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# A BRIEF OVERVIEW OF THE MATRIX TYPES SUSTAINED RELEASE DRUG DELIVERY SYSTEM.

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**ABSTARCT:**

Oral sustained release (SR) products offer an advantage over traditional dosage forms by optimizing biopharmaceuticals, pharmacokinetic and pharmacodynamic properties of drugs to reduce the frequency of administration as much as possible once daily is sufficient for penetration, polymer swelling, drug dissolution, drug diffusion and matrix erosion. Superior water-soluble drugs such as diltiazem; Ranitidine is formulated in sustained-release matrix tablets. This article contains basic information on the design of slow-release preparations and their different types. Development, solid and sustained-release oral matrix tablet, has always been a challenge for the pharmaceutical technologist. Most drugs, if not properly formulated, can release, and likely produce the toxic drug concentration after oral administration. Hydrophilic polymers have become the preferred product as an important product Ingredient for formulating sustained release preparations.

**KEYWORDS:** Sustained release, Matrix system, Polymers, Controlled drug delivery.

## INTRODUCTION:

The sustained-release dosage form has received increased attention due to the greater flexibility in dosage form design in the oral delivery system. A new drug delivery system offers improved therapeutic drug efficacy by providing sustained and controlled delivery, targeting drug to the desired site. (Sahu et al.,2017). These are types of controlled drug delivery systems that continuously release the drug via mechanisms controlled by both dissolution and diffusion. To control the release of drugs that have different dissolution properties, the drug is dispersed in swelling hydrophilic substances, an insoluble matrix of non-swelling inflexible hydrophobic substance or plastics. (Jaimini et al.,2012).

Oral Sustained release (SR) preparations offer an advantage over traditional dosage forms by optimizing the drugs' biopharmaceutical, pharmacokinetic, and pharmacodynamic properties in a way that reduces dosing frequency to the point that the single daily dose is sufficient for penetration, swelling of polymer, drug dissolution, drug diffusion and matrix erosion. (Karyekar et al.,2017).

The advantages of administering a single dose of a drug that is released over a prolonged period, as opposed to administering multiple doses, have since become clear to the pharmaceutical industry for a while. The desire to maintain near-constant and uniform blood drug levels often results in improved patient compliance as well as increased clinical efficacy of the drug in accordance with its intended use. Due to the complications and increased costs associated with bringing new drug entities to the market, it has focused more on the development of sustained or controlled drug release systems. The matrix system is used as sustained release. It is a delivery system that prolongs and controls the release of a dissolved or dispersed drug. Actually, a matrix is defined as a well-mixed compound of one or more drugs with a gelling agent, i.e., hydrophilic Polymers. The purpose of an extended-release dosage form is to maintain a therapeutic plasma level of the drug over a longer period of time. (Rao et al., 2013).

**ADVANTAGES OF A SUSTAINED-RELEASE DRUG DELIVERY SYSTEM OVER A TRADITIONAL DOSAGE FORM:**

1. Reduced dosing frequency.
2. Dose reduction.
3. Improved patient compliance.
4. A constant drug concentration in the blood plasma.
5. Reduced overdose toxicity.
6. Reduces the fluctuating concentration of valley peaks.
7. Nocturnal dosing can be avoided. (Navrang et al., 2022).

**DISADVANTAGES OF A SUSTAINED-RELEASE DRUG DELIVERY SYSTEM OVER A TRADITIONAL DOSAGE FORM:**

1. Dose dumping: Dose dumping can occur with incorrect formulation.
2. Reduced dose titration.
3. costs more than a conventional dosage form.
4. Increases potential for first-pass metabolism.
5. Education of the patient about the correct administration of medication is necessary. (Brahmankar; Reddy et al., 2020 )

**THE MATRIX SYSTEM:**

The Matrix device, as its name suggests, contains a similarly dispersed substance in a polymer matrix. In the model, the outer layer exposed to the bath solution first dissolves and then disperses the matrix.

This process continues at the interface between the solvent solution and the solvent soluble solution, apparently the dissolution rate of the drug particles in the matrix must be too fast for the dispersion to consume the solute for the system to control the dispersion of the drug that leaves the Matrix. (Tarun et al., 2013 ; Pareek et al.,2019)

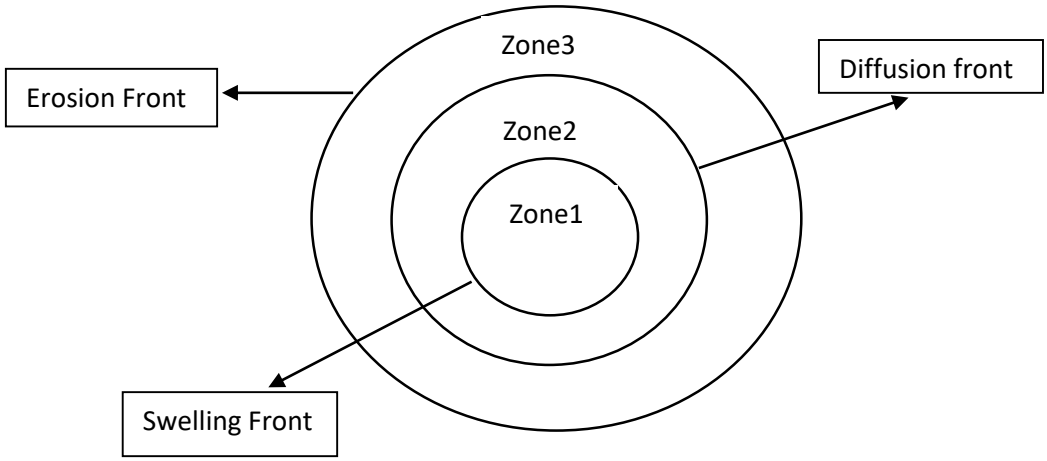


**Fig 1: - Sustained Release Matrix System**

**MATRIX TYPES:**

- **Hydrophobic Matrix**

In this method of manufacturing an extended-release oral dosage form, the drug is mixed with an inert or hydrophobic polymer and compressed into a tablet. Stable emissions are created by distributing the dissolving solvent through a network of channels that exist between the composite polymer particles. Examples of substances that have been used as inert or hydrophobic substances include polyethylene, Polyvinyl chloride, ethyl cellulose and acrylate polymers and their copolymers. (Maderuelo et al., 2011)

- **Lipid Matrix**

These matrices are made from lipid waxes and related materials. The release of active ingredients from these matrices occurs both by diffusion and by erosion of the pores. The release properties are therefore more sensitive to the composition of the digestive fluid than to the completely insoluble polymer matrix. Carnauba wax in combination with stearyl alcohol or stearic acid has been used as a delay base for many sustained release formulations. (Alhalmi et al., 2010 )

- **Hydrophilic Matrix**

Hydrophilic polymer matrix structures are usually utilized in controlled oral drug shipping applications due to their flexibility to achieve the desired drug release profile, cost-effectiveness, and wide regulatory acceptance. Formulation of drugs in capsules or tablets based on hydrophilic polymers with high gelling power Excipients are of particular interest in the area of controlled release. A matrix infection is defined as a well-mixed combination of one or more drugs with a gelling agent (a hydrophilic polymer). These systems are called controlled release intumescent systems. (Langer et al.,2019)

The polymers used to produce hydrophilic matrices are divided into three main groups.

A. Hydroxypropyl methylcellulose (HPMC) 25, 100, 4000 and 15000 cPs; and sodium carboxymethyl cellulose. Cellulose derivatives Methyl cellulose 400 and 4000 cPs, hydroxyethyl cellulose.

B. Natural or semi-synthetic non-cellulose agar agar polymers; locust bean gum; alginates; Molasses; Mannose and galactose polysaccharides, chitosan and modified starches.

C. Carbopol-934 acrylic acid polymers, the most commonly used grade.

- **Biodegradable Matrix**

These are polymers that bind together monomers that are bound together by functional groups and have unstable backbone connections. It is biologically damaged or broken down by enzymes produced by surrounding living cells or by a non-enzymatic process into oligomers and monomers that can be broken down metabolized or excreted. Examples are natural polymers such as proteins and polysaccharides; replacement of natural polymers; manufactured polymers such as aliphatic poly(esters) and polyanhydrides. (Nokhodchi et al., 2012)

- **Mineral matrix**

Consisting of polymers obtained from various types of algae. An example is alginic acid, a hydrophilic carbohydrate obtained from a species of brown algae (Phaephyceae) using dilute bases. (Harris et al.,1998 )

## METHODS OF PREPARATION:

- **Direct Compression**

In this method, the first powder is mixed or blended, and the powder materials are directly compressed without affecting the properties of the drug, such as physical and chemical properties to change. (Misal et al.,2013)

- **Wet granulation**

In this method, a measured amount of drug and excipients is mixed with a sufficient volume of granulating agent. Once sufficient consolidation has been achieved, the wet weight is taken into account. The dried pellets are then Tested on dry granules, then mixed with lubricant and

disintegrant to produce compressed "liquid powder" tablets with a single pierceable tablet compressor. (Shah et al.,2015)

- **Melt granulation**

This process uses a substance that melts at low temperatures. This substance can be added by dissolving it in the substrate, which is then heated above its melting point. Various lipophilic bindings were tested using a granular solution.

- **The Hot Extrusion Process**

In the hot extrusion process, a mixture of active ingredients, thermoplastic polymers and other processed materials is fed into the extruder barrel through a hopper. The materials are transferred into the hot tube by a rotating screw. The soluble substances and the high-temperature melt are processed continuously using an attachment at the end of the cylinder. Depending on the size of the nozzle cylinder, the extruder can also produce films. (Tonde et al.,2022)

## POLYMERS USED IN SUSTAINED RELEASE TABLETS:

The most commonly used polymers to make the matrix system include both hydrophilic and hydrophobic polymers.

a) **Hydrophilic polymers -** typically include hydroxypropyl methyl cellulose (HPMC), hydroxypropyl cellulose (HPC), hydroxyethyl cellulose (HEC), xanthan gum, sodium alginate, polyethylene oxide, and crosslinked homopolymers and copolymers of acrylic acid (Tangde et al.,2022 )

b) **Hydrophobic polymers** - typically include waxes and water-insoluble polymers. (Li H et al.,2007)

c) **Natural Polymers** - Xanthan Gum, Guar Gum, Sodium Alginate, Pectin, Chitosan. (Hayashi et al., 2007)

## FACTORS AFFECTING DRUG RELEASE FROM MATRIX TABLETS:

### A. Physicochemical Factors

#### a. Dose Size

In general, a single dose of 0.5 to 1.0 g is the maximum for a conventional dosage form. drugs or High doses (>500 mg) are difficult to formulate into a matrix system due to the need for large amounts of polymer and other matrix-forming substances (excipients). Compounds requiring high doses sometimes it can be administered in multiple doses or formulated in liquid systems. (Prakhar et al.,2012)

**b. Drug Solubility**

Polymer erosion is more dominant in the matrix for insoluble drugs, while for soluble drugs the combination of diffusion and erosion leads to drug release. The diffusion of a drug depends on the concentration gradient in the medium, which is a function of solubility. Therefore, a drug with high solubility will be released faster, while drugs with low water solubility. (Gupta et al.,2012)

**c. Water solubility, Ionization and pKa**

Most drugs are susceptible acids or susceptible bases. While the drugs penetrate in unchanged form. In case of drug penetration, it is better to administer the drug as is. Unfortunately, the water solubility is reduced by the more complex conversion into the unchanged form. Diffusion or solution dependent delivery systems. It also depends on the solubility of the drug in the aqueous environment.

**d. Partition Coefficient**

When a drug is administered into the digestive tract, it must cross various biological membranes in order to have a therapeutic effect in another area of the body7. Highly lipophilic compounds. The partition coefficients are poorly soluble in water and persist longer in lipophilic tissues. For compounds with a very low partition coefficient, it is very difficult for them to penetrate the membrane which leads to low bioavailability. It is generally believed that these membranes are lipidic; therefore, the partition coefficient of oil-soluble drugs becomes important in determining efficacy. (Pagar et al., 2018)

**B. BIOLOGICAL FACTORS AFFECTING TABLET MATRIX RELEASE:**

**a. Biological half-life**

Drugs with a short half-life are best a candidate for a sustained release formulation. Drugs with a half-life of less than 2 hours, such as B. levodopa are poor candidates for a sustained release formulation. Drugs with a half-life of more than 8 hours are also not suitable for use in prolonged-release formulations because their effect is already prolonged, such as digoxin and phenytoin**.** (Verma et al.,2017)

**b. Absorption**

The goal in developing a sustained release product is to control the rate of release of the drug, which is much slower than the rate of absorption. If we assume the transit time of most drugs through the lymphatic areas of the gastrointestinal tract is about 8-12 hours, the extreme absorption half-life is expected to be about 3-4 hours, removing the dosage form from the likely regions of absorption prior to drug release.

**c. Distribution**

The elimination rate of the drug depends mainly on the apparent volume of distribution. Therefore, medicinal products with a large apparent volume of distribution influencing the elimination rate of drugs, these drugs are considered poor candidates for an oral delivery system for sustained-release drugs such as e.g., Chloroquine. (Chauhan et al.,2017)

**EVALUATIONS OF SUSTAINED-RELEASE MATRIX TABLETS:**

Product strength, safety, stability, and reliability must be ensured before an extended-release product is put on the market by in vitro molding and the like In vivo analysis and correlation. Several authors have discussed the parameters and evaluation methods for sustained release formulations. (Pagar et al.,2011)

a. **Weight Variation:** Twenty weighed tablets the average weight of the tablets was calculated individually and then together. (Hadi et al.,2013)
b. **Hardness:** Hardness testing was performed on each batch of tablets using a Monsanto hardness tester and average values were calculated.

c. **Friability:** Tablets were tested for friability using a Roche friability controller run at 25 rpm for 4 minutes. (Madgulkar et al.,2011)
d. **Thickness**: The thickness of the tablets was determined using a micrometre gauge.
e. **Content Uniformity:** Using a UV-visible spectrophotometer, the amount of drug was determined using the standard curve method. (Reddy ; Zalte et al.,2013)

## CONCLUSION:

This evaluation article makes a speciality of the improvement of sustained release matrix tablets, advantages and disadvantages and different polymers used to design such a system. Over Discussion concludes that matrix pills help overcome patient compliance and dose efficacy worthwhile therapeutic response issues associated with standard dosage forms. Costs power and volume once a day combined points and other benefits. For this reason, matrix tablets were brought onto the market sustainably improves volume formation.

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## REFERENCES:

1. Sahu R, Saha S. SUSTAINED RELEASE MATRIX TYPE DRUG DELIVERY SYSTEM.
2. Jaimini M, Kothari AH. Sustained release matrix type drug deliery system: A review. Journal of drug delivery and therapeutics. 2012 Nov 15;2(6).
3. Karvekar M, Khan AB. A brief review on sustained release matrix type drug delivery system. Journal of pharmaceutical research. 2017 Sep 1;16(3):282-9.
4. Rao NG, Raj K, Nayak BS. Review on Matrix Tablet as Sustained Release. International Journal of Pharmaceutical Research & Allied Sciences. 2013 Jul 1;2(3).
5. Navrang D, Joshi D, Mahajan SC, Jain V, Sharma A. A CONCISE REVIEW ON "SUSTAINED RELEASE DRUG DELIVERY SYSTEM".
6. Brahmankar DM, Jaiswal SB. Biopharmaceutics and Pharmacokinetics: Pharmacokinetics, 2nd Edn, published by Vallabh Prakashan.
7. Reddy YK, Nagaraju A. Formulation and In vitro Evaluation of Sustained Release Matrix Tablet of Azathioprine. Magnesium. 2020 May 7;61(128.5):111.
8. Tarun P, Vishal S, Gaurav S, Satyanand T, Chirag P, Anil G. Novel oral sustained release technology: a concise review sustained release drug disadvantages. Int J Res Dev Pharm Life Sci. 2013;2(2):262-9.
9. Pareek SP, Kumawat S, Sharma V, Sharma D, Rathore DS, Agarwal M. Review on sustained release technology. Int J Pharm Bio Sci Archive. 2019;7(6):29-38.
10. Maderuelo C, Zarzuelo A, Lanao JM. Critical factors in the release of drugs from sustained release hydrophilic matrices. Journal of controlled release. 2011 Aug 25;154(1):2-19.
11. Alhalmi A, Altowairi M, Saeed O, Alzubaidi N, Almoiliqy M, Abdulmalik W. Sustained release matrix system: an overview. World J Pharm Pharm Sci. 2018 Apr 17;7(6):1470-86.
12. Langer RS, Wise DL. Medical applications of controlled release. CRC Press LLC; 2019 Jun 4.
13. Nokhodchi A, Raja S, Patel P, Asare-Addo K. The role of oral controlled release matrix tablets in drug delivery systems. BioImpacts: BI. 2012;2(4):175.
14. Harris LD, Kim BS, Mooney DJ. Open pore biodegradable matrices formed with gas foaming. Journal of Biomedical Materials Research: An Official Journal of The Society for Biomaterials, The Japanese Society for Biomaterials, and the Australian Society for Biomaterials. 1998 Dec 5;42(3):396-402.
15. Misal R, Atish W, Aqueel S. Matrix tablet: A Promising Technique for Controlled drug delivery. Indo American Journal of Pharmaceutical Research. 2013; 3:3791-805.

16. Shah N, Oza C, Trivedi S, Shah N, Shah S. Review on sustained release matrix tablets: An approach to prolong the release of drug. J Pharm Sci Bio Sci Res. 2015;5(3):315-21.
17. Tonde N. Gaikwad A. Raykar M. A review on sustained release matrix tablet. International Journal Of Creative Research Thoughts .2022 May.
18. Tangde S., Gavhane YN., Dr.Saboo. S.s. Sustained release matrix type drug delivery systems. A Review. International Journal of Creative Research Thoughts. 2021 March.
19. Li H, Gu X. Correlation between drug dissolution and polymer hydration: A study using texture analysis. International journal of pharmaceutics. 2007 Sep 5;342(1-2):18-25.
20. Hayashi T, Kanbe H, Okada M, Kawase I, Ikeda Y, Onuki Y, Kaneko T, Sonobe T. In vitro and in vivo sustained-release characteristics of theophylline matrix tablets and novel cluster tablets. International journal of pharmaceutics. 2007 Aug 16;341(1-2):105-13.
21. Prakhar A, Akhtar S. A comprehensive review on sustained release matrix tablets: a promising dosage form. Universal Journal of Pharmaceutical Research. 2018;3(6):49-54.
22. Gupta MM, Ray B. A review on: sustained release technology. International Journal of Therapeutic Applications. 2012; 8:1-23.
23. Pagar R, PATIL D, PAWAR P, Ghule RS, Bairagi VA. Formulation and development of sustained release matrix tablets of lornoxicam. Journal of Drug Delivery and Therapeutics. 2018 Mar 14;8(2):102-6.
24. Verma BK, Pandey S, Arya P. Tablet granulation: current scenario and recent advances. Universal Journa of Pharmaceutical Research. 2017;2(5):30-5.
25. Chauhan V, Kumar K, Teotia D. Fast dissolving tablets: a promising approach for drug delivery. Universal Journal of Pharmaceutical Research. 2017;2(4):51-7.
26. Pagar HB, Shinde UP, Barhate SD, Bari MM, Janjale MV, Agrawal YS. Formulation and evaluation of indomethacin sustained release matrix tablets. Inventi Rapid NDDS. 2011;4.
27. Hadi A, Rao AS, Vineeth P. Formulation and Evaluation of Once Daily Sustained Release Matrix Tablets of Terbutaline Sulphate for the Treatment of Nocturnal Asthma. Research Journal of Pharmaceutical Dosage Forms and Technology. 2013;5(1):27-32.
28. Madgulkar Ashwini R, Bhalekar Mangesh R, Warghade Nikhil S, Chavan Nilesh S. Preparation and evaluation of sustained release matrix tablet of Nateglinide: effect of variables. Inventi Rapid: NDDS. 2011 Mar 23.
29. Reddy AM, Karthikeyan R, Vejandla RS, Divya G, Srinivasa P. International Journal of Allied Medical Sciences and Clinical Research (IJAMSCR).
30. Zalte HD, Saudagar RB. Review on sustained release matrix tablet. International Journal of Pharmacy and Biological Sciences. 2013 Oct;3(4):17-29.