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REVIEW OF NATURAL GUM AS A SUSTAINED RELEASE EXCIPIENT IN TABLET FORM

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ABSTRACT

As a result of the search for abundant natural polymers and the desire to minimize the use of synthetic excipient in formulation development, new natural excipient are being discovered and new uses for existing excipient are being identified. They are safe and effective, which is why they are increasingly used in formulation development. Due to batch-to-batch variation and unreliable content uniformity, the use of natural gums and polymers in the development of pharmaceutical formulations is not as expected. The act of utilizing In addition, natural gum is a cheaper alternative to many existing excipient. Natural materials such as gums and mucilage are widely used in conventional and novel drug delivery methods, respectively. To identify the potential of natural polymers in modulating drug release from formulations of different dosage forms, and to demonstrate their utility in pharmaceutical drug carrier systems. They are designed primarily to provide controlled or sustained drug delivery. To determine the natural gum's physical and chemical properties, tests were performed on the gum's solubility, loss on drying and total and acid-insoluble ash content, as well as its swelling and micromeritic properties. Information about the use of natural polymers is provided in this article.

KEYWORDS: Natural Gum, Sustain Release, Tablet Formulation, Polymer, Content Uniformity.

1. INTRODUCTION

Oral route is the most preferred route for administration of drugs. Tablets are the most popular oral formulation available in the market and preferred by the patients and physician alike. In long term therapy for the treatment of chronic disease conditions conventional formulations are required to be administered multiple doses and therefore have several disadvantages. The primary benefit of a sustained release dosage form, compared to a conventional dosage form, is the uniform drug plasma concentration and therefore uniform therapeutic effect. Over the past two decades, sustained release dosage forms have made significant progress in terms of clinical efficacy and patient compliance. Matrix devices, due to their chemical inertness, drug embedding ability and drug release character, have gained steady popularity for sustaining the release of a drug. Hydrophilic matrices are an interesting option when developing an oral sustained release formulation. The drug release from such matrices can be controlled through their physical properties. Polysaccharides are the choice of materials among the hydrophilic polymers used, because they are nontoxic and acceptable by the regulating authorities. Drug products designed to reduce the frequency of dosing by modifying the rate of drug absorption have been available for many years Sustained Release provides the most desirable dosing regimens with effective pharmacokinetic profile and pharmacodynamics response in treatment. This approach help to maintain drug input and it may ease the variability involved in the administration of multiple doses per day. Thus Sustained Release Dosage Form improves patient compliance. Natural polysaccharides play a significant role in the formulation development of a new controlled release dosage forms as well as in human health care system. In recent years, natural polysaccharides are growing rapidly and it continues to remain and important in the new formulation development of the controlled released dosage form. Natural polysaccharides are much safer than synthetic. They provide many applications in the formulation development of a new controlled release dosage form, such as binder, disintegrator, diluents and release modifier. Therefore, they needs a novel approach to enhance the use of natural polysaccharides in the formulation development of controlled released dosage form, because of the ease availability at an affordable price, high safety margin and higher productivity. Hence, the present study is aimed to enhance the use of natural plant based polysaccharide as a release modifier to develop sustained released tablets.[1, 2, 3] In latest years, polymers derived from plant origin have proven terrific hobby because of their numerous pharmaceutical packages consisting of diluent, binder, disintegration tablets, oral fluids, colloids to prevent drying, gelling

sellers in gels, and foundations in the suppository.[1] They may be also used in cosmetics, paints, fabric, and paper making.[2] Those natural gums and mucilage's are desired over synthetic due to the fact they are dual, cheaper, and more easily available than synthetic ones. Herbal remedies also are popular in synthetic and semi synthetic materials due to the dearth of pollution, low price, comforting action, availability, and the volatile nature of the extractors.[3-6] Call for these gadgets are developing and new sources are being evolved. India, due to its geographical and environmental repute, has historically been a great supply of such merchandise among Asian countries. Gums and Mucilage's. Gums are considered to be transportable products, crafted from plant damage or detrimental conditions, which includes drought, mobile damage (further cell formation: gummosis). Mucilage is mostly a everyday product of metabolism (body products), which is shaped in the cell (the internal shape of cells). The gums are without problems dissolved in water, and the mucilage bureaucracy a small mass. each gums and mucilage's are hydrocolloids flowers that produce a combination of sugars and uronic acids in hydrolysis.[7] Separation primarily based on supply:(a) Gums of marine beginning / algal (seaweed): agar, carrageen, alginic acid, and laminarin;(b) the foundation of the plant:(i) shrubs / trees emerge: gum arabic, gum ghatti, gum karaya, gum tragacanth, and domestic and albizia gums;(ii) seed gums: guar gum, locust bean gum, starch, amylose, and cellulose;(iii) extracts: pectin, larch gum;(iv) tuber and roots: potato starch;krestin, and scleroglucan. Separation and cleansing of the gums with Mucilage's. Mucilage may be extracted from plant parts by means of various way along with warmth, solvent rain, and microwave-assisted auxiliary. An easier manner than simply heaven. in this way the a part of the plant that includes the gum / mucilage is chosen following the drying, grinding, and sifting of that a part of the plant. That is then stirred in distilled water and heated to a full unfold in distilled water and saved for 6-8 h at room temperature. The supernatant is acquired via centrifugation. The remnants are then washed with water and washed after which placed in a extra powerful character separated. A rain solvent is selected and, in the end, the supernatant is doubled the extent of the precipitin solvent via non-stop stirring. Changed goods are washed and distilled Water and then dried at 50-60∘C underneath the machine. Planting material need to be treated with petroleum ether and chloroform (for remove pork and chlorophyll) after which with refined water.[8,9] Comparisons of gums with Mucilage's. Initial assessments to verify dry gums and.[10] Performing art, evaluation techniques can be prepared by means of the sort of facts being produced. Shape. Gums and mucilage's are polysaccharides and comprise sugar. Therefore, the confirmation of the numerous sugars gift can be executed by way of chromatography (TLC / HPLC) and structural specification may be completed through FTIR, mass, and NMR spectroscopy. Cleanliness. To determine the purity of selected tissues and mucilage, tests have been carried out on alkaloids, glycosides, steroids, carbohydrates, flavonoids, terpenes, amino acids, saponins, oils and fats, and and tannins and phenols.pollution Profile. Suitable analytical strategies may be used to assess pollution. Physicochemical homes. coloration, aroma, taste, texture, texture, touch, melting, pH, indication of infection, dryness loss, hygroscopic nature, resting angle, bulk firmness and proper firmness, porosity, and facial firmness may be estimated. Microbial load and the presence of certain pathogens also are determined. The gums and mucilage's are more visible in nature. Therefore, the rheological properties of excipient are a vital means of determining their business use.

1.2 Advantages OF herbal resources

A. Land acquisition: In developing countries, governments are selling the production of crops which include guar gum and Tragacanth due to their good sized use in numerous industries.

B. Compact and non-toxic: Obviously, almost all of those plant extracts are carbohydrates composed of repeating devices of sugar (mono saccharine). Consequently, it is reliable.

C. Perishable decay: Organically derived polymers produced by way of all residing organisms represent a truly renewable supply and haven't any unfavourable effect on people or environmental health (e.g. pores and skin and eye irritation).

1. Three Nature herbal sources

A. decreased viscosity in retention: Commonly, whilst gums and mucilage come into contact with water there's an increase inside the viscosity of the formation. due to the complicated nature of the gums and mucilage (mono saccharides in polysaccharides and compounds), it has been determined that when garage there may be a decrease in viscosity.

B. Batch to batch variation: Energetic manufacturing is a managed manner with a set number of components, while the production of gums and mucilage depends on natural and annual factors.

C. Bacterial infection: The relative moisture content of the gums is commonly 10% or more and, through its very nature, they may be carbohydrates and at some point of production, are uncovered to the external environment and consequently have the ability for microbial infection. however, this may be avoided by way of the proper handling and use of protective gadget.

1.4.1. Poetry Gum

Neem gum is found in the Azadirachta indica timber belonging to the Meliaceae family. each a part of the tree (bark, leaves, roots and fruit) serves a particular cause. Neem gum includes mannose, glucosamine, arabinose, galactose, fructose, xylose and glucose. in the observe Neem gum used as a bond in drug dosage paperwork. The matrix capsules for the continuous release of

Nimesulide the use of the fruit mucilage of Azadirachta indica had been studied.

1.4.2. Xanthan gum

Xanthan gum, high molecular weight, water soluble, anionic-bacterial hetero polysaccharide, used as a rheology solution is obtained with the aid of the effect of glucose fermentation from the Xanthomonas campestris bacterial tissue. The hydrophilic, biocompatible and inert polymer related to delaying drug release affords a well timed release kinetics. El-Gazayerlyet al. prepared pentoxifylline-managed release pills the usage of xanthan gum and determined that the fee of drug launch reduced with an increase in xanthan gum concentration inside the prepared formulation, as indicated by way of the increase in period. Mughal et al. also organized matrix drugs loaded with propranolol hydrochloride the use of guar gum, xanthan gum, and hydroxypropylmethylcellulose (HPMC) as polymers that absorb dosage and take a look at for drug release inside the gastrointestinal and intestinal media. It become investigated from the examine that guar gum by myself could not control drug withdrawal as much as a 1: three drug / gum ratio. However, the installation of HPMC on matrix tablets changed into provided close to 0-order discharge over 12 h while erosion turned into a main contributing factor. further adjustments within the launch profile had been seen via the mixture of a transparent transparent gel forming a polymer HPMC containing guar or xanthan gum that led to Higuchi's launch profile.

1.4.3. Self assurance

Guar gum is a evidently taking place non-ionic, hydrophilic polysaccharide found within the seeds of Cyamopsistetragonolobus. utilized in strong dosage forms (binding and dispersion), it has residences that postpone the discharge and the tendency to germinate. It soaks in cold water and bureaucracy a viscous colloidal answer.

1. Karaya gum

The clearly taking place hydrophilic gum located in Sterculiaurensand composedofgalactose, rhamnose and glucuronic acid. It absorbs water and is for this reason used as a release charge that regulates polymers in diverse ways. It has low hydration power and high erosion. In a have a look at of launch research, it became observed that karaya gum produced 0 drug releases and matric erosion.

1.4.5. Tamarind Seed Polysaccharide

Tamarind Seed Polysaccharide (TSP) is a galactoxyloglucan (a monomer specifically of sugar-galactose, xylose and glucose - a molar ratio of one: 2: 3) separated from the seeds of Tamarindusindica seeds. TSP is a non-toxic, environmentally friendly and cheap agricultural-based product that may be properly utilized in managed drug control structures. Sahooet al. The tablets are made the use of 10%, 20%, 30%, and 40% Tamarind Seed Polysaccharide (TSP) as a natural binding agent and have discovered that very high binder concentrations show greater stiffness and much less durability. therefore, 20% TSP drugs show high drug release even as 40% TSP pills show minimal drug withdrawal after 24 hours. It's been concluded that growing the cost of TSP reduces the price of discharge.

1.4.6. Lepidium-sativum

In a separate study the gel that paperwork the husk powder obtained from Lepidium-sativum seeds has been used to prepare a strong oral extract for a dosage of synthetic tablets, which include one or more healing / drug dealers. The gel that makes the husk powder found in Lepidium sativum seeds is present in the range of 10 to 70% of the overall weight of the full form, the chosen additive enhancement in xanthan gum, karaya gum and so on in portions of between 3 to 10% by means of weight of the form measurement to provide a launch profile inside 4 to twenty hours. the overall number of to be had presenters is among 10 and 40% by using weight of the total rating form.

1.4.7. Bar Gum

Bara Gum is an herbal yellow gourd of the plant Terminalia bellerica belonging to the circle of relatives Combretaceae. Baharaum gum, extracted from the bark of Terminalia bellerica, is a contaminated substance. Main chemical tannins include ß-sitosterol, gallic acid, ellagic acid, ethyl gallate.

2.1 SUSTAIN RELEASE

System designed to achieve a long-term therapeutic effect by continuously releasing the drug over a long period of time after a single administration. The primary goal of treatment is to achieve steady-state blood levels where the therapeutic effect is non-toxic for a long period of time. To all oral systemic pharmaceutical products, regardless of delivery mode (immediate, sustained or long-term). The design of dosage forms (either oral or inject able) and the timing of the controlled release. There must be a development of the dispersion (solid or liquid) within the GI physiology has intrinsic features. Pharmaceutical pharmacokinetics, pharmaceutical pharmaco-dynamics, and pharmaceutical formulation. For a systemic approach, design is necessary. Oral pharmaceutical dosage developed successfully form. Single dose of a drug Drugs that release slowly over time the use of fewer doses

- The design of an appropriate dosing regimen is an important factor in achieving these goals. A sustained-release formulation is a formulation in which one or more drugs are released systemically or locally to a specific target organ in a predetermined pattern and continuously for a certain period of time. Sustained release dosage forms allow better control of plasma drug levels, lower doses, fewer side effects, increased efficacy and more consistent delivery.
- The difference between controlled release and sustained release is controlled drug delivery, which

delivers the drug at a given rate during a specific period of time.

Controlled release is a complete dimensionless emission of drug release over time, regardless of concentration. In order to achieve the desired therapeutic response more quickly, some of the drug (initial volume) is released immediately and the rest (retention volume) is sustained as defined as the type of formulation that is released slowly.

The release formulation, which lasts for a long time, but by achieving a therapeutic level that is not maintained at a constant level. Sustained release means slow release of the drug over a long period of time.

- It may or may not be controlled by allowing rationality in the SR Dosage form of design. The main purpose of pharmaceutical design is to face uncertain fluctuations and to optimize drug delivery to achieve control of therapeutic efficacy. In an environment where drug release occurs.
- This is usually associated with maximum drug availability by trying to reach the maximum rate and range of drug absorption. However, the control of drug action through the drug means the control of bioavailability to reduce the absorption rate of the drug. Sustained Release, Sustained Action, Prolonged Action, Controlled Release, Prolonged Action, Time Release the dosage form was designed to achieve a prolonged therapeutic effect by continuously releasing the drug over a long period of time after drug administration. A term used to identify a drug delivery system. Single dose.
- For inject able formulations, this period can vary from days to months. However, for oral dosage forms, this period is measured on an hourly basis and is highly dependent on the residence time of the dosage form from the gastrointestinal tract. Over the past few years, existing drug dosage forms have been rapidly replaced by new and new drug delivery systems. In particular, controlled release / sustained release dosage forms have become popular in modern therapies.
- The basis for sustained release drug delivery is to use a new drug delivery system or modify the molecular structure or physiological parameters inherent in the route of administration of choice to alter the pharmacokinetics and pharmacodynamics of the drug. That is.
- The duration of action should be a design characteristic of the rate-controlled dosage form, rather than the inherent kinetic properties of the drug molecule. Therefore, optimal design of sustained / controlled release systems requires a thorough understanding of pharmacokinetics. Pharmacodynamics of drugs.
- When the drug is administered in the existing dosage form, fluctuations in drug concentration occur at the site of action (peak and valley pattern), occurring in the systemic circulation and tissue compartment. The sustained release system includes all drug delivery systems to achieve slow release of the drug over a long period of time.
- Whether the system is a temporal and / or spatial characteristic of drug release in the body, that is, the target tissue or cell of the system considers it a controlled release system.[16,17,18]

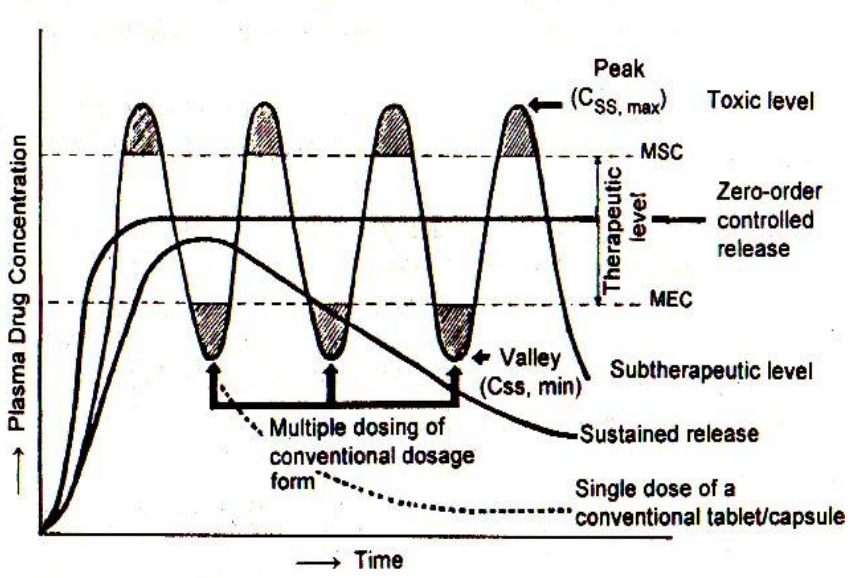

Figure 2.1: a Hypothetical Plasma Concentration Vs Time Profile.

2.2.1 Advantages of SUSTAIN RELEASE DOSAGE FORM

A. Patient adaptability generally a lack of compliance is observed in long-term treatment of chronic diseases. All medications depend on the patient's ability to adhere to the treatment. Patient compliance is influenced by a combination of factors, including awareness of the disease process, patient confidence

in treatment, and understanding of the need to adhere to strict treatment schedules. Also, the complexity of the treatment regimen, the cost of treatment, and the magnitude of the local and/or systemic side effects of the formulation. The problem of patient lack of compliance can be addressed to some extent by administering sustained-release drug delivery systems.

B. Reduction "seesaw": Administration of drugs in conventional formulations (except by intravenous infusion at a constant rate) can often result in a "ball-to-ball" pattern of drug concentrations in body circulation and tissue compartments. The magnitude of these fluctuations depends on drug dynamics such as absorption rate, distribution, deletion, and dosing interval. For drugs with a biological half-life of less than 4 hours, the "seesaw" or "peak and valley" pattern is even more pronounced because the prescribed dosing interval is less than about 4 hours. A well-designed sustained release drug delivery system can significantly reduce the frequency of drug administration and maintain stable blood circulation and drug levels from cells in target tissues.
C. Decrease in total volume: The continuous release drug delivery system repeatedly used less of a total of drugs to treat the disease. By reducing the total dose of the drug, a reduction in systemic or local side effects is observed. This will also lead to a bigger economy.
D. IMPROVING TREATMENT EFFICIENCY: Optimal treatment of disease requires effective delivery of active drugs to the tissues and organs to be treated. Often, doses in excess of those required in cells must be used to achieve the required therapeutically effective concentrations. Unfortunately, this can lead to undesirable toxicological and immunological effects on non-target tissues. The continuous release of dosage forms provides better control of acute or chronic disease.
E. Reduces local and systemic side effects and reduces gastrointestinal irritation.
F. Better reduction of drug use in the total amount consumed.
G. Improve the effectiveness of treatment; optimize therapy, blood concentration more uniform.
H. Reduced fluctuations in drug concentration and therefore more uniform pharmacological response, faster treatment and control of disease and less reduction in drug activity with chronic use.
I. The method used to achieve sustained release may improve the bioavailability of certain drugs, such as those sensitive to enzymatic inactivation, which can be protected by encapsulation in a polymeric system suitable for sustained release.
J. Although the initial unit cost of extended release products is often higher than that of conventional dosage forms due to the special nature of these products, the average cost of extended period therapy may be lower.
K. Savings can also reduce the length of treatment and hospital stay.[19,20,21]

2.2.2 Opportunities and Markets

Market makers do not need to increase their shipments or make efforts just because oral dosage forms are the largest sector of the industry and the market today. The impact of extended delivery times and the business's desire to make their products safe and effective for the elderly are both very surprising to me. A market worth 135 billion dollars existed in 2018 during the globalization era, and it is expected to reach 140 billion dollars in 2019. With a six-year compound annual growth rate of 8.2 percent, the forecast for 2019 is 200 billion dollars. In six years, the compound annual growth rate is expected to be 8.2 percent. A CAGR of 10 percent is expected to drive the controlled target drug delivery systems market segment to a market value of 60 billion in 2018 and 100 billion by 2020 Due to the problem of short half-life, the latter market share is estimated to reach 38 billion in 2019 and 46 billion in 2018, with a CAGR of 5 percent. For sustained-release drugs, dosing is sometimes used to improve adherence.[22,23]

2.3.1 The Challenges Of The Sustainable Development Formula

Dumping: Dumping is a phenomenon in which a relatively large amount of a drug in a sustained release formulation is released rapidly, introducing large amounts of a drug potentially toxic to the system circulation.

i. Overdose can be fatal in the case of potent drugs with an arrowed therapeutic index, such as Phenobarbital.
ii. Limited options for determining the desired dose in the unit. Dosage adjustment in conventional dosage forms is much simpler. For example, a tablet can be divided into two fractions. In the case of extended-release dosage forms, this appears to be much more complicated. If the dosage form is broken, sustained-release properties may be lost.
iii. Weak in vitro - In vivo correlation: In sustained release dosage forms, the drug release rate is intentionally reduced to achieve drug release, possibly over a large area of the gastrointestinal tract. The so-called “absorption window” appears here and it can lead to poor absorption of the drug in the living organism despite its excellent in vitro release properties.
iv. Patient variability: The time it takes to absorb the drug from the dosage form may vary. The concomitant administration of other drugs, the presence or absence of food and the duration of residence in the gastrointestinal tract vary from patient to patient. It also leads to differences in clinical response between patients.[24,25]

2.4.1 Criteria for forming a SUSTAINABLE formulation

A. Expected half-life: The half-life of a drug is an indicator of its lifespan in the body. If the drug has a short half-life (less than 2 hours), the dosage form may contain large amounts of the drug.
B. On the other hand, drugs with half-lives of 8 hours or more are good enough for sustained release drug delivery systems and are generally not needed in such cases Hours.
C. High Therapeutic Index: Drugs with a low therapeutic index are not suitable for incorporation into sustained release formulations. If the system breaks down in the body, dumping can occur leading to death, for example diglycantoxin.
D. Small doses: While the strength of a drug in conventional dosage form is high, its suitability as a candidate for sustained release has not been seriously determined. This is mainly due to the fact that the size of a unit dose of the sustained release formulation would become too large to be used without difficulty.
E. Desirable absorption and solubility characteristics: Drugs which are poorly soluble in water often dissolve at a slow rate, making it difficult to incorporate these compounds into sustained release formulations.
F. Desirable absorption and solubility characteristics: Drugs that are poorly soluble in water are often dissolved at a slow rate. It is therefore impractical to incorporate such compounds in sustained-release formulations and may reduce the overall effectiveness of absorption.
G. Desired absorption window: Some drugs, when taken orally, are absorbed only from a specific part of the gastrointestinal tract. This part is called the "absorption window". Drugs with absorption windows such as fluorouracil, thiazide diuretics, if formulated in extended-release dosage forms, are not suitable.
H. First-passage clearance: As noted earlier in the extended delivery system limitations, the delivery of the drug at the desired concentrations is severely impeded in the event of drug exposure. Through extensive hepatic metabolism, when used sustainably. - Release forms.[26,27,28]

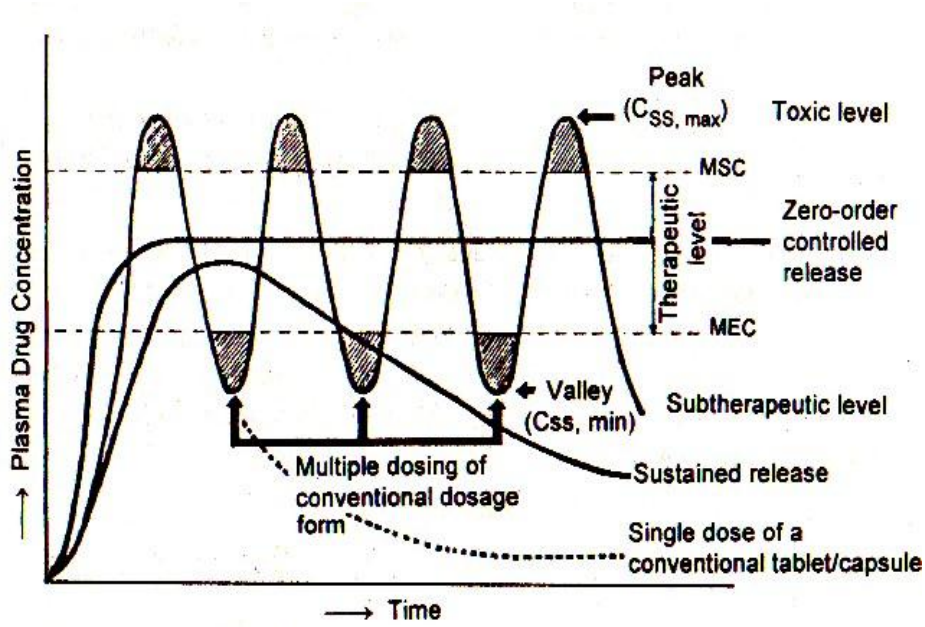

Figure 2.1: A Hypothetical Plasma Concentration Vs Time Profile.

3. CONCLUSION

Drug administration via oral route is the preferred method. This helps to maintain drug intake and may reduce the variability associated with multiple doses administered per day. Sustained Release Dosage Form improves patient compliance, as a result of its sustained release formula. Human health care systems rely heavily on natural polysaccharides for the formulation development of new controlled release dosage forms. Recent years have seen a rapid increase in the use of natural polysaccharides in the development of controlled release dosage forms. As a release retardant, gum was used in formulations to retard drug release. In addition, as the polymer concentration drops, the gum's retarding capacity decreases. As the polymer concentration increases, the gum's retarding capacity increases, and the drug release is effectively controlled. Gum has a lot of potential to replace the conventional release retardant, as shown in this study.

4. REFERENECS

1. Khullar P, Khar R K and Agarwal S R. Evaluation of guar gum in the preparation of sustained release

matrix tablets. Drug Dev Ind Pharm, 1998; 24: 1095-1099.
2. Nayak BS, Nayak UK, Patro KB andRout PK. Design and Evaluation of controlled release bhara gum microcapsules of famotidine for oral use. Res J Pharm and Tech, 2008; 1: 433-436.
3. Alur HH, Pather SI, Mitra AK and Johnston TP. Evaluation of the Gum from hakea gibbosa as a sustained release and mucoadhesive component in buccal tablets, Pharm Dev Technol, 1999; 4: 347.
4. Baveja SK, Rao KVR and Arora J. Examination of natural gums and mucilages as sustaining materials in tablet dosage forms. Ind J Pharm Sci., 1988; 50: 89-92.
5. Girish JK, Dhiren SP, Vipul PD and Vineet JC. Gums and mucilages: versatile excipients for pharmaceutical formulations. Asian J Pharm Sci., 2009; 4: 309-323.
6. Uner M and Altinkurt T. Evaluation of honey locust (Gleditsia triacanthosLinn) gum as sustaining material in tablet dosage forms. Farmaco, 2004; 59: 567-573.
7. Bhardwaj TR, Kanwar Meenakshi, Lal Roshan, Gupta Anubha. "Natural gum and modified natural gums as sustained-release carriers". Drug development and industrial pharmacy, 2000; 26(10): 1025-1038.
8. Billa nashiru, Yuen Kah-hay. "Formulation variables affecting drug release from xantham gum matrices at laboratory scale and pilot scale"AAPS pharmaSciTech., 2000; 1(4): A-30.
9. Kalu VD, Odeniyi MA and jaiyeoba KT. "Matrix properties of a new plant gum in controlled drug delivery". Archives of pharmaceutical research, 2007; 30(7): 887-889.
10. Morkhade DM, Fulzele SV, Satturwar PM, Joshi SB. "Gum copal and gum damar: Novel matrix forming materials for sustained drug delivery". Inter J Pharm Sci., 2006; 68(1-2): 53-58.
11. Chukwu KI, udeala OK. "Binding effectiveness of Colocassia esculenta gum in poorly compressible drugs-paracetamol and metronidazole tablet formulations". Bollettino Chimico Farmaceutico, 2000; 139(2): 89-97.
12. Munday DL, Philip JC. "Compressed xanthan and karaya gum matrices: hydration, erosion and drug release mechanisms". Inter J Pharm., 2000; 203(1-2): 179-192.
13. Wilding I R, Coupe A J, Davis S S. The role of gamma scintigraphy in oral drug delivery, Drug Deliv. Rev., 1991; 7: 87-117.
14. Diffusioncontrolled matrix systems by Lee, on: 1. Kydonieus (Ed.), Treatise on Controlled Drug Delivery, Marcel Dekker, New York, 1992; 155198.
15. Bogan R Treatment options for insomnia pharmacodynamics of zolpidem extended release to benefit nextday performance, Postgrad. Med., 2008; 120: 161-171.
16. Martin A, Bustamante P and Chun Micromeritics in Physical PharmacyPhysical Chemical Principles in Pharmaceutical Sciences, Lippincott Williams and Wilkins, Baltimore, 4th edition, 2002; 446-448.
17. K.P Sampath kumar et al "Journal of pharmaceutical research", 2010; 2(1): 349-360.
18. E. Richelson, T. Souder, Life Sci., 2000; 68: 29–38.
19. Celia farina et al "Journal of pharmaceutical and biomedical application'', 2008; 46: 471-476.
20. Hrushikesh Dewalkar et al JSBPR, Jan Feb 2012; 2,1(1): 18-24.
21. Ziyaur Rehman et al "Design and evaluation of bilayer tablet float captopril'' Acta Pharma, 2006; 56: 49-57.
22. S.j Imnam et al "Powder technology", 2009; 188: 283-294.
23. Fridrun Podczeck et al "European Journal of Pharmaceutical Science", 2010; 41: 483-488.
24. M.S Anuar et al "International Journal of Pharmaceutics", 2010; 387: 42-47.
25. Anil Choudhary 'European Journal of Pharmaceutics' Biopharmaceutics, 2011; 78: 34-40.
26. Longxiao et al "International journal of pharmaceutics", 2008; 352: 230.
27. Chuanyu wu et al "Powder technology", 2009; 189: 285-294.
28. K.D. Wilner, T.G. Tensfeldt, B. Baris, T.A. Smolarek, R.Z. Turncliff, W.A. Colburn, R.A. Hansen, Br. J. Clin. Pharm., 2000; 49: 15S–20S.
29. Habib W, Khankari R, Hontz J., Drug Carrier Systems, 2000; 17(1): 61-72.
30. Kuchekar, B.S. and Arumugam, V., Indian J. Pharma.Edu, 2001; 35-150.
31. Bhaskaran, S., and Narmada, G.V., Indian Pharmacist, 2002; 1(2): 9-12.
32. Pouton CW. "Lipid formulations for oral administration of drugs: non-emulsifying, self-emulsifying and 'self-micro emulsifying' drug delivery systems". Eur. J. Pharm. Sci., 2000; 11(2): 93-98.
33. David J. H, "Lipid-Based Systems for Oral Drug Delivery. Enhancing the Bioavailability of Poorly Water-Soluble Drugs" APR, 2002; 5: 88-93.