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A Review on Drug Delivery System Sustained Release Matrix Tablet

Vaishnavi M. Potdar *, Nida. N. Mulla, Sanjay K. Bais

Fabtech College of Pharmacy, Sangola, Solapur, Maharashtra, India

*Corresponding Author: vaishnavipotdar20@gmail.com

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Abstract

Among the most well-liked and effective drug delivery methods of today, intended to sustain therapeutic medication concentrations within the bloodstream for extended lengths of time. In these systems, the medication is progressively released from a matrix after being incorporated into it. By limiting variations in plasma drug concentration, increasing patient compliance, and lowering dose frequency, matrix-based formulations guarantee a regulated and extended drug release. Wax, hydrophilic or hydrophobic polymers, and other substances that alter. The rate of medication release in response to the drug-matrix interaction can be used as the matrix. When gastrointestinal fluids are present, hydrophilic matrices expand and create a gel layer that permits the medicine to diffuse gradually.

Keywords – Hydrophilic, Hydrophobic polymer, matrix-based formulations

INTRODUCTION

All the medication administration routes, the oral route is the most effective. Benefits like reduced manufacturing costs and ease of administration are the reason behind this. Over the course of many years, a large number of scholars have studied rapid and innovative delivery. Any medication delivery system's goal is to maintain the desired drug concentration by producing a therapeutic impact at the designated site. For the prolonged release of medication following the delivery of a single dose. Matrix tablets with sustained release are utilized. The best commercially available, reasonably priced sustained-action medications are matrix tablets since they don't require special manufacturing conditions and can hold high dosages of medication. To minimize adverse effects, the medicine is administered at a constant dose for a certain amount of time. A sustained release drug delivery system targets specific pharmacokinetic, stoic, and biopharmaceutical properties while maintaining controlled, sustained release. This helps to maximize the drug's usefulness, minimize its side effects, and effectively cure the patient when compared to conventional kinds of dose. The most widely used dose form for this technique is the oral sustained release system. When paired with an inert or hydrophobic polymer, or when administering therapeutic medications with systemic effects, this is the ideal mode of administration and the first choice for the treatment. Utilizing polymers can lead to incredibly specified and well-liked outcomes. If the medication delivery system in tablets can achieve a high gelling capability as basis excipients, then it is said to be often using hydrophilic polymers sustained release method. Hydrophilic polymers are used as foundation excipients in this approach of regulated and measured drug release. A prolonged amount of time. A well-mixed mixture of one or more medication concentrations in the blood is what keeps the matrix constant. the function of matrix tablets in drug administration systems, with an emphasis on their types, benefits, workings, and design. Drugs are incorporated in a polymer matrix that regulates the drug's release rate in matrix tablets, which are solid dosage forms. By serving as a scaffold, the matrix controls how the medication diffuses over time into the gastrointestinal tract (GIT).

This controlled-release function is especially crucial for avoiding fluctuations, preserving steady medication levels in the bloodstream, and extending the duration of therapeutic activity. [1,2,3]

The ideal characteristics of a medication for SRDDS

It must be stable in gastrointestinal (GI) fluid and efficiently absorbed orally.

Drugs like salbutamol sulphate and captopril have short half-lives (2-4 hours), which makes them good candidates for SR dosage form formulation.

Maximum dosage for the SRDDS design is 1.0 gm, and medication dosages, such as metronidazole, shouldn't be less than 0.5 gm.

In the SRDDS, the medication's therapeutic range needs to be suitably wide to prevent. [4,5]

Advantages of Matrix tablet

Performance

A lot of Matrix tablets have strong processors and enough RAM to support multitasking and provide effective performance for a range of apps.

Display Quality

They frequently have high-resolution screens with vivid colors and crisp images, which are excellent for productivity tasks and media consumption.

Battery Life

Matrix tablets often offer a respectable amount of battery life, enabling prolonged use between charges.

Portability

Tablets are often lightweight and portable, which makes them useful for usage when traveling.

Reduce the adverse effects, both systemic and local.

Operating System

A variety of programs and software compatibilities are available for Matrix tablets running on common operating systems like Windows or Android, depending on the model.

Connectivity Options

To enable flexible use, many models come with a variety of connectivity options, including Wi-Fi, Bluetooth, and occasionally even cellular capability.

Storage Options

They frequently have micro-SD card-based expandable storage, giving consumers who require more space greater freedom.

User-Friendly Interface

Tablets typically offer user-friendly interfaces that are simple for users of all ages to operate.

Enhancement of therapeutic effectiveness.

Reduce medication buildup by using continuous dosage.

Simple to produce Sustained release formulations are cost-effective, versatile, and capable of releasing high molecular weight chemicals.

They have the potential to sustain therapeutic doses over extended periods of time.

An increase in the adherence of patients.

Better management of the concentration of medicinal drugs.

An increase in some medications' bioavailability.

Strengthen the medication's stability by shielding it from the gastrointestinal tract's hydrolysis or other derivative alterations.

Because there are fewer doses, cost-effective manufacture is achievable. [6,7,8]

Disadvantages of Matrix tablet

Performance

In demanding applications, certain models may run more slowly due to their reduced processing capability.

Build Quality

Some Matrix tablets may be made using less expensive materials, raising questions about their longevity and robustness.

Software upgrades

It's possible that they don't get frequent software upgrades, which could have an impact on new feature access and security.

App Compatibility

Certain apps, particularly those that require a lot of resources or are sophisticated, may not work properly on some Matrix tablets.

Display Quality

The viewing experience may be impacted if the screen resolution and quality are not on par with tablets of a higher caliber.

Limited Support

Compared to more well-known manufacturers, customer support and warranty options may be less extensive.

Battery Life

A short battery life on some devices may require regular recharging.

Storage Options

Users who have a lot of apps and files may find that their internal storage is limited or that their memory cannot be expanded.

Compared to standard dose forms, the production cost is higher.

There is a poor correlation between in vivo and vitro results.

The possibility for first pass metabolism is enhanced. [9,10]

Types of Matrix tablet

Tablet with a hydrophilic matrix

Hydrophobic matrix tablet

Lipophilic matrix tablet

Biodegradable matrix tablet

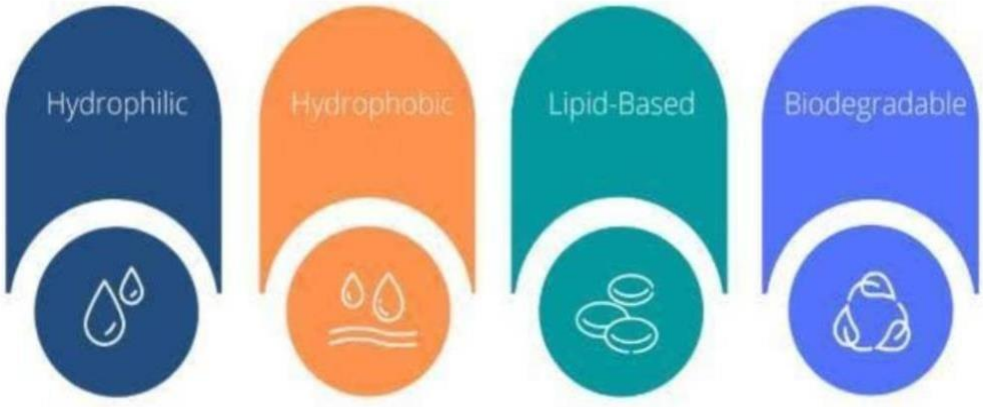

Figure 1*: *Types of Matrix tablet A

Hydrophilic Matrix tablet

Water-soluble polymers like sodium alginate, polyethylene oxide, and hydroxypropyl methylcellulose (HPMC) are used in hydrophilic matrix tablets. These polymers absorb water from the gastrointestinal tract, expand, and deposit a gel coating on the tablet's surface.

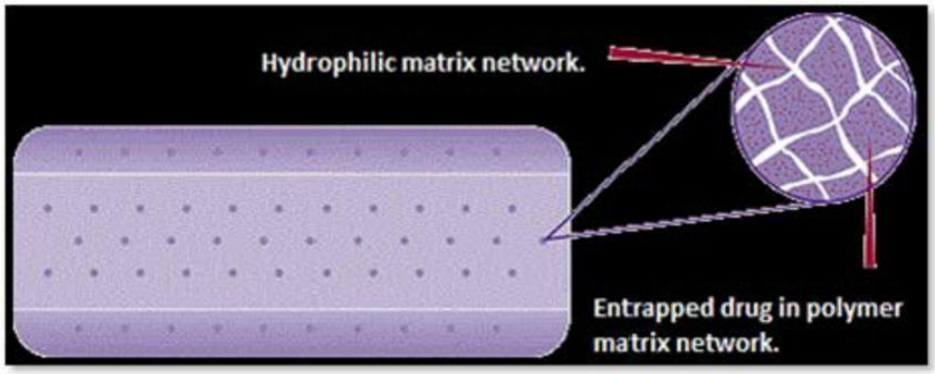

Figure 2: *Hydrophilic Matrix tablet*

Hydrophobic Matrix Tablet

These are composed primarily of water-insoluble components that diffuse the drug through the matrix's pores to release it. A kind of pharmaceutical dosage form called hydrophobic matrix tablets uses hydrophobic polymers to regulate the release of active substances. Poorly water-soluble drugs' release profiles can be changed by these tablets, allowing for sustained or protracted release with a reduced chance of quick drug release and possible side effects. We'll look at the parts, workings, composition, benefits, and uses of hydrophobic matrix tablets below.

Lipophilic Matrix Tablet

The medication is combined with a hydrophobic matrix consisting of glycerides, fatty acids, or waxes in lipophilic matrix tablets. Lipophilic (fat-loving or hydrophobic) materials are used to generate a matrix for the prolonged release of active pharmaceutical ingredients (APIs) in lipophilic matrix tablets, a type of controlled-release dosage form. When preparing medications with limited water solubility, these tablets are especially helpful since they enable a more regulated and prolonged release of the medication into the body. Here is a thorough explanation of tablets made of lipophilic matrix. uses lipids to regulate medication release, such as hydrogenated castor oil, glyceryl monostearate, and glyceryl behenate.

Biodegradable matrix tablet

The drugs and the polymer's physicochemical characteristics as well as Monomers are joined to form biodegradable matrices, which are similarly reliant on a number of biological factors. Another through shaky links between functional groups. In biological systems, they disintegrate into monomers and oligomers either by non-enzymatic processes or by enzymes produced by the surrounding live cells. Following that, these monomers and oligomers are broken down or eliminated. [11,12,13,14,15]

Mechanism of Drug Release

These following systems fall under this category
Release systems with control over diffusion
Release systems with control over dissolution
Systems of regulated release for dissolution and diffusion
Drug compounds with ion exchange resin
Formulation independent of pH
Systems controlled by osmotic pressure

Release systems with control over diffusion

The rate-limiting stage in these kinds of systems is the diffusion of the dissolved medication across a polymeric barrier. Since the diffusional path length lengthens with time as the drug in the insoluble matrix is progressively removed, the drug release rate is never zero-order. These controlled medication delivery systems function according to drug molecule diffusion over a polymeric membrane.

Diffusion-controlled devices, like dissolution-controlled systems, are produced by either encasing distributing the medication within a polymeric matrix or encasing the drug particle in a polymeric membrane. In contrast to dissolution-controlled systems, the medication is made accessible to through partitioning through the polymer.

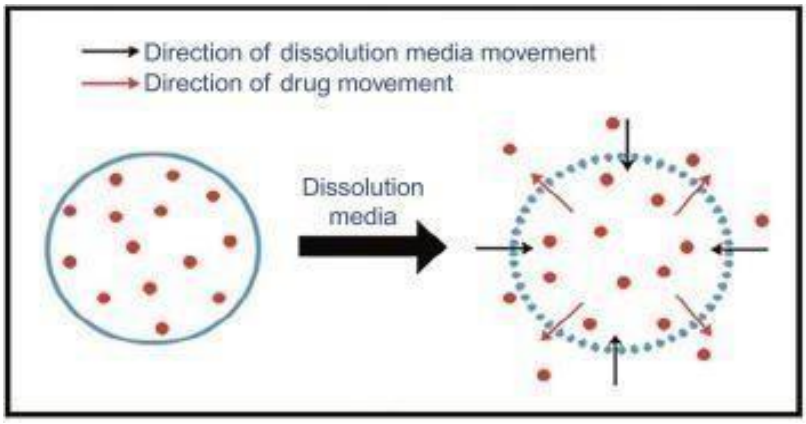

Figure 3: *Release systems with control over diffusion*

In which case,

ADK ΔC/L = dm/dt

The medication release rate is dm/dt

A=membrane surface area through which medication is diffusing.

D= Is the drug's diffusion coefficient across the membrane.

K= Is the partition coefficient, which takes into consideration the drug's membrane solubility.

ΔC =represents a concentration gradient, which is the variation in drug concentration between the reservoir and the external surroundings.

L=diffusion membrane thickness.

This equation simulates the effects of many parameters on including the surface area, membrane thickness, and concentration differential the medication release rate, that drives the diffusion process. [16,17]

Release systems with control over dissolution:

The medication in question may be the following:

Possessing a high rate of aqueous solubility and dissolution. those that dissolve slowly by nature, such as digoxin and griseofulvin. When it comes into touch with GI fluids, it creates forms that dissolve slowly. Drugs can be made to dissolve more slowly in the GI medium, they can be encapsulated in an insoluble polymer, or they can be coated with polymeric materials of different thicknesses to attain release that is controlled by dissolution. The step in the drug dissolving process is diffusion over the aqueous boundary layer. process that limi ists its pace. The diffusional boundary layer of stagnant-fluid opposes the energy source for drug release, which is provided by the drug's solubility.

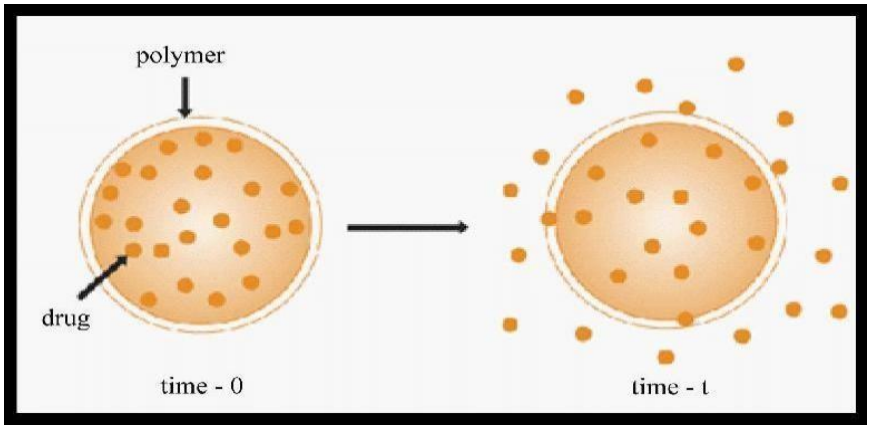

Figure 4: *Release systems with control over dissolution*

The following' equation can be used to approximate the speed of disintegration:

dt/dm = ADS/h

where as formula,

The rate of dissolution, is expressed as dm/dt.

A =stands for the dissolving substances of the surface area,

D = for substance's coefficient of diffusion,

S =for substance's solubility in the solvent,

h = for the boundary layer's thickness.

Numerical values A, D, S, and h are required in order to calculate dm/dt. [18,19]

Systems of regulated release for dissolution and diffusion

The medication in question may be the following:

Possessing a high rate of dissolution and aqueous solubility. Those that dissolve slowly by nature, such as digoxin and griseofulvin. When it comes into touch with GI fluids, it creates forms that dissolve slowly. Drugs can be made to dissolve more slowly in the GI medium, they can be encapsulated in an insoluble polymer, or they can be coated with polymeric materials of different thicknesses to attain release that is controlled by dissolution. The phase of the drug dissolving process that sets a time restriction is diffusion over the aqueous boundary layer. The stagnant-fluid diffusional barrier layer opposes the drug's solubility, which is the energy source for release of drugs.

These subsequent may be used to approximate the rate of dissolution

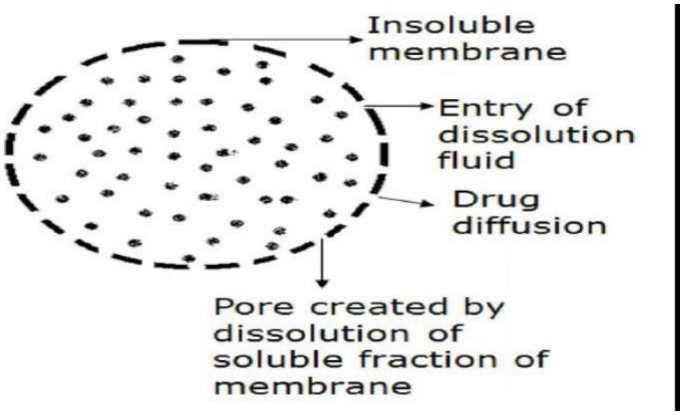

Figure 5: *Systems of regulated release for dissolution and diffusion*

Whereas formula,

dm/dt= ADS/h

A stand for surface area of dissolution substance

D = dissolution of solid of diffusion coefficient

S = solubility of substances

h = for boundary layer's thickness [20,21]

Drug compounds with resin for ion exchange

There are Na+ and Cl- in the digestive tract are released along with the medication from this complex once it is exchanged there. Formulations aimed at enhancing drug delivery and efficacy involve the combination of medicinal components with ion exchange resins. Anionic (negatively charged) or cationic (positively charged) ions from drug molecules can be bound by insoluble polymers called ion exchange resins, which then release the bound ions in return for ions in the surrounding environment. This procedure may aid in regulating the drug's bioavailability, absorption, and release.

Figure 6: *Drug compounds with resin for ion exchange*

Typically, this technique uses an insoluble cross-linked polymer resin component. On a polymer chain, they have a recurring salt-forming function group.

Formulation independent of pH

Formulation independent of pH describes the creation of pharmaceutical formulations in which changes in the environment's pH (for example, in various regions of the gastrointestinal tract) have no appreciable impact on the therapeutic product's solubility, stability, or effectiveness. This can be especially crucial for oral drug administration because the pH of the intestines (pH 6-7.5) is somewhat basic or more neutral than the stomach (pH 1-3). The medicine can be prepared using excipients or methods that maintain its effectiveness independently of the surrounding medium's pH to produce formulations that are pH-independent.

Among these strategies are

Use of pH-modifiers

Substances that can stabilize or buffer the surrounding environment of the medication to keep the pH steady in the face of outside fluctuations.

Drug salt forms

Creating a salt form of the medication that is consistently soluble at different pH values.

Controlled-release formulations

Methods of coating or encapsulation that shield the medication from pH changes and permit a slow release, guaranteeing the medication's continued effectiveness throughout the digestive tract.

4.Solid dispersions: Using a polymer matrix to disperse the medication helps keep it soluble at any pH.

Systems controlled by osmotic pressure

For Osmotic pressure systems control the flow of a solvent, often water, by varying the concentration of the solute across a semi-permeable membrane. These systems use the osmosis principle, which is the natural movement of water from an area of low solute concentration (high water concentration) to an area of high solute concentration (low water concentration), to balance the concentration on both sides of the membrane.

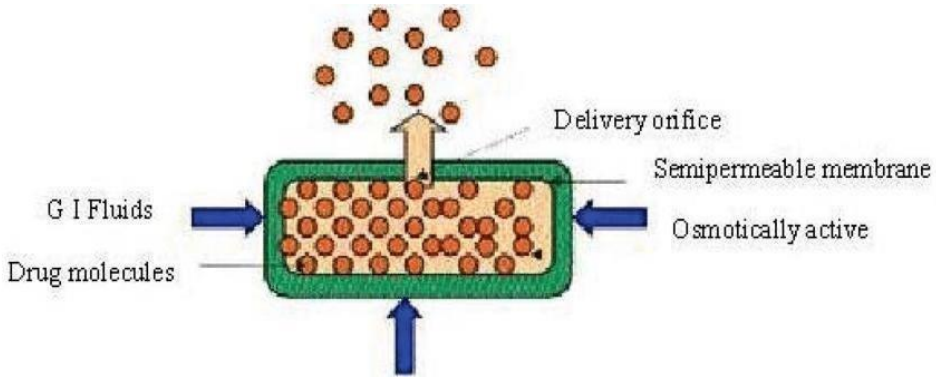

Figure 7: *Systems controlled by osmotic pressure*

Osmotic Pressure

The pressure required to stop water from flowing inward through a semipermeable membrane is known as osmotic pressure. It is directly correlated with the solute's concentration in the mixture. Osmotic pressure-controlled systems move water into or out of cells or compartments based on the gradient in order to balance concentrations.

A membrane that is semi-permeable limits the migration of solute particles while permitting flow of water. Osmosis cannot take place without this selective permeability.

Tonicity Isotonic

Water does not move in a net manner since the concentration of solutes is same within and outside the membrane. [22,23,24]

FACTORS AFFECTED ON SRDDS

There are two different kinds of forces at play

Factor of Biological

Factor of Physicochemical

Factor of Biological

Absorption and Permeability

The rate and effectiveness of a drug's absorption into the bloodstream are determined by the permeability of biological membranes, such as those in the intestines. SRDDS frequently adjusts drug release to correspond with a given tissue's capacity for absorption.

Metabolism

The slow-releasing dose form's decreased bioavailability is demonstrated by Drugs with slow releasing dosage forms that undergo substantial metabolism may have decreased bioavailability in the intestinal lumen or tissue before absorption. A medication with low water solubility may be designed in a dosage form with sustained release. This can be accomplished by using one of the several methods available for improving the drug's solubility following the improvement of the formulation for sustained release. However, during this phase of drug crystallization, which is conceivable when the medication enters the bloodstream, it should be avoided and caution should be exercised to avoid the same.

Distribution

The distribution's apparent volume is the primary determinant of the drug's rate of elimination. Therefore, medications with a high apparent volume of distribution are thought to be a poorsuitable for a system of oral SR medication delivery since they have an impact. The drug's rate of elimination. For instance, chloroquine.

Diffusion and molecular size

A medication needs to spread across a rate-controlling membrane or matrix in a number of sustained release methods. Diffusion coefficient, also known as diffusivity, refers to a drug's ability to permeate through membranes and is influenced by its molecular size. A significant factor influencing the diffusivity rating. The diffusing species' molecular weight is determined by its molecular size, or "D" in polymers.

Margin of safety

Oral SR drug delivery systems are often not the best option for drugs with lower therapeutic index values.

Activity of Enzymes

The length of time a medicine remains in circulation is influenced by the presence of enzymes, particularly in the liver (hepatic metabolism). It may be necessary to use delivery systems or protective coatings for drugs that are prone to enzymatic degradation in order to reduce enzyme exposure.

Gastrointestinal Tract pH

Drug absorption and dissolution are impacted by the pH variations in various GI tract segments. For instance, enteric coating may be necessary for medications that are susceptible to breakdown in acidic environments, such as the stomach.

Drug Half-Life

SRDDS helps medications with short half-lives avoid frequent dosage. On the other hand, medications having lengthy half-lives might not require intricate delivery methods.

Action Location

Depending on whether a drug's target site is localized or systemic, SRDDS can be customized. As an illustration, certain medications could need a release mechanism that targets particular organs or tissues (colon-targeted drug delivery, for instance).

Immune Reaction

The effectiveness of the medication may be impacted by biological responses to drug carriers, such as nanoparticles. In order to prevent immunological reactions that could hasten drug clearance, SRDDS systems need to be biocompatible.

Variability in Patients

Drug metabolism is influenced by individual factors like age, weight, sex, and general health (including liver or kidney function), which is why customized SRDDS techniques can be crucial in some situations.

Proteins binding

All drugs are somewhat bound to tissue proteins and/or plasma, however unbound drug concentration is more crucial for achieving pharmacological response than bound drug concentration. Protein binding of the drug has a major impact in its therapeutic action regardless of the dosage form type since substantial binding to plasma lengthens the biological half-life; hence, for some drugs, an SR drug delivery method is not necessary [25,26]

Factor of Physicochemical

Emulsibility

Drugs that are less soluble may release more slowly than those that are more soluble. The release rate can be increased by increasing solubility by decreasing particle size or adding solubilizing chemicals.

Coefficient of Partition (Log P)

When a medication moves between hydrophilic and lipophilic phases, its distribution is determined by the partition coefficient. Drugs with an ideal Log P value are more effectively absorbed, which affects how the body releases them from SRDDS.

The Ionization and pKa

The degree of ionization has an impact on a drug's permeability and solubility and is pH- dependent. The profile of release and absorption is influenced by nonionized forms, which are often more permeable across biological membranes.

Molecular Mass

Compared to smaller molecules, drugs with larger molecular weights often diffuse through the SRDDS matrix or barrier more slowly, resulting in a longer release.

Polymorphism

The rate at which a medicine dissolves depends on whether it is crystalline or amorphous. While crystalline forms may result in continuous release, amorphous forms often have faster release profiles because to their greater solubility.

Stability of Drugs

Drug release may be impacted by chemical degradation (e.g., hydrolysis, oxidation). To sustain efficacy over time, stability in the gastrointestinal system and in the presence of SRDDS excipients is essential.

Interaction between Drug and Excipient

The release profile may be impacted by the way the medicine interacts with excipients (polymers, surfactants, etc.). While hydrophobic excipients may impede release, hydrophilic ones may accelerate it. [27,28,29,30]

CONCLUSION

Drug delivery using matrix-type sustained release devices is a promising strategy. They have many advantages, such as longer-lasting therapeutic effects, better patient compliance, and fewer adverse effects. Although there are still obstacles, developments in drug formulation, manufacturing processes, and polymer technology are pushing the boundaries of sustained release systems and boosting their effectiveness and versatility. Matrix-based drug delivery technologies will remain crucial to the advancement of contemporary therapies with additional study. After considering the aforementioned points, it is clear that sustained-release formulations aid to improve patient compatibility while also boosting dosage efficiency. Furthermore, all of these are reasonably priced. When it comes to antibiotics, where excessive usage might lead to resistance, the dosage form is highly beneficial and simple to adjust.

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