Review Article

Review of Hydrogel

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ABSTRACT

Hydrogel is one of the semi-solid topical dosage forms, which includes cross-linked three-dimensional networks of hydrophilic polymer chains; therefore, it can entrap a larger amount of water. Hydro-gels have the advantages of increased biocompatibility, porous structure, tunable biodegradability, and proper mechanical strength as compare to other type of topical drugs. Several studies are indicated that the usefulness of gels especially hydrogels in modern drug therapy. They are efficient drug delivery systems in several routes including topical, Parenteral, oral, vaginal, ophthalmic etc. Hydrogel systems are able to deliver not only aqueous soluble drugs but also poorly soluble drugs. Hydrogels offer a highly biocompatible, effective and patient friendly solution for controlled drug delivery.

Keywords: Hydrogel, Classification of Hydrogel, Evaluation of Hydrogel.

INTRODUCTION

Topical drug delivery system is the most preferred route for local delivery of therapeutic agents especially in pain and inflammation management, hormonal therapy, treatment of diseases of the cardiovascular and central nervous systems. Because of its convenience and affordability, it also prevents drug loss due to first-pass metabolism and maximizes the therapeutic effect without interference of pH, enzyme, and intestinal bacteria[1]. Hydrogel is one of the semisolid topical dosage forms, which includes cross-linked three-dimensional networks of hydrophilic polymer chains; therefore, it can entrap a larger amount of water. Hydro-gels have the advantages of increased biocompatibility, porous structure, tunable biodegradability, and proper mechanical strength as compare to other type of topical drugs. Pain can be described as a somatic sensation, a symptom of a few bodily damage or sickness, or maybe emotional misery. Pain is a fundamental issue of the frame's safety mechanisms, and it is a segment of a rapid caution relay training the motor neurons of the important frightened machine to lower physical damage[2]. Pain is directly related with inflammation. Inflammation is an alliance of different routes including generations of interleukin, adhesive proteins, prostaglandins, and factor for activation of platelets. These are agonizing the chemo-taxis. Its mechanism comprises a series of occasions wherein the metabolism of arachidonic acid performs a vital function. Medicinal plants are supposed to be an important source of chemical substances with therapeutic effects in the body and considered to treat various diseases with least side effects. Mostly non-steroidal anti-inflammatory drugs are taken for reducing the inflammation and pain, but these drugs show many side effects like bleeding, ulceration, skin irritation, and failure of organ function[3].

Hydrogel

A hydrogel is a three-dimensional (3D) network of hydrophilic polymers that can swell in water and hold a large amount of water while maintaining the structure due to chemical or physical cross-linking of individual polymer chains (fig 1). Hydrogels were first reported by Wichterle and Lím (1960). Owing to their high-water content, porosity and soft consistency, they intently simulate natural living tissue, more so than any other category of synthetic biomaterials. Hydrogels can either be chemically durable or they may eventually disintegrate and dissolve. Hydrogels are also known as 'reversible' or 'physical' gels if molecular entanglements and/or secondary forces such as ionic, hydrogen bonding or hydrophobic forces play the principal role in forming the linkage. Physical gels are often rescindable and it is achievable to dissolve them by altering the environmental conditions, such as pH and the ionic strength of solution or temperature. In 'permanent' or 'chemical' gels, the linkage of covalent bonds linking distinct macromolecular chains can be attained by crosslinking polymers in the dry state or in solution. These gels may be either charged or non-charged dependent on the behaviour of functional groups existing in their structure. The charged hydrogels typically display changes in swelling upon variations in pH and it is wellknown that they can undergo changes in shape when subjected to an electric field. Hydrogels can be manufactured practically from any water-soluble polymer, including a wide range of chemical compositions and bulk physical properties. Additionally, hydrogels can also be formulated in a number of physical forms such as slabs, microparticles, nanoparticles, coatings or films. Accordingly, hydrogels are universally being employed in clinical practices and

investigational medicine for a wide variety of applications, counting the tissue engineering and regenerative medicine diagnostics, cellular immobilization, separation of biomolecules or cells and barrier materials to control biological adhesions.

Due to its simplicity in manufacturing and self-application hydrogels have been widely used as a drug carrier. Hydrogels may be synthesized in a many of ''classical'' chemical ways. These include one-step procedures like polymerization and parallel cross-linking of multifunctional monomers, by reacting polymers with suitable cross-linking agents and as well as multiple step procedures involving synthesis of polymer molecules having reactive groups and their subsequent cross-linking[4].

Fig.1: Hydrogel

Classification of Hydrogel

Hydrogels can be classified into two groups based on their natural or synthetic origins. Classification according to polymeric composition, the method of preparation leads to formations of some important classes of hydrogels:

(a) Homopolymeric hydrogels are referred to polymer networks derived from a single species of monomer, which is a basic structural unit comprising of any polymer network. Homopolymers may have crosslinked skeletal structure depending on the nature of the monomer and polymerization technique[8].

(b) Copolymeric hydrogels are comprised of two or more different monomer species with at least one hydrophilic component, arranged in a random, block or alternating configuration along the chain of the polymer network[9)].

(c) Multipolymer interpenetrating polymeric hydrogel (IPN) an important class of hydrogels, is made of two independent cross-linked synthetic and/or natural polymer component, contained in a network form. In semi-IPN hydrogel, one component is a cross-linked polymer and other component is a non-cross-linked polymer[10].

Material used hydrogel

Natural material for hydrogel

1. Sodium Alginate

Sodium alginate (SA) is a linear anionic polysaccharide polymer. Because SA contains a large amount of -COOH, SA has obvious pH sensitivity and can quickly form a gel under extremely mild conditions, which can avoid the inactivation of active substances such as sensitive drugs, proteins, cells, and enzymes. Many wound care products take advantage of the structural similarity between alginate and ECM.

2.Collagen

Collagen (COL), as the main component of ECM in animals, has good biological activity, biocompatibility, and biodegradability. When used as the basic component of wound dressings, it has weak antigenicity, promotes cell growth and proliferation, promotes coagulation and avoids scar formation, etc.

3.Starch

Starch is widely used in the preparation of biodegradable hydrogels. It has the advantages of low cost, wide sources, renewable, biocompatibility, and nontoxicity, etc. Due to the shortcomings such as lack of hydrophilicity and low mechanical strength, starch is generally not used alone in the preparation of hydrogels. Oxidized starch is one of the important modified starches. Oxidized starch has the characteristics of low viscosity, high stability, transparency, film formation, and viscosity, and is widely used in the pharmaceutical industry[11].

Synthetic Materials for Hydrogels

1. Acrylamide

Acrylamide (AM) and its derivatives have excellent biocompatibility, noncarcinogenicity, non-toxicity, easy processing, mechanical adjustment, accurate and controllable elastic properties, and good swelling ability. The SA/PAM-Fe DN hydrogels prepared on the basis of hydrophobic interaction and ionic cross-linking had excellent self-healing properties, puncture resistance, fatigue resistance, pH sensitivity, good thermal stability, and self-healing properties. healing. At the same time, AM's mechanical adjustment and precise controllability of elastic properties make it very promising in future intelligent applications.

2. Polyvinyl Alcohol

Polyvinyl alcohol (PVA) is a common polymer and has good biocompatibility, solubility, non-toxicity, non-carcinogenicity, and excellent mechanical properties. However, the pure PVA hydrogels do not have the effects of hemostasis, antibacterial, etc., and lack of elasticity and hydrophilicity. In recent years, researchers have focused on the combination of PVA with other functional components to promote wound healing.

3. Polyethylene Glycol Polyethylene glycol (PEG)

Polyethylene Glycol Polyethylene glycol (PEG) is a kind of amphiphilic polymer with a wide molecular weight range. In recent years, PEG has been widely used in wound dressings because of its non-toxicity, good biocompatibility, biodegradability, easy availability, stable activity, and low preparation cost. However, due to the use

of cross-linking agents, such as formaldehyde, glutaraldehyde, and epichlorohydrin, the prepared hydrogel dressings are cytotol[12].

Preparation

Physical crosslinking of polymer to form its hydrogel can also be achieved by using freeze-thawing cycles. The mechanism involves in formation of microcrystals in the structure due to freeze-thawing. Example of this type of gelatin are freezethawed gels of polyvinyl alcohol and xanthan.

Evaluation of Hydrogel

Physical appearance:

The physical appearance and homogeneity of the prepared gels were tested by visual observations. The marketed formulation was considered as reference.

Spread ability test:

Spread ability can be determined by applying the gel over an even surface and observed for the gritty nature of the hydrogel if present.

PH determination:

The pH of the gel formulations was determined by using a pH meter. For pH determination, 1% of hydrogel formulation in deionized water was prepared and pH was determined[13].

Drug content:

For assay of the drug in gels, diclofenac sodium was extracted from 1 g of each gel formulations with 20 mL of phosphate buffer pH7.4 for 30 min. The resultant mixture was filtered through membrane filter (pore size 0.45 µm). The absorbance of the sample was determined spectrophotometrically at 276 nm (Elico SL150 UV-VIS spectrophotometer) after appropriate dilution with phosphate buffer pH 7.4. The concentration of diclofenac sodium was estimated from the calibration curve.

Determination of viscosity: The viscosity of the gel formulations was determined using Brookfield viscometer with spindle no. 7 at 100 rpm at the temperature of 250C.

Accelerated stability studies:

Stability studies were carried out on optimized formulation according to International Conference on

Harmonization (ICH) guidelines. The formulation packed in aluminium tube was subjected to accelerated stability testing for 3 months as per ICH norms at a temperature (40 ± 2°C) and relative humidity 75 ± 5%. Samples were taken at regular time intervals of 1month for over a period of 3months and analyzed for the change in pH, spreadability, drug content and in-vitro drug release by procedure stated earlier. Any changes in evaluation parameters, if observed were noted. Tests were carried out in triplicate and mean value of the observed values was noted along with standard deviation[14].

CONCLUSION

Several studies are indicated that's the usefulness of gels especially hydrogels in modern drug therapy. They are efficient drug delivery systems in several routes including topical, Parenteral, oral, vaginal, ophthalmic etc. hydrogel systems are able to deliver not only aqueous soluble drugs but also poorly soluble drugs as a suspension. The retardation of drug release depends on several factors like the type of gel polymer, its concentration, swellability drug solubility, gel strength etc.

Altogether hydrogels offer a highly biocompatible, effective and patient friendly solution for controlled drug delivery.

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