1}, which will provide 80–95% absorption during the transit time. Several strategies have been devised for maximizing drug retention and absorption in SR formulations. One such strategy is to formulate low-density pellets or capsules, which are retained in the stomach for as long as possible, slowly releasing the drug. Another strategy uses bioadhesive materials, which stick to the mucosal surface, increasing the residence time of the drug at the absorption site. Such methods have been investigated in response to observations that co-administration of some excipients could increase drug absorption and maintain therapeutic levels.

3. Metabolism:

Those drugs that are metabolized in intestinal lumen or intestinal tissue before absorption, will reduce bioavailability when prepared as continuous-relief products. Slow and prolonged release can lead to excessive metabolism and in systemic circulation can reduce the concentration of the drug. To be an ideal candidate for SR formulation for a medicine, it must meet the following criteria: Short biological half life (<5 hours): Small half -life drugs require frequent doses in traditional formulations, making them suitable candidates for SR system, as controlled release can reduce dosage frequency while maintaining therapeutic level. High water solubility: To ensure frequent absorption, a drug should be sufficiently dissolved in gastrointestinal fluids. Drugs with poor solubility may require increased solubility increase techniques before SR products are prepared. Wide therapeutic window: A drug must have a comprehensive therapeutic index to reduce the risk of poisoning in plasma concentration. Drugs with narrow medical windows may not be ideal for SR formulations due to the challenge of accurate release rate control.

Absorption in the GI tract: Medications that are equally absorbed in gastrointestinal tract are more suitable for SR formulations. If the absorption is limited to a specific area (eg, upper small intestine), an SR will leave the drug beyond the absorption window, reduce its efficacy.

Even poor water solubility drugs can be prepared as SR systems using solid spread techniques such as solid spread, micronization or complexation. However, care should be taken to prevent crystallization during absorption, as it can cause rain and precipitation and reduced bioavailability.

4. Drug Distribution:

The clear amount of distribution (VD) explains how a drug distributes to the body tissue. Drugs with a high VD are not ideal for SR formulations because they distribute rapidly and large -scale tissues, leading to long elimination of drug release kinetics. For example, chloroquein has a high amount of distribution, which makes controlled-resolution formulation unnecessary

5. Protein Binding:

The medicinal effect of a drug depends on the concentration of the drug in the plasma rather than the total drug concentration. Most medicines somewhat bind plasma proteins or tissue proteins. Excessive protein-bound drugs usually have a prolonged biological half life, as only free fraction passes through metabolism and emissions. Because of this, many high protein-bound drugs do not require SR formulations, as their inherent pharmaceutics already provide continuous plasma levels.

6. Security margin:

Therapeutic index (TI) represents the safety margin of a drug. A high TI indicates a safe drug with a large gap between therapeutic and toxic doses. Drugs with a narrow medical index, such as Digoxin or Lithium, face challenges for SR formulations, as minor variations in the release rate can lead to sub -or toxic levels. Therefore, accurate control on drug release is important for such drugs when designing SR formulations.

Physicochemical Factors Influencing Release from Matrix Tablet [21,24]

1. Dosage size:

The total dose of a drug that can be prepared as SR doses is limited by the volume that can be swallowed comfortably. Generally, an oral dose should not exceed 0.5–1.0 grams. If a drug requires high doses, alternative strategies such as liquid formulations, divided doses, or modified drug release mechanisms may be necessary. Additionally, for drugs with narrow therapeutic categories, large doses pose a risk of toxicity, requiring careful fractional strategies. [26]

2. Drug solubility:

Polymer erosion is more dominated in the case of the matrix with insoluble drugs, but with soluble drugs a combination of diffusion and erosion control the release of the drug. Diffusion of the drug is dependent on the concentration gradient across the medium which is solubility-dependent thus

a highly soluble drug demonstrates rapid release while poorly water-soluble drugs. [27]

3. Ionization, PKA, and aquatic solubility in SR system:

The most of the drugs are weak acid or weak base, and their ionization is depends on pH. Because only a non-oriented state of a drug can cross the lipid membrane easily, the equilibrium between ionization and solubility is a crucial point in SR formulations

PKA and absorption: Pka of API determines its ionization in various pH environment of gastrointestinal tract. A drug should ideally remain in a suitable balance between ionized (for solubility) and non-lying (for permeability) to ensure frequent absorption throughout the GI path. pH-dependent solubility: The stomach is very acidic, but the small intestine is more neutral. These areas exhibit quite different characteristics which can impact solubility, absorption and hence appropriateness for SR formulations.

Low-solubility drugs: Those drugs with a solubility of <0.01 mg/ml often exhibit the constant-proves nature of the underlying characteristics as dissolution becomes the rate-limiting step. On the other hand, these medications may not be suitable for SR formulations, as their slow interruptions can lead to incomplete absorption. [28]

4. Partition Coefficient and Membrane Permeability:

Drugs must cross multiple biological membranes to reach systemic circulation. Membranes are primarily lipidic, making the partition coefficient an essential factor in determining drug permeability.

Lipophilic Drugs: Drugs with a high lipid solubility (high partition coefficient) can store

themselves in fatty tissues and have a variable release and prolonged retention. These drugs are not good candidates for SR formulations since they do not require further prolongation.

Hydrophobic Drugs: Drugs that have extremely low prospective partition coefficients are incapable of passing through lipid membranes, thereby leading to a reduced absorption and reduced bioavailability. The polymer can be chosen in accordance with the partitioning properties of the drug to optimize controlled release for SR formulations. [29]

5. Stability:

drugs which are administered orally can degrade through acid-base hydrolysis or enzymatic cleavage within the gastrointestinal tract. Stability related concerns must be examined during the formulation of SR products. Gastric Instability: most of the drugs are degraded rapidly under acidic conditions. For those drugs, SR systems that retard release until the dosage form enters the small intestine (e.g., enteric-coated tablets) are helpful. Intestinal Instability: Compounds that undergo degradation in the small intestine could show lower bioavailability as SR products because the longer they are released, the more time they have been exposed to degradation. Such compounds include propantheline and probanthine, which degrade extensively in the intestine and are not well-suited for SR products.

Solid-State Stability: Solid-state forms of drugs tend to have better stability than liquid ones. Therefore, SR preparations tend to employ solid matrices to shelter drugs against degradation until they arrive at their target site of absorption. [30, 31]

Assessment of Sustained-Release Tablets [21,24]

Sustained-release formulations of drugs require rigorous in-vitro and in vivo testing to confirm their stability, safety, reliability, and therapeutic efficiency. In addition, an in-vitro-in-vivo correlation is extremely critical to forecast drug release and absorption profiles. Evaluation Criteria

The key evaluation criteria are summarized below: [31,32,33,34,35]

Thickness and Diameter

Absorbs light by scanning the tablet surface at a low distance with a high accuracy, a Vernier caliper is used to measure the thickness of the tablet and the diameter of the tablet to achieve the accuracy of the tablet size. Uniform thickness and diameter is crucial in maintaining proper dosage and for smooth tablet coating and packaging.

Hardness (Tablet Strength)

Tablet hardness is the measurement of the amount of manufacturing pressure needed to fracture a tablet. This is determined with a Monsanto hardness tester, which involves placing a tablet between two anvils and applying pressure until it breaks. The hardness of three tablets is measured for each formulation. The hardness of a tablet is carefully controlled to allow it to not break during use, shipping, or storage, but still break down effectively when it is taken.

Resistance to Breakage and Chipping (Friability)

The friability test determines the tablet's ability to withstand wear and tear. In this test, twenty tablets are weighed and placed in a friabilator and rotated at 25 rpm for four minutes. The tablets are then reweighed to measure weight loss. A quality tablet must weigh less than 0.8% of its weight. High levels of friability may be considered as a failure in tablet compression or binder choice and can lead to breakage in the course of handling.

Weight Variation Test

Weight uniformity is any one of the most important quality control parameters. This is critical for the delivery of dosage since all tablets in a batch should be uniform in weight. If, for example, individual tablets are weighed and the average weight compared to individual tablets, twenty tablets are randomly weighed and weighed. The percentage weight calculated as per Pharmacopoeial standards. If the weight variation exceeds the acceptable criteria, the batch considered as failed for commercial use

Determination of drug content:

Drug content is evaluated to calculate amount of active pharmaceutical ingredient (API) present in finished product. The tablet is then immersed in an

appropriate solvent such as a phosphate buffer solution (pH 7.4) and afterwords the concentration drug is measured using a UV-visible spectrophotometer. It compared with the standard calibration curve of pure drug. This test ensures that each tablet provides the right therapeutic dose.

In-vitro Dissolution Testing (Drug Release Profile)

Dissolution testing considered as one of the most important tests in evaluating the drug release pattern from the matrix tablet. It determines how much time requred for a specific percentage of the drug to release under controlled conditions, simulating the environment inside the human body.

The test is conducted using a various kind of dissolution apparatus as specified in pharmacopoeial standards. The dissolution study not only helps in formulation development but also identifies potential risks like dose dumping or non-extended release profile.

3. Stability Studies

The most important stability studies are stability tests to ensure that SR formulations will have potency, safety, quality, and the release profile consistently over shelf life. The studies include:

Standard and Accelerated Conditions: Testing of the drug at controlled temperatures and humidity conditions.

Impact on Release Profiles: Discussion on how climatic factors such as heat and humidity influence in-vitro and in-vivo release profiles.

Good stability data ensures that a formulation remains effective and stable up to the time of consumption.

4. Bioavailability Testing

Bioavailability is the fraction of an administered dose of unchanged drug that reaches systemic circulation. It is a critical parameter for optimal therapeutic effect and proper absorption.

Key considerations include:

Comparing the performance of the SR formulation to that of a standard formulation in fasted, healthy subjects. Evaluation of the absorption of the API or its active metabolite (e.g., prodrugs) from the site of administration.

Optimization of dosage forms to increase absorption and bioavailability.

Effective bioavailability studies are a critical part of the design and development of successful SR products to ensure predictable drug release and therapeutic outcome [18,19]

CONCLUSION:

The use of sustained-release matrix tablet in drug therapy improves the patient compliance, decreases the frequency of dosing, and reduces the variations in plasma concentration. Controlled drug release can be achieved based on polymer properties using various matrix types; these fall into four categories: hydrophilic, hydrophobic, lipid, and biodegradable matrices.

Despite these benefits, challenges such as dose dumping, formulation complexity, and increased cost are still common in such systems. Polymer science and hybrid systems can also contribute to improve drug release and bioavailability. Matrix tablets will continue to progress as one of the most innovative, patient-driven drug delivery systems with continued development.

REFERENCES

1. Kumar AR, Aeila AS. Sustained release matrix type drug delivery system: an overview. Int J Pharm Sci Res. 2019;9(1):470–80.
2. Bisht T, et al. Review on matrix tablet. Indo Glob J Pharm Sci. 2016;6(1):38–42. DOI: 10.35652/igjps.2016.09.
3. Jaimini M, Kothari A. Sustained release matrix type drug delivery system: a review. J Drug Deliv Ther. 2012;2(6):142–8.
4. Nautyal U, Gupta D. Oral sustained release tablets: an overview with a special emphasis on matrix tablet. Int J Health Biol Sci. 2020;3(1):6–13.

5. Nagendrakumar D, Keshavshetti GG, Shardor AG. An overview: matrix tablets as sustained release. Res Rev Sci Tech. 2013;5(4):36–45.
6. Sharma N, et al. Advancement in sustained released dosage form for oral drug delivery. Int J Zool Investig. 2024;10(2):453–66. DOI: 10.33745/ijzi.2024.v10i02.043.
7. Zalte HD, Saudagar RB. Review on sustained release matrix tablet. Int J Pharm Biol Sci [Internet]. [date unknown] [cited 2025 Jan 30]. Available from: https://www.ijpbs.com/ijpbsadmin/upload/ijpbs_528c713232c04.pdf
8. Brahmankar DM, Jaiswal SB. Biopharmaceutics and pharmacokinetics: pharmacokinetics. 2nd ed. Delhi: Vallabh Prakashan; 2009. p. 399–401.
9. Bhargava A, Rathore RPS, Tanwar YS, Gupta S, Bhaduka G. Oral sustained release dosage form: an opportunity to prolong the release of drug. Int J Adv Res Pharm Bio Sci. 2013;3(1):7–14.
10. Chauhan MJ, Patel SA. A concise review on sustained drug delivery system and its opportunities. Am J Pharm Tech Res. 2012;2(2):227–38
11. Pundir S, Badola A, Sharma D. Sustained release matrix technology and recent advances in matrix drug delivery system: a review. Int J Drug Res Technol. 2013;3(1):12–20.
12. Aulton ME. Aulton's pharmaceutics: the design and manufacture of medicines. 3rd ed. Edinburgh: Churchill Livingstone; 2007. p. 441–82.
13. Lieberman HA, Lachman L, Kanig JL. The theory and practice of industrial pharmacy. 3rd ed. Mumbai: Varghese Publishing House; 1990. p. 430–56.
14. Vyas SP, Khar RK. Controlled drug delivery: concept and advances. 2nd ed. Delhi: CBS Publishers; 2012. p. 1–53.
15. Robinson JR, Lee VL. Controlled drug delivery: fundamentals and applications. 2nd ed. New York: Informa Healthcare; 2009. p. 373–421.
16. Kumar S, Kant S, Prashar B. Sustained release drug delivery system: a review. Int J Institutional Pharm Life Sci. 2012;2(3):356–76.
17. Kumar D, Archana, Niranjan AK. A comprehensive review on sustained release matrix drug delivery system. J Drug Deliv Ther. 2022;12(4 Suppl):249–53.
18. Gupta MM, Ray B. A review on sustained release technology. Int J Ther Appl. 2012;8:1–23.
19. Agarwal G, Agarwal S, Karar PK, Goyal S. Oral sustained release tablets: an overview with a special emphasis on matrix tablet. Am J Adv Drug Deliv. 2017;5(2):64–76.
20. Agarwal P, Semimul AS. A comprehensive review on sustained release matrix tablets: a promising dosage form. Univ J Pharm Res. 2019;3(6). DOI: 10.22270/ujpr.v3i6.222.
21. Brahmankar HA, Jaiswal SB. Biopharmaceutics and pharmacokinetics: a treatise. Delhi: Vallabh Prakashan; 2000. p. 337, 348-57.
22. Shargel L, Yu ABC. Modified release drug products. In: Applied biopharmaceutics and pharmacokinetics. 4th ed. New York: McGraw Hill; 1999. p. 169-71.
23. Rao NG, Prasanna Raj KR, Nayak B. Review on matrix tablet as sustained release. Int J Pharm Res Allied Sci. 2013;2(3):1-17.
24. Misal R, Atish W, Aqueel S. Matrix tablets: a promising technique for controlled drug delivery. Indo Am J Pharm Res. 2013;3(5):3791-805. [PMID: 21589795]
25. Patil DM, Pawar PA, Pagar RY, Ghule RS, Bairagi VA. Formulation and development of sustained release matrix tablets of lornoxicam. J Drug Deliv Ther. 2018;8(2):102-6
26. Verma BK, Pandey S, Arya P. Tablet granulation: current scenario and recent advances. Univ J Pharm Res. 2017;2(5):34-9. [DOI: 10.22270/ujpr.v2i5.RW1]

27. Chauhan V, Kumar K, Teotia D. Fast dissolving tablets: a promising approach for drug delivery. Univ J Pharm Res. 2017;2(4):58-64.
28. Cox PJ, Khan KA, Munday DL. Development and evaluation of a multiple-unit oral sustained release dosage form for S(+)-ibuprofen: preparation and release kinetics. Int J Pharm. 1999;193:73-84. [DOI: 10.1016/s0378-5173(99)00320-8]
29. Jantzen GM, Robinson JR. Sustained and controlled-release drug delivery systems. In: Banker GS, Rhodes CT, editors. Modern Pharmaceutics. 3rd ed. Revised and Expanded. Drugs and the Pharmaceutical Sciences, Vol. 72. New York: Marcel Dekker, Inc.; 1995. p. 575-609.
30. International Council for Harmonisation (ICH). ICH guideline on stability testing of new drug substances and products. 2005
31. Singh A, Rajput DS, Gopalrao AA, Chauhan D, Mafidar R, Bhowmick M, Rathi J, Mathur R. Design and characterization of sustained release matrix tablets of metformin hydrochloride using combination of hydrophilic polymers. J Drug Deliv Ther. 2018;8(2):96-101. [DOI: 10.4103/2229-516X.112242]
32. Lachman L, Herbert A, Liberman. The theory and practice of industrial pharmacy. Mumbai: Varghese Publishing House; 1990. p. 318
33. Amsa P, Mathan GK, Magibalan S, Velliyangiri EK, Kalaivani T, Priya S. Formulation and evaluation of gabapentin sustained release matrix tablet using Hibiscus rosa-sinensis leaves mucilage as release retardant. J Pharm Res Int. 2021;33(58B):564–72. DOI: 10.9734/jpri/2021/v33i58b34238.
34. Priyanka P, Kumar K, Teotia D, et al. A comprehensive review on pharmaceutical mini tablets. J Drug Deliv Ther. 2018;8(6):382–90. DOI: 10.22270/jddt.v8i6.2060.
35. Siddiqui M, et al. Formulation of metformin sustained release tablet using natural polymer. J Drug Deliv Ther. 2021;11(2):31–7. DOI: 10.22270/jddt.v11i2.4579.

HOW TO CITE: Chetan Patil*, Rohini Patil, Ajit Patil, A Comprehensive Review of Matrix Tablets and Assessment Techniques, Int. J. of Pharm. Sci., 2025, Vol 3, Issue 3, 1047-1057. https://doi.org/10.5281/zenodo.15014891