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Review Article

Polymers in Drug Delivery Technology, Types of Polymers and Applications

V Sri Vajra Priya*, Hare Krishna Roy, N jyothi, N Lakshmi Prasanthi
Department of Pharmaceutics, Nirmala college of Pharmacy, Athmakur (V), Guntur, Andhra Pradesh, India

***Corresponding author**
V. Sri Vajra Priya
Email: vajrapriya05@gmail.com

Abstract: Polymers play a major role in the development of drug delivery technology by release of two types of drugs like hydrophilic and hydrophobic. In a synchronized manner and constant release of formulations over extended periods. There are numerous advantages of polymers acting as an inert carrier to which a drug can be conjugated, for example the polymer improves the pharmacokinetic and pharmacodynamic properties of biopharmaceuticals through various ways, like plasma ½ life, decreases the immunogenicity, build ups the stability of biopharmaceuticals, improves the solubility of low molecular weight drugs, and has a potential of targeted drug delivery. However they have their own limitations, such as the naturals polymers are most abundant and biodegradable but are difficult to reproduce and purify. Synthetic polymers have high immunogenicity, which prevent their long term usage. Non-biodegradable polymers are needed to be sugary after they release the drug at the targeted site. The general characteristic features that makes the polymer a potential candidate for drug delivery include, safety, efficacy, hydrophilicity, absence immunogenicity biological inactivity, sufficient pharmacokinetics, and presence of functional groups for covalent conjugation of drugs, targeting moieties, or formation of copolymer.
Keywords: polymer, pharmacokinetics, controlled drug delivery, target-base drug deliver, co polymer, novel drug delivery.

INTRODUCTION

Polymers are substances whose molecules have high molar masses and compressed of a large number of repeating units. Polymers can form particles of solid dosage form and also can change the flow property of liquid dosage form. Polymers are the backbone of pharmaceutical drug delivery systems. Polymers have been used as an important tool to control the drug release rate from the formulation[2]. They are also mostly used as stabilizer, taste-making agent, and proactive agent. Modern advances in drug delivery are now predicated upon the rational design of polymers tailored specific cargo and engineered to exert distinct biological functions.

Polymers are both naturally occurring and synthetic. Among naturally occurring polymers are proteins, starches, latex and cellulose. Synthetic polymers are produced on a large scale and have a many properties and used.

The polymers for the drug delivery system are classified on the following characteristics:-

- Origin- The polymers can be natural or synthetic, or a combination of both.
- Chemical nature- It can protein based, polyester, cellulose derivatives, etc.
- Backbone Stability- The polymers can be degradable or non biodegradable.
- Solubility- The polymer can hydrophilic or hydrophobic in nature [5,9].

Polymers act as inert carriers to which a particular drug can be conjugated. There are numerous advantages of polymer acting as an inert carrier, for example, the polymer enhances the pharmacodynamic and pharmacokinetic properties of biopharmaceuticals though several sources, such as, increases the plasma ½ life, decreases the immunogenicity, boost stability of biopharmaceuticals, improves solubility of low molecular weight drugs, and has potential for targeted drug delivery[1]. Some drugs have a limited concentration range by which utmost benefit can be delivered. The concentrations above or below can cause toxic effects or show no therapeutic effect. On the other hand, the very slow progress in the efficacy of the treatment of severe diseases, has suggested a growing need for a multidisciplinary approach to deliver the therapeutic to targets in the tissue. Through these new innovations in pharmacodynamic, pharmacokinetic, non specific toxicity, immunogenicity, biorecognition and

efficacy of the drug were generated. These new strategies were often called as drug delivery systems (DDS).

BIOMATERIALS FOR DELIVERY SYSTEMS

The polymers in the very starting stage they were particularly used for non-biological uses, and were selected because of their desirable physical properties, for example:

- Poly (methyl methacrylate) for physical strength transparency.
- Poly (vinyl alcohol) for hydrophilicity and strength.
- Poly (urethanes) for elasticity.
- Poly (ethylene) for toughness and lack of swelling.
- Poly (siloxanes) or silicones for insulating ability.
- Poly (vinyl pyrrolidone) for suspension capabilities.

In order for controlled drug delivery formulation, the polymers must be chemically inert and free from impurities with appropriate physical structure, minimal undesired aging, and to readily processable[7,22]. Few examples

- Poly (ethylene-co-vinyl acetate)
- Poly (methyl methacrylate)
- Poly (vinyl alcohol)
- Poly (N-vinyl pyrrolidone)
- Poly (acrylic acid)
- Poly (2hydroxy ethyl methacrylate)
- Polyacrylamide
- Poly (methacrylic glycol)
- Poly (ethelene glycol)

However in recent years the use of polymers were to words medical applications and drug targeting few examples are

- Polyrthoesters
- Poly (lactide-co-glycolides) (PLGA)
- Polyactide (PLA)
- Polyanhydride
- Polyglycolides (PGA)

ROLE OF POLYMERS IN DRUG DELIVERY:-

Immediate drug release dosage form tablets:

Polymers including polyvinyl pyrrolidone and hydroxypropylmethylecellulose (HPMC) are found to be a good binder which increases the formation of granules that improves the flow and compaction properties of tablet formulations prior to tableting.

Capsules:

Many of the polymeric excipients used to "bulk out" capsules fills are the same as those used in intermediate release tablets. For hard and soft shell gelatin has most often used[10]. By recent advances HPMC has been accepted as alternative material for hard and soft capsules.

Modified drug release dosage forms:

To achieve gastro retention mucoadhesive and low density, polymers have been evaluated, with little success so far their ability to extend gastric residence time by bonding to the mucus lining of the stomach and floating on top of the gastric contents respectively[11,12].

Extended release dosage forms:

Extended and sustained release dosage forms prolong the time that' systemic drug levels are within the therapeutic range and thus reduce the number of doses the patient must take to maintain a therapeutic effect there by increasing compliance[4,7]. The most commonly used water insoluble polymers for extended release applications are the ammonium ethacrylate copolymers cellulose derivatives ethyl cellulose and cellulose acetate, and polyvinyl derivative, polyvinyl acetate[15,17,20].

Gastro retentive Dosage forms:

Gastro retentive dosage forms offer an alternative strategy for achieving extended release profile, in which the formulation will remain in the stomach for prolonged periods, releasing the drug insitu, which will then dissolve in the liquid contents and slowly pass into the small intestine.

TYPES OF POLYMERS IN PHARMACEUTICAL DRUG DELIVERY

Polymers used as colon targeted drug delivery:

Polymers plays a very important role in the colon targeted drug delivery system. It protects the drug from degradation or release in the stomach and small intestine. It also ensures abrupt or controlled release of the drug in the proximal colon[8].

Polymers in the mucoadhesive drug delivery system:

The new generation mucoadhesive polymers for buccal drug delivery with advantages such as increase in the residence time of the polymer, penetration enhancement, site specific adhesion and enzymatic inhibiton, site specific mucoadhesive polymers will undoubtedly be uitilized for the buccal delivery of a wide variety of therapeutic compounds. The class of polymers has enormous for the delivery of therapeutic macromolecules[14].

Polymers for sustained release:

Polymers used in the sustain by preparing biodegradable microspheres containing a new potent osteogenic compound[16].

Polymers as floating drug delivery system:

Polymers are generally employed in floating drug delivery systems so as to target the delivery of drug to a specific region in the gastrointestinal tract i.e. stomach. Natural polymers which have been explored for their promising potential in stomach specific drug delivery include chitosan, pectin, xanthan gum, guar gum, gellan

gum, karkaya gum, psyllium, starch, husk, starch, alginates etc[13].

Polymers in tissue engineering:

A wide range of natural origin polymers with special focus on proteins and polysaccharides might be potentially useful as carriers systems for active biomoleculesor as cell carriers with application in the tissue engineering field targeting several biological tissues[18].

RECENT DEVELOPMENTS IN USE OF POLYMERS FOR DRUG DELIVERY SYSTEMS

Oraldrugdelivery system has been in practice since many years as the most widely used root of administration among all the roots that have been employed for the systemic delivery of drug via various pharmaceutical products for different dosage forms. A large of both synthetic and natural has been studied for possible application in drug delivery system[6].

The most advantageous property of polymers is that they have been most widely used now a days. Two promising synthetic polymers which have been developed for biomedical applications are form polyvinylpryolidone and polyethylene glycol acrylate based hydrogels. Both of them are biodegradable and forms copolymers with natural macromolecules.

On the other side, natural polymers have the advantage of high biocompatibility and less immunogenicity. A special attention has been shown through the gelatin and collagen which are natural polymers[20]. Other natural polymers include chitosan, alginate, starch pectin, casein and cellulose derivatives. The composites of some of the above natural polymers with synthetic polymers give added advantages as carriers for drugs delivery by complimenting the properties of each other.

Hybrid copolymers of collagen with biodegradable synthetic polymers polyethylene glycol 6000 and polyvinylpyrolidone were developed for the controlled released of contraceptive some drugs have an optimum range within which maximum benefit is derived, and concentrations above or below this range can be toxic or produce no therapeutic belief it at all. On the other hand, the very slow progress in the efficacy of the treatment of severe disease, has suggested a growing need for a multidisciplinary approach to the delivery of therapeutics to targets in the tissues[19]. From this, new idea on controlling the pharmacokinetic, pharmacodynamics, non-specific toxicity, immunogenicity, biorecognition, and efficacy of drugs were generated. These new strategies, often called drug delivery system (DDS), are based on interdisciplinary approaches that combine pharmaceutics, polymer science, analytical chemistry, and molecular biology[25,26].

Polymers are used in the conventional dosage forms like binders for enteric coted tablets which mask the unpleasant taste, viscosity enhancers for controlling flow in liquids[12], gel preparation in case of semisolids and also used in preparation of transdermal patches[21,27].

Future trust

Many researchers are working in this filed and have developed many modify copolymers with desirable functional groups, who visualize their use not only for controlled drug delivery systems, but also used for artificial organs lining, immunology testing, agents in drug targeting, chemical reactors and substrates for cell growth[17]. The most potential opportunities for these polymers in controlled drug delivery lie in the field of responsive delivery systems, it is expected that, in future even more than today, researches and doctors will have a wealth of products using biodegradable polymers that will help faster patient recovery and eliminate follow up surgeries[3]. Looking to present scenario and a wide range of research, total use of these biodegradable polymers in drug delivery applications is within reach in the near future.

CONCLUSION

The use if novel polymers not only offers benefits but also can to be harmful because of the toxicity and other incompatibilities associate with them. Polymers possessing a unique strength in their application towards drug delivery application which enables the new advancement in the formulating new drug delivery systems which improves the therapy and treatment . Care should be taken to properly select polymers while designing a delivery system. The ultimate goal is to introduce cost effective ,biocompatible, multifunctional. less toxic polymers so that the delivery systems pass through the various phases of clinical trials and benefit the society . Among various types of polymer hydrogels polymer blends of natural and or synthetic polymer are used in the pharmaceutical formulations .In that controlled drug delivery systems having a advantages over conventional therapy fall into various categories such as diffusion – controlled chemically controlled, solvent activated and modulated release systems. On the whole, polymers are being extensively used in pharmaceutical industry due to their vast applications.

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