Polymers used in the transdermal drug delivery system of carvedilol: Review

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ABSTRACT: The current review article focuses on polymers in Transdermal drug delivery system. Polymers are the backbone of transdermal drug delivery system as they control the release of the drug from the device. As 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 suitable for application. Polymers' primary function is to protect drugs from their physiological environment and prolong their release to increase their stability. Diffusion, degradation, and swelling release the drug from the polymer. This review highlights the role of different polymers in the transdermal drug delivery system of carvedilol drug. Carvedilol is the antihypertensive drug used in the hypertension and cardiac heart failure (CHF). This also gives information about polymers classification. The collected data provides knowledge about polymers which is further useful for the researchers for transdermal drug delivery system of carvedilol.

INDEX TERMS: Polymers, transdermal drug delivery system, controlled release, carvedilol.

INTRODUCTION:

POLYMERS:

Polymers are the backbone of a transdermal drug delivery system. Systems for transdermal delivery are fabricated as multilayered polymeric laminates in which a drug reservoir or a drug–polymer matrix is sandwiched between two polymeric layers: an outer impervious backing layer that prevents the loss of drug through the backing surface and an inner polymeric layer that functions as an adhesive and/or rate-controlling membrane. [1] Polymer Matrix: Polymer matrix can be prepared by dispersion of drug in liquid or solid state synthetic polymer base. Polymers used in TDDS should have biocompatibility and chemical compatibility with the drug and other components of the system such as penetration enhancers and PSAs. Additionally they should provide consistent and effective delivery of a drug throughout the product's intended shelf life and should be of safe status. [2] The following criteria should be satisfied for a polymer used in the transdermal drug delivery system: a) The polymer's molecular weight and chemical functionality should be such that the specific medicine diffuses and is released properly through it. b) The polymer should be stable. c) The polymer must not be harmful. d) The polymer should be easily of manufactured e) The polymer should be affordable. f) The polymer and its degradation product must not be poisonous or hostile to the host organism. g) It contains large quantities of the active ingredient [3]. The polymers used in transdermal drug delivery system can be classified as,

TYPES OF POLYMERS:

Natural Polymers: e.g. cellulose derivatives, zein, gelatin, shellac, waxes, gums, natural rubber and chitosan etc .

Synthetic Elastomers: e.g. polybutadiene, hydrin rubber, polyisobutylene, silicon rubber, nitrile, acrylonitrile, neoprene, butyl rubber etc.

Synthetic Polymers: e.g. polyvinyl alcohol, polyvinylchloride, polyethylene, polypropylene, polyacrylate, polyamide, polyurea, polyvinylpyrrolidone, polymethylmethacrylate *etc*. [2]

To change the polymer characteristics and consequently the release rates, many approaches have been used:

Polymers with Cross-Linking The more crosslinking there is, the denser the polymer becomes and the slower drug molecules diffuse through the matrix.

POLYMERS IN TDDS:

Reservoir systems. In this system, the drug reservoir is embedded between an impervious backing layer and a rate controlling membrane. The drug releases only through the rate-controlling membrane, which can be microporous or nonporous. In the drug reservoir compartment, the drug can be in the form of a solution, suspension, or gel or dispersed in a solid polymer matrix. On the outer surface of the polymeric membrane a thin layer of drug-compatible, hypoallergenic adhesive polymer can be applied. [1]

Matrix systems. Drug-in-adhesive system. The drug reservoir is formed by dispersing the drug in an adhesive polymer and then spreading the medicated polymer adhesive by solvent casting or by melting the adhesive (in the case of hot-melt adhesives) onto an impervious backing layer. On top of the reservoir, layers of unmedicated adhesive polymer are applied. [1]

Matrix-dispersion system. The drug is dispersed homogeneously in a hydrophilic or lipophilic polymer matrix. This drug containing polymer disk then is fixed onto an occlusive base plate in a compartment fabricated from a drug-impermeable backing layer. Instead of applying the adhesive on the face of the drug reservoir, it is spread along the circumference to form a strip of adhesive rim.

Microreservoir systems. This drug delivery system is a combination of reservoir and matrix-dispersion systems. The drug reservoir is formed by first suspending the drug in an aqueous solution of water-soluble polymer and then dispersing the solution

homogeneously in a lipophilic polymer to form thousands of unleachable, microscopic spheres of drug reservoirs. The thermodynamically unstable dispersion is stabilized quickly by immediately cross-linking the polymer in situ. Polymers are used in transdermal delivery systems in various ways, including as

- matrix formers
- rate-controlling membranes
- pressure-sensitive adhesives (PSAs)
- backing layers
- release liners.[1]

POLYMERS USED IN TRANSDERMAL DRUG DELIVERY SYSTEM OF CARVEDILOL:

1. HPMC:

Hydroxypropyl methylcellulose (HPMC). HPMC, a hydrophilic swellable polymer widely used in oral controlled drug delivery, also has been explored as a matrix former in the design of patches of propranolol hydrochloride. HPMC has been shown to yield clear films because of the adequate solubility of the drug in the polymer. Matrices of HPMC without rate-controlling membranes exhibited a burst effect during dissolution testing because the polymer was hydrated easily and swelled, leading to the fast release of the drug. [1]

2. Eudragit RL-100:

It's a quaternary ammonium copolymer made up of ethyl acrylate, methyl methacrylate, and a little amount of methacrylic acid ester. Ammonium groups exist as salts in the polymers, making them permeable.

Product Form- Granules Targeted Drug Release Area- Time controlled release, pH independent.

Characteristics

Insoluble , High permeability

pH independent swelling

Customized release profile by combination of RL and RS grades in different ratios.

Suitable for matrix structures [4]

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4. Ethyl cellulose:

Ethyl cellulose (EC) is hydrophobic polymer and is essentially tasteless, odorless, colorless and physiologically and pharmacologically inert. It has been extensively used as a pharmaceutical solid vehicle in preparing microcapsules, coating material for tablets and granules and matrix forming material for sustained release dosage forms But EC is considered as an ideal polymer for microencapsulation technology and it has been proved that EC can be used successfully for both oil-in-water and water-in-oil emulsion solvent evaporation technique.[5]

5. Polyvinyl pyrrolidone (PVP):

PVP, commonly known as polyvidone or povidone, is a biodegradable and water-soluble polymer formed from the monomer N-vinylpyrrolidone. PVP is a hydrophilic polymer with great solubility in a variety of polarity solvents and outstanding binding characteristics. PVP is a non-toxic and biocompatible polymer [11].

PVP has a number of distinct physical and chemical properties, including being chemically inert, colourless, temperature-resistant, and pH-stable. The various molecular weight PVPs are distinguished by different K-values, e.g., K12 (3100–5700 Daltons), K17 (7900–10,800 Daltons), K25 (23,000–32,000 Daltons), K30 (35,000–51,000), and K90 (900,000–1,300,000 Daltons). PVP has been used to produce several drug delivery systems in the pharmaceutical and biomedical areas, including oral, topical, transdermal, and ocular administration.

The influence of the polymer's molecular weight on formulation preparation and drug dissolution kinetics was investigated using different molecular weights of PVP (PVP K15, K30, and K90). PVP is a polymer with a lot of potential for making pharmaceutical formulations because of its versatility and distinctive features. PVP has good film-forming properties, and PVP-based films were primarily made by solution casting and solvent evaporation. Because of the water absorption, PVP film is more flexible.[6]

6. Polyvinyl alcohol (PVA):

PVA is a synthetic, biocompatible, and toxicologically safe polymer that can be utilised as a matrix forming for sustained release hydrogel drug delivery systems. It is suitable for a wide range of pharmaceutical formulations, including solid, liquid, and semi-solid formulations. Poly vinyl alcohol (PVA) is a granular powder with a cream colour that is made from polyvinyl acetates. PVA comes in a variety of grades, and its viscosity is related to its molecular weight. It thickens and adheres to surfaces. PVA solution can be gelled without the use of an external crosslinking agent by freezing and thawing it repeatedly, giving highly strong, ultrapure, biocompatible hydrogels that have been utilised for vascular stents, cartilages, contact lenses, and other applications. The dry PVA films with xanthan gum and plasticizers had their mechanical performance tested as well. When compared to polyvinyl alcohol film alone, polyvinyl alcohol xanthan gum mixes demonstrated a high rate of drug release. Skin is unaffected by PVA, which is incompatible with inorganic salts.[7]

7. Sodium CMC:

Sodium carboxymethyl cellulose (CMC) is one of the most important products of cellulose ethers, which are cellulose derivates with an ether structure generated through natural cellulose modification. Because the acid form of CMC has a low water solubility, it is normally maintained as sodium carboxymethylcellulose, which is widely utilised in many industries and is commonly referred to as monosodium glutamate. CMC can be used as a flocculant, chelator, emulsifier, thickener, water-retaining agent, sizing agent, and film-forming material, among other things. [8]

C**ONCLUSION:**

This article provides valuable information regarding the transdermal drug delivery system. To optimize this drug delivery system understanding of the different mechanisms of biological interactions and polymer are required. The synthetic polymers can be made as per requirement of the formulation by changing polymer characteristics and on the other hand natural pharmaceutical excipients are biocompatible, non-toxic, eco-friendly and economical. TDDS a realistic practical application as the next generation of drug delivery system.

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