

An Updated Review on Applications of Natural Polymers in Sustained Release Drug Delivery System

Menkudale Amruta^{1*}, Khuspe Pankaj², Otari Kishor³, Khemnar Manisha⁴, Kulkarni Vaishali⁵

Assistant Professor

Navsahyadri Institute of Pharmacy, Naigaon, Nasarapur, Pune, Maharashtra, India

INFO

Corresponding Author:

E-mail Id:

*amrutacmenkudale@gmail.com

DOI: 10.5281/zenodo.3608397

ABSTRACT

Sustained release drug delivery system is area of interest for formulation scientists in pharmaceutical industry because of advantage of administering a single dose of a drug that is released for an extended period of time instead of numerous doses. SDDS have various advantages like it optimize biopharmaceutical, pharmacokinetic and pharmacodynamic properties of drug in order to increase its use, reduce adverse effects, cure the disease, decrease the frequency of administration and thus, increase the patient compliance, increase safety margin of potent drugs, reduce healthcare costs etc. The objective of present study is to understand meaning of sustained release drug delivery system, meaning of polymer, meaning of natural polymers and its types, overview on various natural polymers along with their biological source and part used in formulation of sustained release drug delivery system. Sustained release polymers are the important additives in sustained release drug delivery system for which various natural polymers have been discovered. This review article will help you to select the different natural polymers or combination of natural and synthetic polymers to formulate the sustained release matrix tablets.

Keywords: Biopharmaceutical, Pharmacokinetic, Pharmacodynamic and Sustained release.

INTRODUCTION

Sustained drug delivery system

These days many of the pharmaceutical scientists are involved in developing an ideal DDS. This standard system should have the advantage of decrease in frequency of administration for whole duration of the treatment & site specific

delivery should be possible. A sustained release (SR) tablet is typically designed to release drug over 12-24 hours and might contained in an immediate release tablet [1]. Controlled and sustained release both have been used in inconsistent and confusing manner. Both represent separate delivery process. Sustained release

includes any dosage form that delivers the medication over an extended time or elicit or able to provide some kind of actual therapeutic control whether this is of a temporal nature, spacial nature or both. SR system generally do not show zero order type release kinetics and mimic zero order release by retarding the drug by slow first order [2]. The goal in designing sustained release drug delivery system is to reduce frequency of dosing, to increase the effectiveness of the drug at the required site thereby minimising or eliminating side effects, providing uniform drug delivery. Sustained release has received most of the attention because of the fact that there is more feasibility in dosage form [3]. The important aim of sustained release dosage form is to release the medication for extended period of time and to get desired therapeutic effect after administration of single dose. Another advantage of sustained release dosage form is to alter and to improve the drug performance by increasing the time of action, decreasing the frequency of administration, decreasing the quantity of dose and providing the uniform drug delivery. In last few years many pharmaceutical scientist shown interest in sustained release drug delivery system because of different factors like decrease in cost of developing new formulation, expiration of existing international patents, research on new drug release retarding polymers and improvement in therapeutic efficacy and safety. Sustained release dosage forms are formulated by coating the tablets by drug release retarding polymers to control the rate of solubility or by encapsulating the drug in polymers in the form of microparticles of different sizes to control the rate of dissolution [1, 2].

NATURAL POLYMERS

A polymer is a macromolecule composed of repeating structural units or chains typically linked by covalent chemical bonds. While polymer in popular usage suggests plastic, the term actually refers to a large class of natural and synthetic materials with a diversity of properties and

purposes. Polymers consist of long chains of un-branched or branched monomers or may be cross-linked networks of monomers in two or three dimensions. Many vital natural materials are organic polymers including cellulose, lignin, rubber, proteins and nucleic acids. Synthetic organic polymers many plastics, including polyethylene, the nylons, polyurethanes, polyesters, vinyl's (e.g. PVC), and synthetic rubbers. The silicone polymers with an inorganic backbone of silicon and oxygen atoms and organic side groups are among the most chief mixed organic-inorganic compounds [1- 8].

Also polymers can be classified as

Natural polymers

The polymers obtained naturally either from plants or animals are called as natural polymers. These polymers are very important for life. They are as follows.

- **Starch:** It is food reserve of plant and is polymer of glucose.
- **Cellulose:** It is a polymer of glucose. It is a vital structural material of the plant both starch and cellulose is made by plants from glucose produced during photosynthesis.
- **Proteins:** These are polymers of α -amino acids; they have generally 20 to 1000 α -amino acid linked together in an organized arrangement. These are building blocks of animal body and constitute an important part of our food.
- **Nucleic acids:** Polymers obtained from various nucleotides are called as Nucleic acids. For example RNA and DNA are common nucleotides. Polymers such as polysaccharides (starch, cellulose), proteins and nucleic acids etc. which control different life processes in plants and animals are also called biopolymers [2, 4].

Synthetic polymers: The polymers which are prepared in the laboratories by chemical reactions are called as synthetic polymers. These are also called man made polymers. For example polythene, PVC

nylon, teflon, bakelite terylene, synthetic rubber etc. [2].

Semi synthetic polymers: These polymers are chemically modified derivatives of naturally occurring polymers. For example cellulose diacetate polymers and vulcanized rubber [2, 10].

Polymers have been fruitfully employed in the formulation of solid, liquid and

semisolid dosage forms and are especially useful in the design of modified release drug delivery systems. Synthetic as well as natural polymers are found to be helpful in development of SDDS but natural polymers has advantages like they are cheap and are easily available, non-toxic and capable of chemical modifications, potentially biodegradable and with few exceptions also biocompatible hence now a days they are of key interest [1-8].

Table 1: Sustained release formulations containing natural polymers.

Sl. No	Name of Polymer	Biological source of polymer	Part Used	Drug Used	Formulation	Ref. No
1	Aloe mucilage	Aloe- barbadensis (Liliaceae)	Leaves	Glimepiride	Sustained release matrix tablets	9,10
2	Fenugreek mucilage	Foenum Graecum (Leguminous)	Mucilgae	Propranolol Hydrochloride	Sustained release matrix tablets	13
3	Guar gum	Cyamopsis tetragonolobus (Leguminous)	Seed (Endosperm)	Furosemide	Sustained release matrix tablets	17
4	Guar gum	Cyamopsis tetragonolobus (Leguminous)	Seed (Endosperm)	Zidovudine	Controlled release matrix tablets	20
5	Guar gum	Cyamopsis tetragonolobus (Leguminous)	Seed (Endosperm)	Phenytoin sodium	Sustained release matrix tablets	21
6	Hakea Gum	Hakea Gibbosa (Proteaceae)	Dried Exudate (Gum)	Chlorpheniramine maleate	Sustained release matrix tablets	23
7	Hibiscus Mucilage	Hibiscus rosasinensis (Malvaceae)	Mucilage	Diclofenac sodium	Sustained release matrix tablets	24
8	Karaya gum	Sterculia urens (Sterculiaceae)	Dried gummy exudate	Diltiazem Hydrochloride	Sustained release matrix tablets	27
9	Mimosa pudica	Mimosa pudica (Mimosaceae)	Mucilage of seeds	Diclofenac sodium	Sustained release matrix tablets	28
10	Okra gum	Hibiscus esculentus (Malvaceae)	Fruits	Paracetamol	Controlled release matrix tablets	30
11	Okra gum	Abelmoschus esculentus (Malvaceae)	Fruits	Ibuprofen	Prolonged release matrix tablet	32, 33
12	Tamarind Gum	Tamarindus indica (Fabaceae)	Seed endosperm	Diclofenac sodium	Sustained release matrix tablets	35
13	Tamarind Gum	Tamarindus indica (Fabaceae)	Seed endosperm	Ketoprofen	Sustained release matrix tablets	36, 37
14	Gum copal	Bursera Bipinnata (Burseraceae)	Resin	Metformin HCl	Sustained release matrix tablets	38
15	Gum damar	Shorea wiesneri (Diphrocarpaceae)	Resin	Metformin HCl	Sustained release matrix tablets	38
16	Xanthan Gum	Xanthomonas Compestris	Polysaccharide	Furosemide	Sustained release matrix tablets	39
17	Bees Wax	Honey bees (Genus Apis)	Wax	Furosemide	Sustained release matrix tablets	39
18	Carnauba Wax	Copemic cerifela	Vegetable wax	Furosemide	Sustained release matrix tablets	39
19	Xanthan gum	Xanthomonas Compestris	Polysaccharide	Atenolol	Sustained release matrix tablets	40
20	Gum Acacia	Acacia Arabica (Leguminosae)	Exudate	Atenolol	Sustained release matrix tablets	40
21	Gum Tragacanth	A.tragacantha	Polysaccharide	Atenolol	Sustained release matrix tablets	40
22	Hupu Gum	Cochlispermum religiosum (Bixaceae)	Exudate	Atenolol	Sustained release matrix tablets	40
23	Hibiscus mucilage	Hibiscus-rosa sinensis (Malvaceae)	leaves	Diclofenac Sodium	Sustained release matrix tablets	41

CONCLUSION

The polymers help to control or retard the drug release rate from the formulations. Many naturally occurring gums and mucilages are used as polymers to control and sustain the drug release because they are easily available, cheap, potentially degradable and compatible. Instead of using synthetic polymers pharmaceutical scientist prefer to use natural biodegradable polymers and hence it continues to be area of active research. Development and synthesis of new combinations of polymers will expand the scope of new drug delivery system in the future.

REFERENCES

1. Evans WC, Trease and Evans. (1996), "Pharmacognosy 14th ed.", *Harcourt Brace and co. Asian Pvt. Ltd*, Volume 16, Issue 3, pp. 182-183. DOI: [org/10.1177/096032719701600311](https://doi.org/10.1177/096032719701600311).
2. Nadkarni KM. (1976), "Indian Materia Medica, 3rd ed.", *Bombay Popular Prakashan*, Volume 2, pp.981-982.
3. J. Hyung Park, Mingli Ye and Kinam park, (2005), "Biodegradable polymers for microencapsulation of drugs", Volume 10, Issue 1, pp. 146-161. DOI: <https://doi.org/10.3390/10010146>.
4. Manjanna KM, Pramod kumar TM, Shivakumar B, (2010), "Natural polysaccharide hydrogels as novel excipients for modified drug delivery system", *Industrial journal of chem. tech research*, Volume 1, pp. 509-525.
5. Cohan, Wendy, (2010), "Could Xanthan Gum Sensitivity be Complicating your Celiac Disease Recovery", pp. 05-19.
6. Guo J, Skinner GW, Harcum WW, Barnum PE. (1988), "Pharmaceutical applications of naturally occurring water-soluble polymers", Volume 1, Issue 6, pp. 254-261. [https://doi.org/10.1016/S1461-5347\(98\)00072-8](https://doi.org/10.1016/S1461-5347(98)00072-8).
7. Choi S, Chung MH, (2003), "A review on the relationship between Aloe vera components and their Biologic effects", Volume 1, Issue 1, pp. 53-62. [https://doi.org/10.1016/S1543-1150\(03\)00005-X](https://doi.org/10.1016/S1543-1150(03)00005-X).
8. Jani GK, Shah DP, Jain VC, Patel MJ, Vithalan DA, (2007), "Evaluating mucilage from Aloe Barbadensis Miller as a pharmaceutical excipient for sustained-release matrix tablets", *Pharm Technol*, Volume 31, pp. 90-98. [www.cabi.org, http://iccn.loc.gov/2016002562](http://iccn.loc.gov/2016002562), ISBN-13:978 178064 559 9.
9. Hindustan Abdul et al, (2010), "Design and evaluation of sustained release matrix tablets of glimepiride based on combination of natural and synthetic polymers", *Int. J. of applied biology and pharmaceutical technology*, Volume 1, Issue 3, pp. 770-777. ISSN 0976-4550, Available online at www.ijabpt.com.
10. Ali N, Hossein N, Afagh K, Tarifeh S, Hadi V, Ford JL, (2008), "An In Vitro Evaluation of Fenugreek Mucilage as a Potential Excipient for Oral Controlled-Release Matrix Tablet", *Drug Dev Ind. Pharm.* Volume 34, pp. 323-29. <http://dx.doi.org/10.1155/2014/204849>.
11. Sourabh Jain, SK Yadav and UK Patil (2008), "Preparation and Evaluation of Sustained Release Matrix Tablet of Furosemide using Natural Polymers", *Research J. Pharm. and Tech*, Volume 1, Issue 4, pp. 374-376.
12. Amit.S.Yadav, Ashok Kumar P, Vinod R, Someshwara Rao B, Suresh V Kulkarni (2010), "Design and Evaluation of Guar Gum Based Controlled Release Matrix Tablets of Zidovudine", *J. of Pharma. Sci. and Tech.*, Volume 2, Issue 3, pp. 156-162. ISSN: 0975-5772.
13. Md Sajid ali, Swati Singh, Awdhesh kumar, Sant singh, Md Tahir Ansari, Gurudutta pattnaik (2010), "Preparation and in vitro evaluation of sustained release matrix tablets of phenytoin sodium using natural

- polymers”, *Int. J. of Pharmacy and Pharmaceutical Sci.*, Volume 4, Issue 4, pp. 25-29. ISSN: 0975 1491.
14. Kokate CK, Purohit AP and Gokhale SB (2003), “Pharmacognosy, 22nd ed.”, Pune, Nirali Prakashan; Volume 1, Issue1, pp. 5-8.
http://www.jbsoweb.com/admin/php/uploads/4_pdf.pdf.
 15. Raghavendra Raon G, Gandhi Sagar, Patel Tarun (2009), “Formulation and evaluation of sustained Release matrix tablets of tramadol hydrochloride”, *Int. J. of pharmacy and Pharma. Sci.*, Volume 1, Issue, pp. 124-131.
 16. Peter FK, Alistair MS, Shirley CC (1999), “Molecular Structures Of Gum Exudates From Hakea Species”, *Phytochemistry*, Volume 34, Issue 3, pp.709-713.
<http://dx.doi.org/10.1155/2014/204849>.
 17. Alur HH, Pather SI, Mitra AK, Johnston TP. (1999), “Evaluation of the Gum from Hakea gibbosa as Sustained-Release and Mucoadhesive Component in Buccal Tablets”, *Pharm Dev Technol*, Volume 4, Issue 3, pp. 347-358. DOI:10.1081/pdt-100101370.
 18. Khanna M, Nandi RC, Sarin JPS. (1987), “Standardisation of Tamarind Seed Polyose for Pharmaceutical Use”, *Indian Drugs*, Volume 24, pp. 268–69.
 19. Kulkarni D, Dwivedi DK, Sarin JPS, Singh S (1997), “Tamarind Seed Polyose: A Potential Polysaccharide for Sustained Release of Verapamil Hydrochloride as a Model Drug”, *Indian J Pharm Sci*, Volume 59, Issue 1, pp. 1–7.
 20. Rao PS, Ghosh TP, Krishna S. (1946), “Extraction and purification of tamarind seed polysaccharide”, *J Sci. Ind. Research*, Volume 6, Issue 4, pp. 705.
 21. Burgalassi S, Panichi L, Saettone MF, Jacobsen J, Rassing MR (1996), “Development and in vitro/in vivo testing of mucoadhesive buccal patches releasingbenzylamine and lidocaine”, *Int. J Pharm*, Volume 133, Issue 1-2, pp. 1-7.
[https://doi.org/10.1016/0378-5173\(95\)04392-6](https://doi.org/10.1016/0378-5173(95)04392-6)
 22. R.Deveswaran, Sindhu Abraham, S.Bharath, B.V.Basavaraj, Sharon Furtado, V.Madhavan(2009), “Design and Characterization of Diclofenac sodium tablets containing Tamarind seed polysaccharide as Release retardant”, *Int. J. of Pharm Tech Research*, Volume 1, Issue 2, pp. 191-195. ISSN: 0974-4304./
 23. Bharath Srinivasan, Anusha Ganta, Deveswaran Rajamanickam, Basavaraj Basappa Veerabhadraiah, Madhavan Varadharajan (2011), “Evaluation of tamarind seed polysaccharide as a drug release retardant”, *Int. J. of Pharm. Sci. Review and Research*, Volume 9, Issue 2, pp. 27-31. ISSN 0976 – 044X.
 24. Wadher K.J, Kakade.R.B.Umekar M.J (2011), “Formulation and Evaluation of sustained release matrix tablets of Metformin HCl using Hydrophilic synthetic and Hydrophobic natural polymers”, *Indian J Pharm Sci*, Volume 73, Issue 2, pp. 208-215. DOI: 10.4103/0250-474x.91579.
 25. Niaz sultan, Naqui syed et al (2018), “Formulation and Evaluation of Sustained release matrix tablet of Furosemide using different polymers”, *RADS J Pharm Pharm Sci*, Volume 6, Issue 2, pp. 144-151.
 26. Bhowmik A, Nijhu R et.al (2013), “Design and development of Atenolol matrix tablet employing natural and synthetic polymers”, *J. of applied Pharma. Sci*, Volume 3, Issue 9, pp. 103-108. DOI: 10.7324/JAPS.2013.3919.
 27. Pawan P, Porwal M et.al (2011), “Role of Natural polymers in sustained release drug delivery system, application and recent approaches”, *IRJP*, Volume 2, Issue 9, pp.6-11. ISSN. 22308407.