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Review Article

A Review On Nano Gel As A Novel Drug Delivery System

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ABSTRACT

Nanogel". Known as nanosized hydrogels, nanogels are tiny, swelling particles composed of chemically or physically cross-linked flexible hydrophilic or amphiphilic polymer networks. The size and other physical characteristics of nanogels can be effortlessly modified and maintained in line with the intended delivery molecule. Biocompatibility and degradability: Polymers, either synthetic or natural, are used to make nanogel. They don't accumulate because of their great biocompatibility and biodegradability. inside organs. The nanogel is made using chitosan, methylcellulose, ethyl cellulose, and a variety of polysaccharide-form polymers such pullulan, dextran, and dextrin. These polymers are biodegradable, hydrophilic, stable, and non-toxic.Nanogels are promising and innovative drug delivery system that can play a vital role by addressing the problems associated with old and modern therapeutics such as nonspecific effects and poor stability.

INTRODUCTION

Nanogels are micro-sized hydrogel systems that are heavily cross-linked and co-polymerized, or they can be monomers that are either ionic or non-ionic. [1] The nanoscale size can be useful in drug delivery due to its ability to enhance drug dispersion, increase tumour accumulation, boost stability against chemical and enzymatic degradation, and decrease cytotoxic side effects during cancer treatment. [2] Nanogels can be used as charged solutes, hydrophilic and hydrophobic medications, and extra diagnostic agents.Polymeric micellar nanogel designs that exhibit fair equilibrium over the surface active agent micelles, progressive rates of dissociation, reduced critical micelle concentrations, and extended drug retention are the building blocks of nanogel formulations. [3] A hydrogel nanoparticle having a cross-linked hydrophilic polymer network is referred to as a "Nanogel". Known as nanosized hydrogels, nanogels are tiny, swelling particles composed of chemically or physically

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cross-linked flexible hydrophilic or amphiphilic polymer networks. These networks of polymers could have an anionic or ionic composition. They serve as drug carriers and are made in a way that makes it simple for them to absorb chemicals that are physiologically active through the creation of biomolecular interactions such hydrogen bonds, salt bonds, and hydrophobic interactions. By maximising molecular composition, size, and shape, these Nanogels are made to conveniently encapsulate a broad variety of biomolecules and provide regulated drug release in vivo. [4] The swelling networks of Nanogels become pliable and capable of encasing the necessary amount of water when they are distributed in aqueous conditions. Desired biological or medicinal molecules can be included into the Nanogels to create highly distributed hydrophilic particles by enabling the polymer matrix and agents to interact spontaneously. This final structure has the ability to prevent the desired loaded biomolecule from disintegrating. The process of giving a pharmaceutical substance to have a therapeutic effect in people or animals is known as drug delivery. The majority the popular noninvasive oral (via the mouth), topical (skin), transmucosal (nasal, buccal, sublingual, vaginal, ophthalmic, and rectal), and inhalation routes are referred to as frequent techniques of delivery. [5]

List of drug carriers within the NDDS

- Nanosome
- Liposomes
- Niosomes
- Nanospheres
- Nanoparticles (Nanogel)
- Microspheres
- Microparticle
- Nanosuspension
- Micelles [6]

BENEFITS of NANOGEL DRUG DELIVERY APPROACH

1. It guards against the body's natural breakdown of medications.
2. The size and other physical characteristics of nanogels can be effortlessly modified and maintained in line with the intended delivery molecule.
3. The quantity of medication needed is minimal, and fewer dosages are needed.
4. Reduces drug toxicity and increases absorption of therapeutic molecules.
5. Drug-loaded Nanogels can be applied transdermally and penetrate the body without having any negative or side effects.
6. These are able to cross physiological barriers like the skin and the blood-brain barrier. [7,8]

Advantages of Nanogels

1. Biocompatibility and degradability:

Polymers, either synthetic or natural, are used to make nanogel. They don't accumulate because of their great biocompatibility and biodegradability. inside organs. The nanogel is made using chitosan, methylcellulose, ethyl cellulose, and a variety of polysaccharide-form polymers such pullulan, dextran, and dextrin. These polymers are biodegradable, hydrophilic, stable, and non-toxic.

2. Swelling characteristics in aqueous media

When placed in an aqueous solution, nanogels can swell or remain and absorb water because of their strong affinity for aqueous solutions. medium. This is the most advantageous feature of nanogels since it gives them the best chance of absorbing and delivering large medications, proteins, peptides, and bio-macromolecules. Only when medium ions apply osmotic pressure and there is an imbalance in the swelling pressure of the polymer network does swelling occur.

3. High drug loading capacity:

When it comes to drug loading capacity, nanogels outperform conventional dosage forms. This is mostly because to the swelling characteristic, which enables the mixture to absorb a significant volume of water, creating enough cargo space for

salts and biological materials. A few more elements, including composition, molecular weight, potential interactions between the medication and the polymer being used, and the various functional groups in each polymeric unit, also play a role in the high loading capacity.

4. Permeability and particle size

Due to their nanosize, surface charge and hydrophobicity Nano gels have good skin permeability: Reduced particle size, surface charge, and hydrophobicity in nanogels can greatly increase permeability. They have a permeability of 200 nm and can diffuse through tissues, the endothelium, and occasionally a specific transport mechanism.

5. Colloidal stability:

Aggregation is a propensity that occurs when handling nanoparticles and jeopardises colloidal stability. raising the zeta potential (to a minimum of ±30 mV), which causes the particles to repel one another more strongly and become electrostatically stabilised. Other methods include adding a surface modification, such as polyethylene glycol (PEG), which creates hydration forces and steric effects to provide a stable nanosuspension.

6. Non-immunologic response:

This kind of medication administration method doesn't trigger any immune reactions. Nanogels do not trigger any immunological reactions in the body and are inert in the bloodstream and internal aquatic environment.

7. Ease of synthesis:

Nanogel synthesis is a stress-free technique that doesn't require extreme conditions or the use of mechanical energy. Organic solvents are not introduced throughout this method. As a result, the medication can be loaded without difficulty and doesn't have to be subjected to any harsh circumstances while being prepared.

8. High encapsulation stability:

In order to achieve optimal therapeutic outcomes with minimal toxicity or adverse effects, medication molecules encapsulated in the nanogel must be kept and not escape or leak throughout circulation.

9. Controlled and sustained drug release:

Nanogels are designed to release medications to the target site in a predetermined and extended pattern, hence increasing the therapeutic efficacy of the treatment and preventing its side effects.

10. Response to stimuli:

Drugs can be delivered to a specific location using nanogels without compromising their effectiveness, and when the drug disperses to reach the desired location, it releases spontaneously in response to the right stimuli. [9]

Applications of Nanogels

- Cancer treatment
- Autoimmune disease
- Neurodegenerative disorders
- Diabetes
- Inflammatory disorders
- In stopping bleeding
- Used for delivering the drugs intracellularly
- Local Anesthetic
- Vaccine delivery
- Bone regeneration [10,11]

Local Anesthetics:

Local anesthetics are drugs which induce analgesia and give relief from pain. Local anesthetics give analgesic effect by blocking nerve impulses in nerve cell membranes by blocking Na voltage gated channels. [1]

Herbal nanogels:-

Herbal nanogels may be used for transdermal and oral applications.. Oral route is a most preferable route for delivery of many clinical drugs. But when drugs give orally there are many processes are seen such as absorption, distribution, metabolism and elimination which takes time for drugs to show its effect. Apart from this oral

administration also shows first pass metabolism effect, poor bioavailability, GI degradation.On the other hand transdermal applications of herbal nanogel has various advantages over the other conventional drug delivery such as good patient compatibility, controlled release of drug, and it avoids first-pass metabolism effectof the drug Curcumin based nanogel is one of the example of the herbal nanogel . [12]

CNS delivery:-

Delivery of drugs (hydrophilic) to the brain is still challenge for the treatment of various CNS related disorders. Methotrexate loaded nanogel were prepared by using ionic gelatin method. [13] Latest developments in studying the cell biology of BBB have opened new point of view in directing drugs to the CNS. [14]

Protein delivery:-

Nowadays, more therapeutically active proteins have been discovered and attracted attention in specific diseases such as malignant, viral and autoimmune disease.[15]

Nanogel for bone regeneration:-

Nanogel formulations are used as injectable carriers for systemic and local administration of drugs or gene material also can be incorporated into scaffolds for exact hosting and release of the active substances (API) during the newly formed tissue growth and for the modulation of the scaffold physical properties. Systemic delivery can strongly benefit from nanogels decorated with targeting ligands capable of recognize bone cells and the mineral component, while exact localized release can also requires the nanogels to be responsive to the healing states of the bone.[16]

Anticancer therapy:-

Cancer treatment involves targeted delivery of drugs which has low toxic effects to surrounding tissues and have therapeutic efficacy . Many polymeric nanogels have been used for cancer therapy. Integrating chemotherapeutic drugs into the nanogel not only increases the bioavailability but also increases permeability and retention. Nanogel are being used to deliver drugs more successfully in cancer chemotherapy. One of the example of polymeric nanogels for use in patients with breast cancer, which has FDA approved, is Genexol-PM . [17,18]

Vaginal drug delivery:-

Vaginal nanogel carrying antibacterial drugs have been used to prevent various vaginal infections. They may also be used to decrease vaginal irritation, discharge and other sexual problems. Along with that there are some disadvantages of vaginal nanogel are that they can be contraindicated during menstruation and pregnancy. Researchers have studied that some of vaginal nanogel having antiretroviral drugs can reduce the risk of HIV infection among women. One of the example of vaginal nanogel is Tenofovir vaginal gel has been investigated in the prophylaxis of HIV. [17]

Diabetes:-

Injectable Nano-Network which responds to Glucose and releases Insulin has been developed. In vivo studies done in 2012 on diabetic rats revealed that insulin-loaded nanogels caused a 51% drop in blood glucose levels. Crucially, the insulin-loaded nanogels were able to prevent blood sugar fluctuations and maintain stable blood glucose levels as compared to free insulin. [17,18]

CONCLUSIONS:-

Nanogels are promising and innovative drug delivery system that can play a vital role by addressing the problems associated with old and modern therapeutics such as nonspecific effects and poor stability. This system plays crucial role in delivery of wide variety of medicaments and therapeutics in bacterial and microbial diseases. They possess significant characteristics and bypass problems associated with formulation like stability, absorption, and compatibility. Nanogels appear as a significant candidate in multiple targeting like brain, lungs, colon, skin, GIT and

heart with enormous advantage of various routes of administration. Future design and development of effective nanogel based DDSs for in vivo applications requires a high degree of control over properties. Nanogels appear to be excellent candidates for brain delivery. One future goal of research in this area should be the improved design of nanogels with specific targeting residues to enable highly selective uptake into particular cells. This will be especially important for the targeting of cancer cells, thereby reducing non-specific uptake into healthy cells. More and more in vivo and in vitro study should be needed to confirm the use of this delivery system on human being.

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