Polymer in pharmaceutical medication delivery systems

[1]Priti Ravindra Padse, [2]Vaishnavi Dnyaneshwar Dhudat, [3]Pranita Sudhakar Mandal, [4]Vaishali Bhimrao Khedkar

Nandkumar shinde college of pharmacy,vaijapur

ABSTRACT

The polymers used in pharmaceutical medication delivery of therapeutic agents are the main topic of the current review paper. Tablets, patches, cassettes, films, semisolids, and powders are some examples of these dosage forms. As they regulate the drug's release from the device, polymers form the foundation of a pharmaceutical drug delivery system. Because they can be broken down into non-toxic monomers and, more importantly, because they can be used to build controlled release devices, biodegradable polymers are attractive for application. Natural polymers can be utilised to transport drugs at predetermined rates, and because they are readily available and have favourable physico-chemical properties, they can be used as a polymer for drug delivery systems. The use of biodegradable polymers is widespread.

KEYWORDS : *POLYMERS, CLASSIFIED POLYMER,USE POLYMER, APPLICATION*

INTRODUCTION

A significant problem with current medicine is the failure to utilise the potential of readily available bioactive chemicals. Many of the currently used medication compounds are effective against tumour, bacterial, and fungal cells. However, due to low solubility, poor biodistribution, poor stability, and quick bodily removal from the body, their administration in a typical form is characterised by limited effectiveness [1,2]. In order to maximise the dosage and duration of the drug's action at the target site, smart drug delivery systems (DDS) are being extensively researched and developed [1,3,4,5].

The use of a polymer as an inert carrier for a medicine has a number of benefits, such as improving the pharmacokinetic and pharmacodynamic characteristics of the drug. Biopharmaceuticals boost the effectiveness of medications in a variety of Plasma half-life, which lowers immunogenicity and increases the stability of Low molecular weight medications' solubility is improved by biopharmaceuticals.It offers the potential to administer drugs to specific areas [6-7]. Is a polymer Conjugates have fought against a number of illnesses, including rheumatoid arthritis, , diabetes, hepatitis B and C, and cancer [8].

Natural polymers: organic and inorganic

Organic polymers play a crucial role in living things, providing basic structural materials and participating in vital life processes. For example, the solid parts of all plants are made up of polymers. These include cellulose, lignin, and various resins. Cellulose is a polysaccharide, a polymer that is composed of sugar molecules. Lignin consists of a complicated three-dimensional network of polymers. Wood resins are polymers of a simple hydrocarbon, isoprene. Another familiar isoprene polymer is rubber.

Polynucleotide chain of deoxyribonucleic acid (DNA)

Other important natural polymers include the proteins, which are polymers of amino acids, and the nucleic acids, which are polymers of nucleotides—complex molecules composed of nitrogen-containing bases, sugars, and phosphoric acid. The nucleic acids carry genetic information in the cell. Starches, important sources of food energy derived from plants, are natural polymers composed of glucose.

Various Polymers Used in Drug Delivery

1. PLGA

2. Conventional Use of Polymers in Drug Delivery

3. Smart Polymers

4. Polymers in Novel Drug Delivery Systems

5. Drug Delivery Devices-Requirements of Polymers in Drug Delivery System

5.1. Dendrimers

5.2. Polymeric-Nano Particulate Systems

5.3. Hydrogel System

5.4. Solid Lipid Nanoparticles

5.5. Magnetic Nanoparticles (MNPS)

5.6. Polymeric Micelles (PMS)

5.7. Liposomes

5.8. Implants

6. Application Scopes of Polymers in Drug Delivey System

6.1. Biodegradable Polymers

6.2. Non-Biodegradable Polymers

6.3. Smart Polymers

6.4. Gels

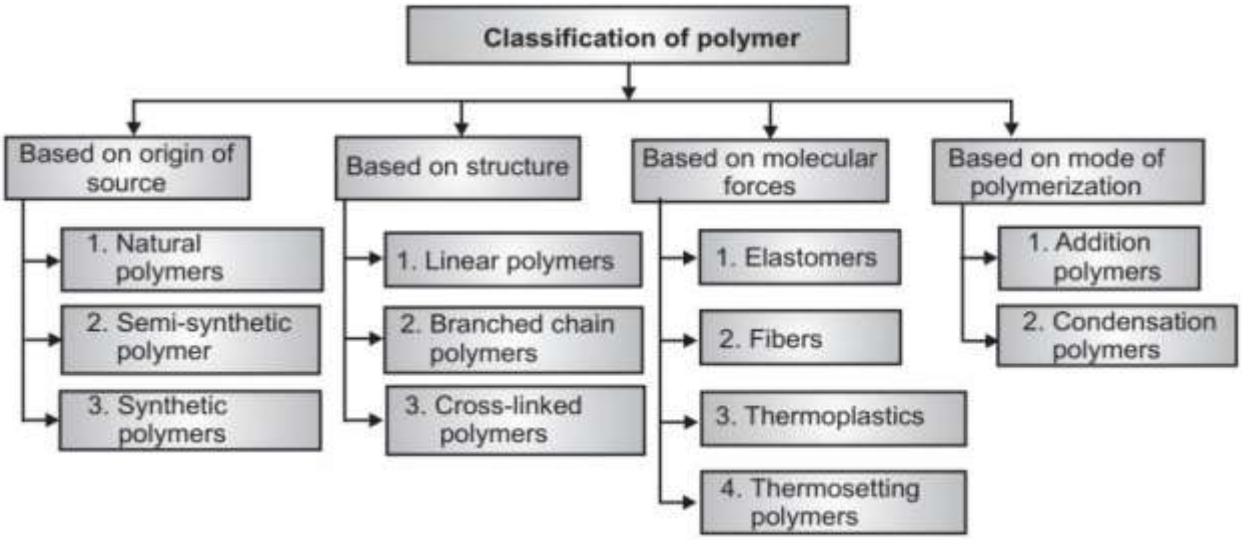
6.5. Polymers in Mucoadhesive Delivery

6.6. Polymer Drug Conjugate Used for Cancer Treatment

Classification of Polymers

A polymer is made up of macromolecules, or very big molecules, which have several repeating structural subunits. Today, polymers serve as the foundation for four distinct sectors, including those of fibres, plastics, elastomers, and varnishes. The word "polymer" comes from the words "poly," which means "many," and "mer," which means "unit" or "part." As was already established, macromolecules known as polymers are created by repeatedly repeating structural components. Simple and reactive molecules called monomers make up the repeating units. Covalent bonds connect these components. Polymerization is the process of creating polymers from their corresponding monomers.

Due to their incredibly complex structures, diverse behaviours, and wide range of uses, polymers are challenging to categorise under a single heading. In light of this, we categorise polymers according to:



Source of Availability

Structure

Polymerization

Monomers

Molecular Forces

Classification of Polymers based on the Source of Availability

Polymers are classified as natural polymers, synthetic polymers, and semi-synthetic polymers based on the source of availability.

Natural Polymers

Both plants and animals have these polymers, which are present in nature on a natural basis. Bipolymers, which are biodegradable polymers, are another option. Starch, proteins, rubber, and cellulose were a few examples.

Semi-synthetic polymers

These polymers are created by chemically altering natural polymers. Cellulose acetate, cellulose nitrate, etc. Are a few examples.

Synthetic polymers

These polymers are entirely synthetic. The synthetic polymer that we use most frequently is plastic. Some dairy products and businesses employ synthetic polymers. Examples include nylon-6, polyether, 6, and others.

Classification of Polymers based on its Structure

Based on structure, polymers are classified as Linear polymers, Branched-Chain polymers, and Cross-Linked polymers.

Linear Polymers

Chains in linear polymers are long and straight due to their structural design. PVC is utilised, for instance, in pipes and electrical lines.

Branched chain polymers

Branched-chain polymers are ones that contain linear chains. Low-density polythene is an example**.**

Cross linked polymers

Monomers with two or three functions are seen in cross-linked polymers. They possess a stronger covalent bond when compared to linear polymers. Melamine and bakelite are a couple

Classification of Polymers based on Polymerization

Based on polymerization, polymers are classified as addition polymerization and condensation polymerization.

Addition Polymerization

Molecules of the same or various monomers combine in addition polymerization to produce polymers on a large scale. Alkenes, alkadienes, and their corresponding derivatives are examples of these monomers' unsaturated materials. For instance, addition polymerization produces Teflon, Polyvinyl chloride (PVC), Polyethane, etc.

Condensation polymerization

A condensation process between two monomeric units with bi- or tri-functional functions is repeated in condensation polymerization. Condensation polymers include things like perylene, polyesters, Nylon-6, etc.Inn Addition Polymerization, molecules of the same or different monomers add up together on massive scales to form polymers. These monomers are unsaturated compounds like alkenes, alkadienes, and their respective derivatives For example, Teflon, Polyvinyl chloride (PVC), poly ethane, etc are addition polymerization.

Classification Based on Monomers

Based on the monomers, polymers can be classified as homomers and heteropolymers.

Homomer

Only one kind of monomer unit is found in homomers. Polythene is one instance.

Heteropolymer or co-polymer

Heteropolymers, as opposed to homomers, contain various kinds of monomer units. Nylon-6, 6, is one illustration.In homomers, only single types of monomer units are present. An example is Polythene.

Classification Based on Molecular Forces

Based on molecular forces, polymers are classified as elastomers, fibers, thermoplastics, and thermosetting polymers.

Elastomers

Weak interaction forces characterise elastomers. Rubber and Buna-S are two examples.

Fibers

Fibers possess extremely powerful forces of interaction as well as a tough, strong, and high tensile strength. Nylon -6, 6, as an illustration

Thermoplastics

The forces of attraction in thermoplastics are intermediate. Polyvinyl chloride is a good illustration.

Thermosetting polymers

The mechanical characteristics of the material are considerably enhanced by thermosetting polymers. Moreover, they offer improved heat and chemical resistance. Phenolics, epoxies, and silicones were a few examples.

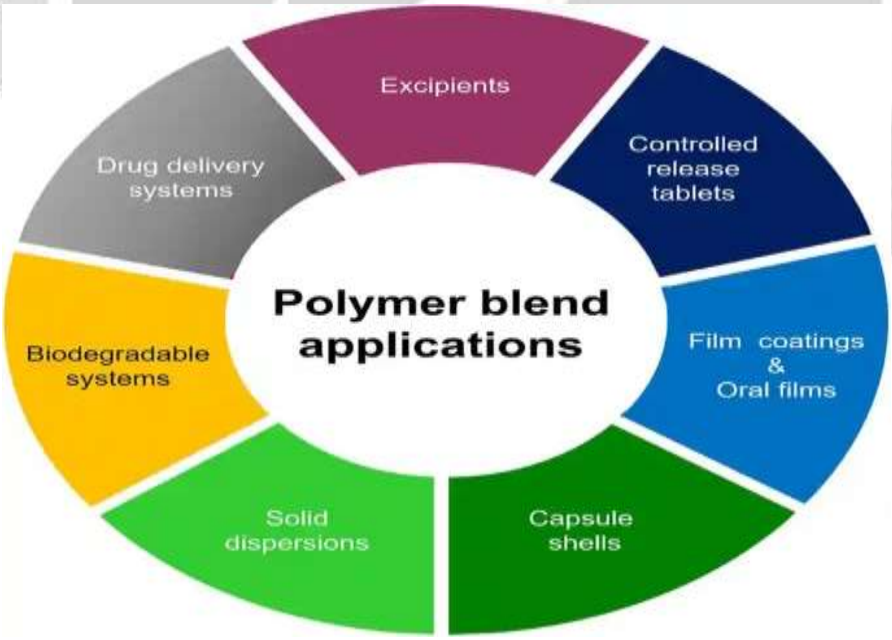
Polymer Structure

The majority of the polymers that surround us have a hydrocarbon backbone. Due to the tetravalent nature of carbon, a hydrocarbon backbone is a lengthy chain of linked carbon and hydrogen atoms.

The hydrocarbon backbone polymer types include polystyrene, polypropylene, and polybutylene. Furthermore, polymers can be used in place of carbon.

Application

The majority of the scientific literature on the use of polymer blends in pharmaceutical products, excipients, and drug delivery systems has concentrated on particular properties or applications of polymer blends, such as



miscibility [9,10], film coating [11,12], orally disintegrating films [13], matrix tablets [14 15, 16], solid dispersions [17,18,19], biodegradable systems [20,21], transdermal drug delivery [22], environmentally responsive systems [23,24], and 3D printing [25,26,] and electrospinning [27,28] are two recently developed pharmaceutical manufacturing methods that utilise polymer mixtures. The creation of polymer blends for application in tissue engineering and wound dressings has also been accomplished using these methods [29,30]

Conclusion:

Drug delivery benefits greatly from the use of polymers. This improves drug delivery and handles all safety factors through superior pharmacokinetics. It is still necessary to investigate the mechanism and duration of the drug delivery system for a certain tissue or cellular compartment. Gene delivery is just one of many questions that must be addressed in order to build the best polymer therapy. This results in the synthesis of the intelligent Polymer. The site of action in targeted medication delivery systems ought to be well understood. Biodegradable plastics Give better control over sample toxicity, which improves drug administration and protects patients' safety.

Reference

1. Wilczewska, A.Z.; Niemirowicz, K.; Markiewicz, K.H.; Car, H. Nanoparticles as drug delivery systems. Pharmacol. Rep. 2012, 64, 1020–1037. [Google Scholar] [CrossRef]

2. Kalepu, S.; Nekkanti, V. Insoluble drug delivery strategies: Review of recent advances and business prospects. Acta Pharm. Sin. B 2015, 5, 442–453. [Google Scholar] [CrossRef][Green Version]

3. Jelonek, K.; Kasperczyk, J. Polyesters and polyester carbonates for controlled drug delivery. Part II. Implantable systems. Polimery 2013, 58, 858–863. [Google Scholar] [CrossRef]

4. Jones, D. Pharmaceutical Applications of Polymers for Drug Delivery; Rapra Review Reports; Rapra Technology: Shrewsbury, UK, 2004; ISBN 978-1-85957-479-9. [Google Scholar]

5. Nakielski, P. Drug Release Systems Based on Nanofibers; IPPT Reports on Fundamental Technological Research; IPPT PAN: Warsaw, Poland, 2015; ISBN 978-83-89687-93-7. [Google Scholar]

6 Lockman PR, Koziara JM, Mumper RJ, Allen DD (2004) Nanoparticle Surface charges alter blood-brain barrier integrity and permeability. J Drug Target 12: 635.

7. Kodaira H, Tsutsumi Y, Yoshioka Y, Kamada H, Kaneda Y, et al. (2004) Biomaterials 25: 4309.

8. Cooper PD (1993) Activators and Inhibitors of Complement, Sim RB (Ed.),Kluwer Academic Publishers, Springer Netherlands.

9.Lecomte F, Siepmann J, Walther M, MacRae RJ, Bodmeier R (2003) Blends of enteric and GIT-insoluble polymers used for film coating: physicochemical characterization and drug release patterns. J Control Release 89:457–471. https://doi.org/10.1016/s0168-3659(03)00155-xa

10. Chan LW, Ong KT, Heng PW (2005) Novel film modifiers to alter the physical properties of composite ethylcellulose films. Pharm Res 22:476–489. https://doi.org/10.1007/s11095-004-1886-7

11. Tedesco MP, Monaco-Lourenço CA, Carvalho RA (2016) Gelatin/hydroxypropyl methylcellulose matrices – polymer interactions approach for oral disintegrating films. Mater Sci Eng C 69:668–674. https://doi.org/10.1016/j.msec.2016.07.023

12. Ranga Rao KV, Padmalatha Devi K, Buri P (1988) Cellulose matrices for zero-order release of soluble drugs. Drug Dev Ind Pharm 14:2299–2320. https://doi.org/10.3109/03639048809152017

13 Samani SM, Montaseri H, Kazemi A (2003) The effect of polymer blends on release profiles of diclofenac sodium from matrices. Eur J Pharm Biopharm 55:351–355. https://doi.org/10.1016/s0939-6411(03)00030-4

14 Ebube NK, Jones AB (2004) Sustained release of acetaminophen from a heterogeneous mixture of two hydrophilic non-ionic cellulose ether polymers. Int J Pharm 272:19–27. https://doi.org/10.1016/j.ijpharm.2003.11.020

15 Papageorgiou GZ, Bikiaris D, Kanaze FI, Karavas E, Stergiou A, Georgarakis E (2008) Tailoring the release rates of fluconazole using solid dispersions in polymer blends. Drug Dev Ind Pharm 34:336–346. https://doi.org/10.1080/03639040701662669

16 Lehmkemper K, Kyeremateng SO, Bartels M, Degenhardt M, Sadowski G (2018) Physical stability of API/polymer-blend amorphous solid dispersions. Eur J Pharm Biopharm 124:147–157. https://doi.org/10.1016/j.ejpb.2017.12.002

17 Ueda K, Yamazoe C, Yasuda Y, Higashi K, Kawakami K, Moribe K (2018) Mechanism of enhanced nifedipine dissolution by polymer-blended solid dispersion through molecular-level characterization. Mol Pharm 15:4099–4109. https://doi.org/10.1021/acs.molpharmaceut.8b00523

18 Lao LL, Venkatraman SS, Peppas NA (2008) Modeling of drug release from biodegradable polymer blends. Eur J Pharm Biopharm 70:796–803. https://doi.org/10.1016/j.ejpb.2008.05.024

19 Saini P, Arora M, Kumar M (2016) Poly(lactic acid) blends in biomedical applications. Adv Drug Deliv Rev 107:47–59. https://doi.org/10.1016/j.addr.2016.06.014

20 Pichayakorn W, Suksaeree J, Boonme P, Amnuaikit T, Taweepreda W, Ritthidej G (2012) Nicotine transdermal patches using polymeric natural rubber as the matrix controlling system: Effect of polymer and plasticizer blends. J Membr Sci 411–412:81–90. https://doi.org/10.1016/j.memsci.2012.04.017

21 Bajpai AK, Shukla SK, Bhanu S, Kankane S (2008) Responsive polymers in controlled drug delivery. Prog Polym Sci 33:1088–1118. https://doi.org/10.1016/j.progpolymsci.2008.07.005

22 De Souza Ferreira SB, Moço TD, Borghi-Pangoni FB, Junqueira MV, Bruschi ML (2016) Rheological, mucoadhesive and textural properties of thermoresponsive polymer blends for biomedical applications. J Mech Behav Biomed Mater 55:164–178. https://doi.org/10.1016/j.jmbbm.2015.10.026

23 Alhijjaj M, Belton P, Qi S (2016) An investigation into the use of polymer blends to improve the printability of and regulate drug release from pharmaceutical solid dispersions prepared via fused deposition modeling (FDM) 3D printing. Eur J Pharm Biopharm 108:111–125. https://doi.org/10.1016/j.ejpb.2016.08.016

24 Khaled SA, Burley JC, Alexander MR, Roberts CJ (2014) Desktop 3D printing of controlled release pharmaceutical bilayer tablets. Int J Pharm 461:105–111. https://doi.org/10.1016/j.ijpharm.2013.11.021

25 Solanki NG, Tahsin M, Shah AV, Serajuddin A (2018) Formulation of 3D printed tablet for rapid drug release by fused deposition modeling: screening polymers for drug release, drug-polymer miscibility and printability. J Pharm Sci 107:390–401. https://doi.org/10.1016/j.xphs.2017.10.021

26 Carson D, Jiang Y, Woodrow KA (2016) Tunable release of multiclass anti-HIV drugs that are water-soluble and loaded at high drug content in polyester blended electrospun fibers. Pharm Res 33:125–136. https://doi.org/10.1007/s11095-015-1769-0

27 Chachlioutaki K, Tzimtzimis EK, Tzetzis D, Chang MW, Ahmad Z, Karavasili C, Fatouros DG (2020) Electrospun orodispersible films of isoniazid for pediatric tuberculosis treatment. Pharmaceutics 12:470. https://doi.org/10.3390/pharmaceutics12050470

28 Qin ZY, Jia XW, Liu Q, Kong BH, Wang H (2019) Fast dissolving oral films for drug delivery prepared from chitosan/pullulan electrospinning nanofibers. Int J Biol Macromol 137:224–231. https://doi.org/10.1016/j.ijbiomac.2019.06.224

29 Sill TJ, von Recum HA (2008) Electrospinning: applications in drug delivery and tissue engineering. Biomaterials 29:1989–2006. https://doi.org/10.1016/j.biomaterials.2008.01.011

30 Hu X, Liu S, Zhou G, Huang Y, Xie Z, Jing X (2014) Electrospinning of polymeric nanofibers for drug delivery applications. J Control Release 185:12–21. https://doi.org/10.1016/j.jconrel.2014.04.018