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Review on hydrogel

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A B S T R A C T

Hydrogel product constitute a group of polymeric material, the hydrophilic structure of which render them capable of holding large amount of water in their three dimensional networks. Due to their high water content, porosity and soft consistency, they closely simulate natural living tissue, more so than any other class of synthetic biomaterials. Furthermore, hydrogels can be formulated in a variety of physical forms, including slabs, microparticles, nanoparticles, coatings, and films. As a result, hydrogels are commonly used in clinical practice and medicine for a wide range of applications, including Tissue engineering and Regenerative medicine, Diagnostics, Cellular immobilization, separation of biomolecules or cells, and barrier materials to regulate biological adhesions. This biomaterial can hold large amount of biological fluids and swell. When swell, they are soft and rubbery and resemble the living tissue exhibiting excellent biocompatibility. The prime objective of this article is to concern the classification of hydrogel on different bases, properties of hydrogel and its method of preparation and physical and chemical characteristics of these products.

Keywords: Hydrogel Properties, Method of Preparation, Applications and features of hydrogel

A R T I C L E I N F O

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1. Introduction

Hydrogels are hydrophilic, three dimensional network that hold the large quantity fluid water is the large constituents of human body which applied for the biomedical purposes. Generally it based on the chemical composition which is responsive to the various stimuli such as heating, pH, light, and chemicals. Hydrogels can also be prospect by rheological manners and swollen polymer network which flatter hydrated in the liquid media that are referred to as the hydrogel structure. Many theories are involved in the swelling mechanism such as Equilibrium swelling theory, Rubber elastic theory, Mechanism of Gelation and Calculation of mesh size. Hydrogels can be prepared from natural polymers are polysaccharides, polypeptide. Hydrogels formulation applied on the skin surfaces which categories into two groups such as topical and transdermal route. Topical formulations provide the drug at the particular site of the skin surfaces without systemic exhibition while transdermal formulations applied to the local area of the skin surfaces which maintain and deliver the effective concentration of drug in the systemic circulations. Aerosol, spray, semi-solid and patches are the examples of the transdermal formulations. Hydrogel have different method for the in vivo administration of drug, which are based on the localization and pathological condition. Most available topical subcutaneous, orthotopic, intraperitoneal, oral, ocular and rectal. Topical or transdermal plays a vital role for the skin infection, subcutaneous for toxicological effect, orthotopic and intraperitoneal injections for therapy while oral administration have some disadvantage due to the presence of some digestive enzymes. According to Witchterls and Lim in 1960, cross-linked hydroxyl ethyl methaacrylate has

excellent water holding capacity, high water retention, good biocompatibility and biodegradability, limited or minimal toxicity and simplified synthetic method. Hydrogels are formed by physical and chemical cross- linking network. Conductive hydrogel, Injective hydrogel, Double network hydrogel, Responsive hydrogel, Nanocomposite hydrogel, sliding hydrogel and other Novel hydrogel. Advanced hydrogel materials have unique properties to swell under particular sympathetic circumstances and response to available of stimuli that are referred to as the environmental or stimuli sensitive. Some synthetic polymer hydrogels are included cross- linking hydrogel, water in hydrogel, poly (vinyl alcohol), poly (hydroxyethyl methaacrylate), polyvinyl pyrrolidone, polymidine, polyacrylate, polyurethane, polyethylene glycol and derivatives

Features of Hydrogel

- It should have rewetting capacity and highest absorbancy under load (AUC).
- They exhibit little residual manners and soluble content.
- During storage condition it has good stability and durability in the swelling environment.
- It is colorless, odorless, non-toxic and also exhibit highest photo stability in nature.
- Hydrogel must be pH neutrality after in swelling media and highest biodegradability
- Drug should have adapted hydrophilicity and molecular weight of less than 500 Daltons.
- PH value of drug between 5 and 9.
- Drug must be high acidic or alkaline in solution which are not suitable for topical drug delivery system.
- The highest absorption capacity in saline.
- Desired rate of absorption depending on the application requirements
- The highest durability and stability in the swelling environment and during the storage.
- Colorlessness, colorlessness, and absolute non-toxic.
- High electrical conductivity

2. Hydrogel Preparation

Hydrogels are polymer networks having hydrophilic properties. While hydrogels are generally prepared based on hydrophilic monomers, hydrophobic monomers are sometimes used in hydrogel preparation. In general, hydrogels can be prepared from either synthetic polymers or natural polymers. The synthetic polymers are hydrophobic in nature and chemically stronger compared to natural polymers. Their mechanical strength results in slow degradation rate, but on the other hand, mechanical strength provides the durability as well. These two opposite properties should be balanced through optimal design. Also, it can be applied to preparation of hydrogels based on natural polymers provided that these polymers have suitable functional groups or have been functionalized with radically polymerizable groups. The polymerization techniques have been described below:

Bulk polymerization:

Bulk hydrogels can be formed with one or more types of monomers mainly include vinyl monomers for the productions of hydrogels. Usually, a small amount of cross-linking agent is added in any hydrogel formulation. Radiation, ultraviolet, or chemical catalysts is used for the initiation of the polymerization reaction. The initiator is chosen which depends upon the type of monomers and solvents being used. The polymerized hydrogel may be produced in a wide variety of forms including rods, particles, films and membranes, and emulsions.

Free radical polymerization:

The main monomers which are used in this method for the preparation of hydrogels are such as acrylates, vinyl lactams and amides. These polymers have suitable functional groups or have been functionalized with radically polymerizable groups. This method involves the chemistry of typical free-radical polymerizations, which includes propagation, chain transfer, initiation, and termination steps. For the radical generation in the initiation step a wide variety of thermal, ultraviolet, visible, and redox initiators can be utilized, the radicals react with the monomers which convert them into active forms.

Solution polymerization:

In these ionic or neutral monomers are mixed with the multifunctional crosslinking agent. The polymerization is initiated thermally by UV-irradiation or by a redox initiator system. The major advantage of the solution polymerization over the bulk polymerization is the presence of solvent serving as a heat sink. The prepared hydrogels is washed with distilled water to remove the initiator, the soluble monomers, oligomers, cross-linking agent, and extractable polymer, and other impurities. Solvents used water–ethanol mixtures, water, ethanol, and benzyl alcohol.

Suspension polymerization:

This method is employed to prepare spherical hydrogel micropartical with size range of 1μm to 1mm. in this method the monomer solution is dispersed in non-solvent forming fine droplet, which is stabilized by stabilizer. The polymerization initiated by thermal decomposition of free radical. The prepared micro particle washed to remove un-reacted monomers cross-linking reagent and initiator.

Grafting to a support:

Grafting involves the polymerization of a monomer on the backbone of a preformed polymer. The polymer chains are activated by the action of chemical reagents, or high energy radiation treatment. The growth of functional monomers on activated macroradicals leads to branching and further to crosslinking.

3. Applications

Wound healing: Hydrogels have the ability to hold water and drug in them due to their cross linked structure. Due to their water holding ability they can hold and retain wound exudates. Polyvinyl pyrrolidine or polyacrylamide in the form of a gel containing 70-95% water.

Colon Specific Hydrogels:

Colon specific hydrogels of polysaccharide have been specifically designed because of presence of high concentration of polysaccharide enzymes in the colon region of GI. Dextran hydrogel is formulated for colon-specific drug delivery.

Drug delivery in GI tract:
Hydrogels delivers drugs to specific site in the GIT. In presence of micro flora drug loaded with colon specific hydrogels show tissue specificity and change in the pH or enzymatic action which causes degradation of drug.

Rectal Delivery:
Hydrogels showing bio adhesive properties are used for rectal drug delivery.

Transdermal Delivery:
Various hydrogel based drug delivery device are formed to deliver drug through transdermal route. Hydrogel based formulations are being explored for transdermal iontophoresis to obtain enhanced permeation of products viz. hormones and nicotine

Drug delivery in the oral cavity:
Drug is incorporated into hydrogels and delivers to oral cavity for local treatment of diseases of the mouth, such as stomatitis, fungal diseases, periodontal disease, viral infections, and oral cavity cancers.

Gene delivery: Change in composition of hydrogels leads to effective targeting and delivery of nuclei acids to specific cells for gene therapy. Hydrogels has more potential application in the treatment of many genetic o acquired diseases.

Tissue Engineering:
Micronized hydrogels are used to deliver macromolecules into cytoplasm of antigen presenting cells. Natural hydrogels material is used for tissue engineering include agarose, methylcellulose and other naturally derived products.

Ocular drug delivery:
Hydrogels are most widely used in ocular drug delivery system. Hydrogel show Controlled or sustain release in order to reduce the frequency of dosing or to increase the effectiveness of the drug by localization at its site of action, decreasing the dose required or providing uniform drug delivery.

4. Conclusion

Hydrogel based delivery devices can be used for oral, ocular, epidermal, subcutaneous application due to their high water contents and soft consistency hydrogels resemble natural living tissue more than any other class of synthetic biomaterials. Recently, many hydrogel based networks have been designed and personalized to meet the needs of different applications. When putted in contact with an aqueous solution these hydrogels is either ability to swell. The present review demonstrates about the classification of hydrogels on different bases, physical and chemical characteristics and technical feasibility of their utilization, method of preparation and application.

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