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Sustained Release of Matrix Tablet: An Overview

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ABSTRACT

Sustained release pharmaceutical products became a very useful tool in medical practice, offering a wide range of actual and perceived advantages to the patients. Sustained release is also providing promising way to decrease the side effect of drug by preventing the fluctuation of the therapeutic concentration of the drug in the body [1]. Sustained release matrix tablet is formulated mainly by wet granulation or direct compression method or by dispersion of solid particle within solid particle within a porous matrix formed by using different polymers like, HPMC etc. [2]. The basic rational behind sustained release drug delivery is to alter biopharmaceutical, pharmacokinetic and pharmcodynamic of drug to reduce side effect, give patient compliance and cure the disease. The matrix controls the release rate of drug. Release retardants like HPMC can aid in sustained release and thus they form core excipient of the formulation. The method involves the direct compression of blend of drug, retardant material and additives to formulate a tablet in which the drug is embedded in a matrix core of the retardant, alternatively granulation can be carried out prior to compression. Hydrophilic, hydrophobic, mineral, and biodegradable matrices may be use the drug release rate can be studied by in-vitro dissolution studies. Thus, sustained release matrix tablets can assure better patient compliance through reduction in total dose and dosage regimen, which can be of great help to treat chronic diseases [3].

Keywords*: Sustained release, Mechanism of drug release, Matrix tablet, Drug properties.*

INTRODUCTION

The delivery of accurate drug concentration to the site of action in order to achieve appropriate therapeutic effect or response in the body is the key objective of the drug delivery systems [4]. In order to achieve definite therapeutic responses, there is an alteration in the rate, site and kinetic performance of the API released inside the body in these types of drug delivery systems [4]. The best route of administration of drugs among all other routes is oral route of Administration. This is because of advantages like low manufacturing cost, ease of administration etc. For the release of medication for a long period of time After administration of a single dose. Sustained release Matrix tablets are used. Matrix tablets are the best commercial affordable sustained action drugs as they can accommodate large doses of drugs, no special requirements while manufacturing. Sustained release matrix type drug delivery system is the novel drug delivery system (NDDS) which plays an important role in improving the therapeutic effectiveness of the drugs by providing controlled, sustained release and by targeting to the desired site. A constant drug level is maintained for a specific period of time so that the adverse effects are cut down. The basic principle of sustained release drug delivery system is to enhance the pharmacokinetic and pharmacodynamic as well as biopharmaceutical properties in a way where its use is maximized, the side effects are cut down and the disease is cured efficiently when compared to conventional dosage forms [5]. In modern therapeutics, the controlled release/sustained release dosage forms have become extremely popular. The matrix system is a release system that prolongs and controls

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the release of a drug that has been dissolved or dispersed. Matrix tablets may be defined as the "oral solid dosage forms in which the drug or active ingredient is homogeneously dispersed throughout the hydrophilic or hydrophobic matrices which serves as release rate retardants". These systems release drug in continuous manner by dissolution-controlled and diffusion-controlled mechanisms [3].

Advantage of Sustained Release Drug Delivery System [6]

1. Since the frequency of drug administration is reduced, patient compliance can be improved, and drug administration can be made more convenient as well.
2. The blood level oscillation characteristic of multiple dosing of conventional dosage forms is reduced, because a more even blood level is maintained.
3. A less obvious advantage, implicit in the design of sustained release forms, is that the total amount of drug administered can be reduced, thus maximizing availability with a minimum dose.
4. In addition, better control of drug absorption can be attained, since the high blood level peaks that may be observed after administration of a high -availability drug can be reduced by formulation in an extended action form.
5. The safety margin of high -potency drugs can be increased, and the incidence of both local and systemic adverse side effects can be reduced in sensitive patients.
6. Overall, administration of sustained release forms enables increased reliability of therapy.

Disadvantages Sustained Release Drug Delivery System [6]

1) Administration of sustained release medication does not permit the prompt termination of therapy. Intermediate changes in drug need during therapy, such as might be encountered if significant adverse effects are noted, cannot be accommodated.
2) The physician has less flexibility in adjusting dosage regimens. This is fixed by the dosage form design.
3) Sustained release forms are designed for the normal population, *i.e.* on the basis of average drug biologic half lives. Consequently, disease states that alter drug disposition, significant patient variation, and so forth are not accommodated.
4) Economic factors must be assessed, since more costly processes and equipment are involved in manufacturing many sustained release forms.

Certain Considerations for the Formation of Sustained Release

Formulation [3]

1) If the pharmacological activity of the active compound is not related to its blood levels, time releasing has no purpose.
2) If the active compound has a long half-life (over 6 hours), it is sustained on its own.
3) If the absorption of the active compound involves an active transport, the development of a time-release product may be problematic
4) Finally, if the active compound has a short half-life, it would require a large amount to maintain a prolonged effective dose. In this case, a broad therapeutic window is necessary to avoid toxicity; otherwise, the risk is unwarranted and another mode of administration would be recommended.

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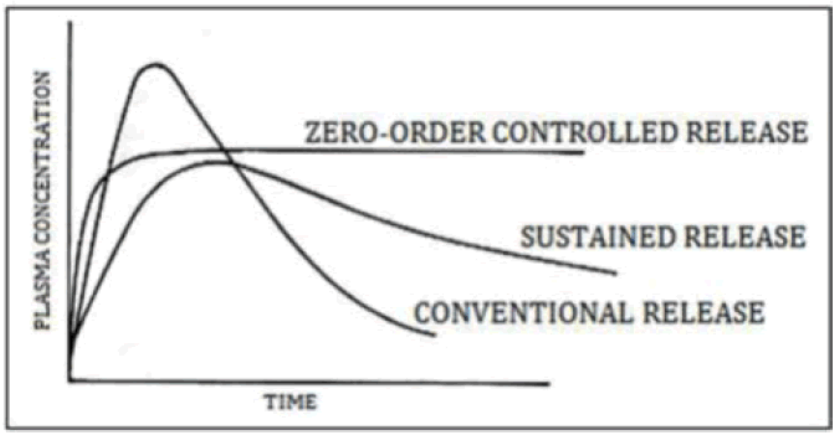

Figure 1. Plasma drug concentration vs. time profile for oral conventional dosing and single oral dose of sustained and controlled release formulation

Figure 1: Ideal Plasma Concentration Curves for Conventional Release, Zero Order Release, Sustained Release Drug Delivery System [7]

Classification of Sustained Release Drug Delivery System [8,9,10]

Classification of oral Sustained or Controlled Release Systems The controlled release systems for oral use are mostly solids and are controlled by dissolution, diffusion, or a combination of both mechanisms. Based on how drugs are published, these systems are listed as follows:

1) System of continuous release
2) Mechanisms of delayed transit and continuous release
3) Systems with a delayed release

1. Continuous release systems:

Through standard transportation of the dosage type, continuous release systems release the drug for a prolonged period of time over the entire length of the gastrointestinal tract. The following are the different systems that fall into this category:

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

a. Diffusion Controlled Release Systems

The rate-limiting step in these systems is the diffusion of dissolved drug through a polymeric barrier. Since the diffusion path length increases over time as the insoluble matrix is steadily depleted of drug, the drug release rate is never zero-order. The regulated drug delivery systems are based on the diffusion of a drug molecule through a polymeric membrane.

b. Dissolution-Controlled Release Systems

Dissolution-controlled release can be achieved by slowing the dissolution rate of a drug in the GI medium, incorporating the drug in an insoluble polymer, and coating drug particles or granules with polymeric materials of varying thickness The rate limiting step for dissolution

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of a drug is the diffusion across the aqueous boundary layer. The solubility of the substance provides the source of energy for drug release, which is countered by the stagnant fluid diffusion boundary layer.

The following equation can be used to approximate the rate of dissolution

(dm/dt): dm/dt = ADS/h…….(1)

Where,
A = Surface area of the dissolving particle or tablet
D = Diffusivity of the drug
S = Aqueous solubility of the drug
h = Thickness of the boundary layer

The two types of dissolution-controlled release are:

Matrix (or Monolith) Dissolution-Controlled Systems

The medication is suspended in an insoluble matrix of swellable hydrophobic or hydrophilic materials.

Reservoir Dissolution-Controlled Systems

This mechanism is hollow, with an inner drug core encased in a water-insoluble polymer membrane.

c. Dissolution and Diffusion Controlled Release Systems

The drug centre is encased in a partially soluble membrane in such systems. Pores are formed when sections of the membrane dissolve, allowing aqueous medium into the centre and thus drug dissolution, as well as the diffusion of dissolved drug out of the system.

d. Ion Exchange Resin-Drug Complexes

It is based on the formulation of a drug-resin complex that forms when an ionic solution comes into contact with ionic resins. The drug in this complex is exchanged in the gastrointestinal tract and released when there is an excess of Na+ and Cl present in most cases, an insoluble cross linked polymer resin is used in this system. They have a salt forming function group in a polymer chain that repeats.

e. pH-Independent Formulation

Because the majority of drugs are weak acids or bases, their release from sustained release formulations is pH dependent. However, a buffer can be added to the formulation, such as citric acid salt, amino acid, or tartaric acid, to help maintain a constant pH by delaying pH dependent drug release. Mixing a simple or acidic drug with one or more buffering agents, granulating with sufficient excipients, and coating with gastrointestinal fluid permeable film forming polymer results in a buffer retain release formulation. As gastrointestinal fluid passes through the membrane, the buffering agent changes the pH of the fluid within, resulting in a steady rate of drug absorption release.

f. Osmotic Pressure Controlled Systems

A semipermeable membrane is placed around the tablet, particle, or drug solution to allow water to enter the tablet, with drug solution eventually being pumped out through a small delivery aperture in the tablet cantered. The following are two types of osmotic pressure-controlled systems: a. With drug b, Type 1 has an osmotic core. Type 2 contains the drug in a

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flexible bag with an osmotic core surrounding it. By optimising the formulation and processing factors, an osmotic system can be developed to deliver a variety of drugs at a predetermined rate

2) Delayed Transit and Continuous Release Systems
These systems are designed to keep them in the GI tract for a longer period of time after they have been written. This category includes mucoadhesive and size-based systems, which are designed to detain in the stomach and therefore contain a medication that is stable at gastric pH.

4) Delayed Release Systems
Drug release is limited to a specific position in the GIT due to the nature of such systems. The following drugs can be contained in such a device:
Known to cause gastric distress

- Destroyed.
- Meant to extent local effect at a specific GI sit
- Absorbed from a specific intestinal site The two types of delayed release systems are
  - ✓ Intestinal release system
  - ✓ colonic release system

Matrix Tablets [11]
Matrix systems are widely used for the purpose of sustained release. It is the release system which prolongs and controls the release of the drug that is dissolved or dispersed. In fact, a matrix is defined as a well-mixed composite of one or more drugs with gelling agent i.e. hydrophilic polymers. By the sustained release method therapeutically effective concentration can be achieved in the systemic circulation over an extended period of time, thus achieving better compliance of patients.

These are the type of controlled drug delivery systems, which release the drug in continuous manner by both dissolutions controlled as well as diffusion-controlled mechanisms. To control the release of the drugs, which are having different solubility properties, the drug is dispersed in swell able hydrophilic substances, an insoluble matrix of rigid non swell able hydrophobic materials or plastic materials.

Advantages of Matrix Tablet

- Easy to manufacture
- Versatile, effective and low cost
- Can be made to release high molecular weight compounds
- The sustained release formulations may maintain therapeutic concentrations over prolonged periods.
- The use of sustain release formulations avoids the high blood concentration.
- Sustain release formulations have the potential to improve the patient compliance.
- Reduce the toxicity by slowing drug absorption
- Improvement in treatment efficacy.
- Minimize drug accumulation with chronic dosing.
- Usage of less total drug.
- Improvement the bioavailability of some drugs.
- Improvement of the ability to provide specialeffects.[6]

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Disadvantages of Matrix Tablet

- Release rate continuously diminishes due to increased diffusional resistances and decrease in effective area at the diffusion front.
- Increase potential for first pass metabolism.
- Greater dependence on GI residence time of dosage form
- Delay in onset of action.
- Release rate are affected by food and the rate transit through the gut.
- The remaining matrix must be removed after the drug has been released.

CLASSIFICATION OF MATRIX TABLETS

(A) On the Basis of Retardant Material Used

1. Hydrophilic Matrix Tablet [1]

Hydrophilic matrix may be formulated by a wet granulation of the drug and hydrophilic matrix materials or by direct compression of the blended mixture of active ingredient and certain hydrophilic carriers. The hydrophilic matrixes offer several advantages, such as ease of manufacture, cost effectiveness, uniformity of matrix tablets and broad regulatory acceptance. When immersed in fluid the drug release is controlled by a gel diffusion barrier that is formed and tablet erosion. The best choice to use in a hydrophilic matrix tablet formulation is the matrix building material with fast polymer hydration capability. An insufficient polymer hydration rate may cause premature diffusion of the drug and disintegration of the tablet owing to fast penetration of water.

2. Hydrophobic Matrices (Plastic Matrices)

The concept of using hydrophobic or inert materials as matrix materials was first introduced in 1959. In this method of obtaining sustained release from an oral dosage form, drug is mixed with an inert or hydrophobic polymer and then compressed in to a tablet. Sustained release is produced due to the fact that the dissolving drug has diffused through a network of channels that exist between compacted polymer particles. Examples of materials that have been used as inert or hydrophobic matrices include polyethylene, polyvinyl chloride, ethyl cellulose and acrylate polymers and their copolymers. The rate controlling step in these formulations is liquid penetration into the matrix. The possible mechanism of release of drug in such type of tablets is diffusion. Such types of matrix tablets become inert in the presence of water and gastrointestinal fluid.

3. Fat-wax Matrix Systems

The drug can be incorporated into fat-wax granulations by spray congealing in the air, blend congealing in an aqueous media with or without the aid of a surfactant and spray-drying techniques. The mixture of active ingredients, waxy materials and fillers also can be converted into granules by compacting with roller compactor, heating in a suitable mixture such as fluidized-bed and a steam jacketed blender or granulating with a solution of waxy Material or other binders. The drug embedded into a melt of fats and waxes is released by leaching and/or hydrolysis as well as the dissolution of fats under the influence of enzymes and pH change in the gastrointestinal tract. The addition of surfactants to the formulation can also influence both the drug release rate and the proportion of total drug that can being corporate into a matrix [12].

4. Biodegradable Matrix Systems

Biodegradable matrices are composed of monomers linked to one another through functional

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groups with unstable linkage. They degraded by enzymes generated by surrounding living cells or by non-enzymatic process into oligomers and monomers in the biological systems. These oligomers and monomers are then metabolized and excreted. Examples are natural polymers such as proteins and poly-saccharides; modified natural polymers; synthetic polymers such as aliphatic poly (esters) and polyanhydrides [12].

5. Mineral Matrices

The polymers obtained from different species of seaweeds are used to prepare mineral matrices. Alginic acid, a hydrophilic carbohydrate obtained from brown seaweeds (Phaephyceae) by the use of dilute alkali.

On the Basis of Porosity of Matrix [13]

In this the drug molecules diffuse across the matrix and produce sustained release. The matrix is further divided into 3 types.

Macro porous systems:

This type of matrix has pores that are larger than the diffusant molecule dimension, ranging from 0.1m to 1m. Drug permeation occurs through these pores in this type of system.

Micro porous systems: Drug molecules pass into pores with diameters ranging from 50 to 200 microns.

Non-porous systems: There are no pores in these structures. Molecule diffusion is mediated by network meshes. The polymeric phase is present, but there is no pore phase

MECHANISM OF DRUG RELEASE FROM MATRIX TABLET [14]

Drug in the outside layer exposed to the bathing solution is dissolved first and then diffuses out of the matrix. This process continues with the interface between the bathing solution and the solid drug moving toward the interior. It follows that for this system to be diffusion controlled, the rate of dissolution of drug particles within the matrix must be much faster than the diffusion rate of dissolved drug leaving the matrix.

Derivation of the mathematical model to describe this system involves the following assumptions:

a) A pseudo-steady state is maintained during drug release,
b) The diameter of the drug particles is less than the average distance of drug diffusion through the matrix,
c) The bathing solution provides sink conditions at all times.

The release behaviour for the system can be mathematically described by the following equation:

$$dM/dh = Co.\ dh - Cs/2 \quad \text{..... (1)}$$

Where,

dM = Change in the amount of drug released per unit area dh = Change in the thickness of the zone of matrix that has been depleted of drug Co = Total amount of drug in a unit volume of matrix Cs = Saturated concentration of the drug within the matrix.

Additionally, according to diffusion theory:

$$dM = (Dm.\ Cs / h)\ dt \quad \text{..... (2)}$$

Where,

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Dm = Diffusion coefficient in the matrix. h = Thickness of the drug-depleted matrix dt = Change in time

By combining equation 1 and equation 2 and integrating:

$$M = [Cs.\ Dm\ (2Co - Cs)\ t]^{1/2} \quad \text{(3)}$$

When the amount of drug is in excess of the saturation concentration then:

$$M = [2Cs.Dm.Co.t]\ 1/2 \quad \text{(4)}$$

Equation 3 and equation 4 relate the amount of drug release to the square-root of time. Therefore, if a system is predominantly diffusion controlled, then it is expected that a plot of the drug release vs. square root of time will result in a straight line. Drug release from a porous monolithic matrix involves the simultaneous penetration of surrounding liquid, dissolution of drug and leaching out of the drug through tortuous interstitial channels and pores.

The volume and length of the openings must be accounted for in the drug release from a porous or granular matrix:

$$M = [Ds.\ Ca.\ p/T.\ (2Co - p.Ca)\ t]\ 1/2 \quad \text{(5)}$$

Where,
p = Porosity of the matrix, t = Tortuosity, Ca = solubility of the drug in the release medium, Ds = Diffusion coefficient in the release medium, T = Diffusional path length.

For pseudo steady state, the equation can be written as:

$$M = [2D.Ca\ .Co\ (p/T)\ t]^{1/2} \quad \text{(6)}$$

The total porosity of the matrix can be calculated with the following equation:

$$p = pa + Ca/\rho + Cex\ /\ \rho ex \quad \text{(7)}$$

Where,
p = Porosity, ρ = Drug density, pa = Porosity due to air pockets in the matrix, ρex = Density of the water soluble excipients, Cex = Concentration of water soluble excipients.

For the purpose of data treatment, equation 7 can be reduced to:

$$M = k.\ t\ 1/2 \quad \text{(8)}$$

Where, k is a constant, so that the amount of drug released versus the square root of time will be linear, if the release of drug from matrix is diffusion-controlled. If this is the case, the release of drug from a homogeneous matrix system can be controlled by varying the following parameters:

- Initial concentration of drug in the matrix
- Porosity
- Tortuosity
- Polymer system forming the matrix
- Solubility of the drug.

Polymers used in the Matrix

The polymers most widely used in preparing matrix systems include both hydrophilic and hydrophobic polymers.

a) Hydrophilic Polymers [15]

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Hydroxyl propyl methylcellulose (HPMC), hydroxyl propyl cellulose (HPC), hydroxyl ethyl cellulose (HEC), Xanthan gum, Sodium alginate, poly (ethylene oxide), and cross-linked homopolymers and copolymers of acrylic acid.

b) Hydrophobic Polymers

This usually includes waxes and water-insoluble polymers in their formulation.

c) Natural Polymers [16]

Xanthan Gum, Guar Gum, Sodium Alginate, Pectin, Chitosan.

d) Biodegradable Polymers

Polylactic acid (PLA), Polyglycolic acid (PGA), Polycaprolactone (PCL), Polyanhydrides, Polyorthoesters26.

e) Non-biodegradable polymers

Polyethylene vinyl acetate (PVA), Polydimethylsiloxane (PDS), Polyether urethane (PEU), Polyvinyl chloride (PVC), Cellulose acetate (CA), Ethyl cellulose (EC).

FACTOR AFFECTING OF SUSTAINED RELEASE DRUG DELIVERY SYSTEM

Biological Factors

a) Absorption [3]

The rate, extent and uniformity of absorption of a drug are important factors when considering its formulation into an extended-release system. The most critical in case of oral administration is Kr<<<Ka. Assuming that the transit time of drug through the absorptive area of gastrointestinal tract is between 9-12 hours, the maximum absorption half-life should be 3-4 hours. This corresponds to a minimum absorption rate constant Ka value of 0.17-0.23/hr necessary for about 80-95% absorption over a 9-12 hr transit time. For the drugs with very slow rate of absorption (Ka<<0.17/hr), the first order release rate constant Kr less than 0.17/hr results in unacceptably poor bioavailability in many patients. Therefore, slowly absorbed drug will be difficult to be formulated into extended-release systems where the criterion Kr<<<Ka must be met. If the drug absorbed by active transport or transport is limited to specific region of GIT this drug are poor candidates for sustained release systems.

b) Biological Half-life

Drug with biological half-life of 2-8 hours is considered suitable candidate for sustain release dosage form, since this can reduce dosing frequency. However this is limited in that drugs with very short biological half lives may require excessive large amounts of drug in each dosage unit to maintain sustained effects, forcing the dosage form itself to become limit large. In general drug with short half life than 2 hr are poor candidates of sustained release systems.

c) Distribution [2]

The rate of elimination of drug is mainly depends upon the apparent volume of distribution. So, drugs with high apparent volume of distribution, influence the rate of elimination of the drug, these drugs are considered to be a poor candidate for oral SR drug delivery system. E.g., Chloroquine.

d) Protein Binding

To achieve pharmacological response unbound drug concentration is important rather than bound drug concentration and all drug bound to some extent to plasma and or tissue proteins.

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Protein binding of drug which shows a main role in its therapeutic effect in spite of the type of dosage form as extensive binding to plasma increase biological half-life and thus sometimes SR drug delivery system is not required for this type of drug.

e) Molecular Size and Diffusivity
In several sustained release systems Drug must diffuse through a rate controlling membranes or matrix. Ability of a drug to diffuse through membranes, it's so-called diffusivity (diffusion coefficient), is a role of its molecular size. An important influence upon the value of the diffusivity. 'D' in polymers is the molecular size for molecular weight of the diffusing species.

e) Margin of Safety
Safety of drug generally depends upon the therapeutic index, Larger the value of therapeutic index of a drug safer is the drug. Drugs having less therapeutic index are generally poor candidates for oral SR drug delivery system

Physicochemical Factors [4,17,18]

a) Dose Size [4]
In general, a single dose of 0.5-1.0 gm is considered maximal for a conventional dosage form to be administered orally. This also holds for sustained-release dosage forms.

b) **Aqueous Solubility**
Drugs with very low solubility (less than 0.01mg/ml) are inherently sustained. 0.1 mg/ml is considered the lower limit for the solubility of a drug to be formulated in a sustained-release system, therefore the solubility of the drug will limit the choice of mechanism to be employed in the sustained delivery system.

c) Partition Coefficient (P (o/w)
Partition coefficient is defined as the fraction of drug in an oil phase to that of an adjacent aqueous phase. Drugs that pass though biological membrane, if partition co-efficient of drug influences shows very much bioavailability because lipophilic nature of biological membrane. Drugs that have lower partition coefficient are not suitable for oral CR drug delivery system and drugs that have higher partition coefficient are also not suitable for oral SR drug delivery system because they will not partition out of the lipid membrane once it gets in the membrane

d) Drug pKa and Ionization at Physiological pH [17]
Drugs existing largely in ionized form are poor candidates for oral Sustained release drug delivery system. Absorption of the unionized drugs are well whereas permeation of ionized drug is negligible because the absorption rate of ionized drug is 3-4 times less than that of the unionized drug. The pKa range for acidic drug whose ionization is pH sensitive is around 3.0-7.5 and pKa range for basic drug whose ionization is pH sensitive is around 7.0-11.0 are ideal for optimum positive absorption. Drug shall be unionized at the site to an extent 0.1-5.0%

e) Stability
Both acid-base hydrolysis and enzymatic degradation can occur when drugs are taken orally. Systems that prolong distribution over the entire duration of transit in the GI tract are useful for drugs that are unstable in the stomach. Compounds that are unstable in the small intestine may have lower bioavailability when delivered from a sustaining dosage type.

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EVALUATION OF SDDS

Pre-Compression Studies

a) Angle of Repose (θ)

The angle of repose of granules was determined by the funnel method. The accurately weighed powder blend were taken in a funnel. The height of the funnel was adjusted in such a way that the tip of the funnel just touches the apex of the heap of the granules. The powder blend was allowed to flow through funnel freely onto the surface [19]. The diameter of the powder cone was measured and angle of repose was calculated using the following equation:

$$\theta = \tan^{-1} h / r$$

where
θ = angle of repose
h = height of the cone
r = radius of the cone base

Table 2: Relationship between Angle of Repose (θ) and Flow Ability

Angle of Repose (θ)	Flow Ability
< 20	Excellent
20 – 30	Good
30 – 34	Passable
> 40	Very poor

b) Bulk Density

The Bulk density of the powder was evaluated using bulk density apparatus. It is the ratio of total mass of powder to the bulk volume of powder. It was measured by pouring the weighed powder into a graduated measuring cylinder and the volume was noted. It is expressed in gm/ml and is

$$D_b = \frac{M}{V_b}$$

where
M= Mass of the powder

c) Tapped Density (Dt):

It is the ratio of total mass of powder to the tapped volume of powder. The tapped volume was measured by tapping the powder to constant volume. It is expresses in gm/ml and is given by

$$D_t = M/V_t$$

Where,
M= Mass of the powder
V_t= Tapped volume of powder

d) Compressibility Index (CI) and Hausner's Ratio (HR)

Carr's index or compressibility index and Hausner's ratio measure the propensity of powder to be compressed and the flow ability of powder. Carr's index and Hausner's ratio were calculated using the following formula given by

$$\text{Carr's index} = \frac{\text{Tapped density} - \text{Bulk density}}{\text{Tapped density}} \times 100$$

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$$\text{Hausner Ratio} = \frac{\text{Tapped density}}{\text{Bulk density}}$$

Table 3: Effect of Carr's Index and Hausner's Ratio on Flow Properties

Compressibility Index (%)	Flow Properties	Hausner's Ratio
1-10	Excellent	1.00-1.11
11-15	Good	1.12-1.18
16-20	Fair	1.19-1.25
21-25	Passable	1.26-1.34
26-31	Poor	1.35-1.45
32-37	Very poor	1.46-1.59
＞38	Very very poor	＞1.60

Post Compression Studies [20]

a) Thickness and Diameter

Thickness and diameter of the tablets were measured using a Vernier caliper. Three tablets of each formulation were picked randomly and the dimensions of each three tablets were measured in mm. This was done in triplicate and standard deviation was calculated [20].

b) Weight Variation Test

The Weight variation test was carried out in order to verify the uniformity of the weight of tablets in each formulation. 20 Tablets were selected randomly and weight individually to check for the weight variation. he following percentage deviation in weight was allowed [20].

Table 4: Limits for Weight Variation (USP)

Average weight of a tablet	Percentage deviation (%)
130 mg or less	±10
More than 130mg and less than 324mg	±7.5
324mg or more	±5

c) Hardness of Tablets

The tablet hardness, which is the force required to break a tablet in diametric compression force were measured by the Monsanto hardness tester.

d) Friability

The friability of the tablets was measured in a Roche friabilator. 20 tablets were weighed initially (Wo) and was placed in the friabilator and the drum was revaluated for a fixed time of 100 revolutions and weighed (W1) again. Percentage friability was calculated from the loss in weight as given in equation as below. The weight loss should not be more than 1%.

$$\text{Friability (\%)} = \frac{\text{Initial Weight (Wo)} - \text{Final Weight (W1)}}{\text{Initial Weight (Wo)}} \times 100\%$$

CONCLUSION

The review of the above article is mainly focused on the formulation and uses of the SRDDS. It concludes that the use of matrix tablets was really helpful to overcome the patient compliance problems which are associated with the conventional dosage forms. The cost of

production of the matrix tablets is also under control. Due the use of these tablets the daily required frequency of the doses was also reduced.

REFERENCES

1) N.G Raghavendra Rao, K.Richard Prasanna Rai, B.Sanjeev Nayak. Review on Sustained Release. International Journal of Pharmaceutical Research and Allied Scienes. 2013; 2(3); 1-17.
2) H.D Zalte, R.B Saudagar. Review on Sustained Release Matrix Tablet. International Journal of Pharmaceutical Research and Allied Sciences. 2013;3(4);17-29
3) Anil B. Phad , N.B Mahale, et al .As a Sustained release of Drug Delivery System. World Journal of Pharmaceutical Research. 2014;3(5);1377-1390.
4) Abdulsalam Alhalmi. Marwan Altowairi et al. Sustained Release Matrix System. An Overview. World Journal of Pharmacy and Pharmaceutical Science. 2018;7(6);1470-1486.
5) A.Rohit Kumar, Arjun Sai Sreekar Aeila. Sustained Release Matrix Type Drug Delivery System.World Journal of Pharmacy and Pharmaceutical Sciences.2019;9(1);470-480.
6) Lachman, Liebermans. The Theory and Practice of Industrial Pharmacy. 4th edition. New Delhi. CBS publishers and Distributors pvt.Ltd. 2013;597-620.
7) Oral Sustained Release Tablet: An Overview with a special emphasis on Matrix Tablet.www.imedpub.com.2022/5/14/Am.
8) Parashar T, Soniya, Singh V, Singh G, Tyagi S , Patel C , Gupta G. Novel oral sustained release technology: A concise review. Int. J. Res. Dev. Pharm. L. Sci. 2013; 2(2):262-9.
9) Agarwal G,Agarwal S, Karar P.K, Goyal S. Oral sustained release tablets: An Overview with a Special Emphasis on matrix tablet. Ame J Adv Drug Deliv. 2017;5(2):64-76.
10) Mandev Mehta, H.S Keerthy, Rajkumar Prasad Yadav. Sustained Release Matrix Tablet. Asian Journal of Pharmaceutical Research and Development.2021;9(3);112-117.
11) Patel H, Panchal DR, Patel U, Brahmbhatt T, Suthar M. Matrix type drug delivery system: A review. J Ph'calSci&Biosci Res. 2011; 1(3):143-51.
12) Mondal NI. The role of matrix tablet in drug delivery system. Int J App Pharm. 2018;10(1):1-6.
13) Kumar A.R, Aeila A.S.S. Sustained release matrix type drug delivery system: An overview. World J Pharm Pharm Sci,2019;8(12):470-80.
14) Harnish Patel, Dhrupesh R.Panchal et al. Matrix Type Drug Delivery System. Journal Of Pharmaceutal Science and Bioscientific Research.2011;1(3);143-151.
15) Ujjwal Nautyal, Deepak, Diksha Gupta. Oral Sustained Release Tablets. An Overview with a special Emphasis on Matrix Tablet. International Journal Of Health and Biological Sciences. 2020;3(1);6-13.
16) Prakhar Agarwal, Semimel Akhtar. A Comprehensive Review on Sustained Release Tablets. A Promising Dosage forms. Universal Journal of Pharmaceutical Research.2018;3(6);53-58.
17) Ratnaprachi M.P, Gupta Jyotip. Sustained Release Oral Drug Delivery System. International journal of Pharma Research and Review. 2013;2(3);11-21.
18) D.M. Brahmankar, Sunil B. Jaiswal. Biopharmaceutics and Pharmacokinetics. 2nd edt.New Deli.Vallabh Prakashan;2009:397-430.
19) Prasanna KD, Vaishnavi G, Divya K, Lakshmi U. An Overview on Preformulation Studies: *Indo Am J Pharm Sci.* 2015;2(10):1399-407.
20) Indian Pharmacopoeia, New Delhi: Ministry of Health and Family Welfare, Government of India, Controller of Publications, vol. II,2014;2344-45.