Journal of Current Pharma Research (JCPR)

Volume 21, Issue 3, March 2025 **jcpr.humanjournals.com** ISSN: 2230-7842, 2230-7834

Herbal Nanogel; Novel Approach for Drug Delivery

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Received: 2025-2-22 Revised: 2025-3-7 Accepted: 2025-3-12

ABSTRACT:

This study examined the most recent advancements in Nanogel production and drug delivery. Phytochemistry is a discipline of chemistry that studies herbal compounds. Herbal substances have aided in the development of innovative remedies for a wide range of illnesses. Several of these compounds are forbidden from being used in medications due to broad medical characteristics and pharmacokinetics. A variety of new technical approaches have been investigated to ameliorate herbal discoveries in the pharmaceutical sector. The article focuses on the historical data for herb-related Nanogel that are used to treat a variety of disorders with great patient compliance, delivery rate, and efficacy. Stimulus-responsive Nanogel such as temperature responsive and pH-responsive systems are also discussed. There are many new technological ways and comparisons have been studied to improve the herbal discoveries in pharmaceutical market. This review paper will there are many new technological ways and comparisons have been studied to improve the herbal discoveries in pharmaceutical market. This review paper will highlight on the basic methodology of Nanogel, Drug loading techniques, release mechanisms, and their application in industry for herbal medicines The term "Nanogel" define as a hydrogel nanoparticle with a network of cross-linked hydrophilic polymers. Nanogel are nanoparticles made up of cross liked polymer that swell in a suitable solvent. Nanogel have an strength of drug loading capacity and it shows better permeation capabilities due to smaller size. They can be administered by various routes such as oral, nasal, parenteral, pulmonary antra-ocular etc. Nanogel favoured for herbal medicines due to stability and for the comfort. Nanogel in terms of herbal drugs are hopeful and novel approach which also can be called future generation drug delivery systems to high drug encapsulation capacity, uniformity, minimal toxicity greater stability.

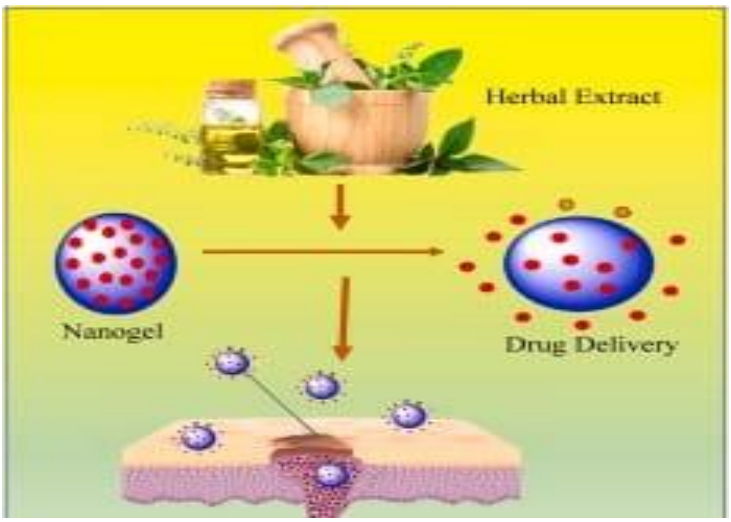
Kewords: Herbal medicine, sustained release, herbal nanogel, drug loading mechanism, applications.

INTRODUCTION:

HERBAL MEDICINE

Plant-based products used to treat diseases or to maintain health, are called herbal products, botanical products, or phytomedicines. A product made from plant sources and used only for internal use is called an herbal supplement. Many prescription medicines and over-the-counter medicines are also made from plant products. But these products contain only purified ingredients and are regulated by the FDA. Herbal supplements may contain entire plants or plant parts. Herbal supplements come in all forms. They may be dried, chopped, Herbal medicines that are those with working ingredients made from plant parts, like leaves, roots or flowers. Herbal medicine is a special and remarkable form of traditional medicine in which the traditional mean in this case known as the herbalist. Specializes in the use of herbs to treat various ailments. Herbal medicine is often defined as "the therapeutic practices that are alive for many years, before the event and spread of recent medicines", This branch of other medicines that medicinal plants for therapy is applied as herbal medicine which exploits medicinal plants for therapy is applied as herbal medicine which is mostly researched by many researchers. Nanogel have emerged as suitable vehicle for delivering and releasing medications to patients in recent years as one of the many dimensions of Nano medicine the junction of nanotechnology, medicine, and pharmaceuticals. Nanogel are cross-linked polymer networks that are nanoscale in size and capable of absorbing enormous amounts of water. Nanogel are hydrogels with a size of nanometres. or less. A hydrogel is a polymer-based that is made by connecting polymer chains to form a macromolecular network. Hydrogels can be made in a variety of ways but all require the creation of polymeric monomers, which must then be polymerized with functional cross-linker molecules to form a 'not-like polymer structure. Pharmaceuticals can be loaded into the pores and then released flatter through the pores. Nanogel, on the other hand, are essentially hydrogels but on a 20 200 nm scale. Emulsion polymerization is used to make the vast majority of Nanogel. Patients can be given Nanogel orally, pulmonary, nasally, parentally, or intra-ocularly. The medications are released from the Nanogel in a variety of ways, but the mechanism including activation by external stimulation alters internal properties. Due to this physical change, which causes the polymer network to swell or compress, the medicinal is delivered to the desired area. Depending on the release mechanism used, this stimulation could come from the body's immediate

surroundings or an external stimulus source. A certain change in temperature within a specific volume are the most common internal-external components that produce a physical change [also known as the volume phase transition].



ADVANTAGES OF NANOGEL:

- Biocompatible and biodegradable.
- No immunogenic
- Natural component of vitreous chamber fluid of the eye
- Good hydrophobicity due to high water retention capacity.
- Exhibits pseudo plastic flow behaviour.
- Adjustable chemical and mechanical properties.
- Abundant in nature.
- Suitable for both hydrophilic and hydrophobic drugs,
- Increase ocular residence time as a Viscosity enhancer. Delivered drug directly to site of action.

PROPERTIES OF NANOGEL:

- Biocompatibility and Degradability: Nanogel based drug delivery system is highly biocompatible and biodegradable, due to this characteristic it is highly suitable for the patients.

- Swelling Property in Aqueous Media: The most beneficial features of Nanogel is their rapid swelling/de-swelling characteristics.

- Higher Drug Loading Capacity: Drug loading capacities of Nanogel depend on the functional group present in the polymeric unit. These functional. Groups have an effect drug carrying and drug releasing properties, and some functional groups have the potential to conjugate with drugs/antibiotics for targeting for application.

- Particle Size: Nanogel ranges in size of 200nm in diameter and therefore effect avoiding the rapid renal exclusion but are enough to avoid the uptake by the endothelial system.

- Solubility: Nanogel are able to soluble hydrophobic drugs and diagnostic agents in core or network of gel.

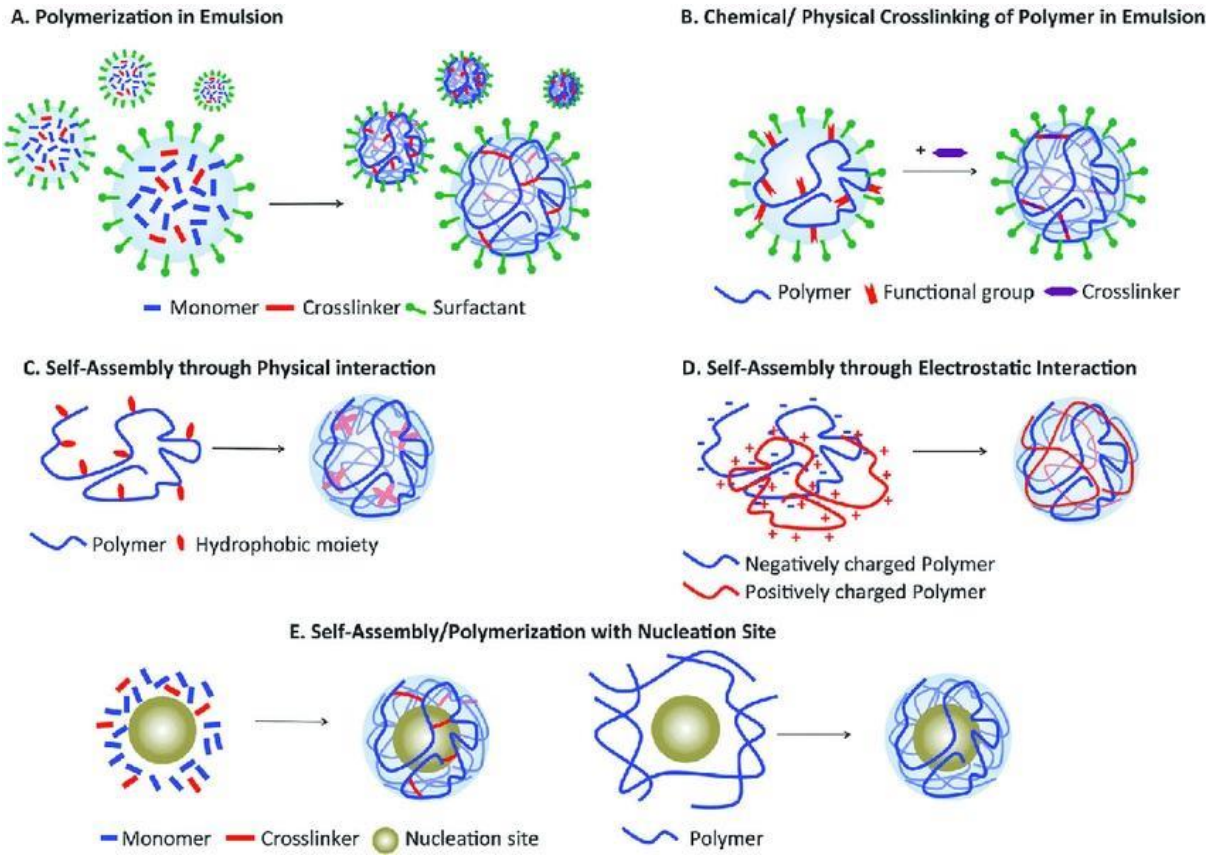
- Electro mobility: Nanogel could he prepare without employing energy or harsh condition such as sonication or homogenization, which is critical for encapsulating bio-macromolecules.

- Colloidal Stability: Nanogel have better stability over the surfactant micelle concentrations, slower rate of dissociation, and longer retention of loaded drugs.

Basic methodology of Nanogel:

Basic method of preparation of Nanogel Method used for synthesis of Nanogel are listed as follows:

- Biopolymer synthesis system
- Water in oil (W/O) heterogeneous emulsion method
- Inverse Nano emulsion method
- Reverse micellar method.
- Membrane emulsification method
- Heterogeneous free radical polymerization method



Drug loading and interaction with nanogel

Nanomaterial and Nanogel complex possess the ability to interact with many inorganic and organic components. The interaction between these components is mostly through a hydrogen bond, covalent bond, electrostatic and van der Waals forces [38]. These interactions determine the effectiveness of drug entrapment by Nanogel Biological molecules are released from Nanogel through various mechanisms, such as diffusion, degradation, pill and environmental stimuli [39]. Following mechanisms explain the Nanogel interactions with the drug.

- Physical entrapment
- Covalent conjugation.
- Controlled self-assembly

Physical entrapment

The drug entrapment within Nanogel can be achieved through non-covalent interactions, such as ionic, lipophilic and hydrogen bonding an example would be the self-assembly of cholesterol containing hyaluronic acid insitu Nanogel for protein delivery. Encapsulation of curcumin into chitin Nanogel for skin cancer treatment is a good example of hydrogen bonding, Chitin is mostly preferred for Nanogel synthesis because of its high biocompatibility, biodegradability, skin non-irritability, easy availability, and cost-effectiveness. It can form polyelectrolyte complexes due to the large number of-Oil and-NHCOCH, reactive groups. The cationic charge of chitin and the lipophilic nature of both chitin and curcumin facilitate skin penetration. However, Nanogel are hydrophilic, and thus the hydrophilic-lipophilic balance of chitin-curcumin Nanogel is beneficial. The end to end interaction of curcumin is through its terminal-OH group with the-OH and-NHOOCH, of chitin.

Covalent conjugation

Nano systems provide a platform for convenient drug delivery.

This is a result of their inherent functional groups that are involved in determining the structure and properties of the Nanogel. Covalent conjugation of the drug with cross-linked angels provides additional stability to the encapsulated drug Polysaccharides contain hydroxyl groups that readily interact With the carboxyl group in the drug by forming esters linkages.] In such instances, premature drug release can occur due to cleavage of functional group bonds by enzymes like stresses. In addition, by introducing easily cleavable linkers, degradable Nanogel, Nanogel can be synthesized for a variety applications.

Controlled self-assembly

Controlled self-assembly essentially contains non-covalent incubation drugs. Polyelectrolyte based Nanogel have the tendency to self-assemble in the presence of oppositely dared solutes, such as surfactants, polynucleotides, proteins and synthetic polyions. The strategy followed in non-covalent drug conjugation is like that of covalent conjugation functionalities like triggering of drug release stimulated by external factors. Non-covalent drug conjugation is potentially supported by disulphide bonds which help drugs to interact with Nanogel, at times induced by the stimulus to release the drug. Disulphide cross-linked Nanogel have the highest drug loading capacity of Doxorubicin and Paditaxel are sensitive to temperature and ph.. Amphiphilic molecules instantaneously form self-assembled nanoparticles in an aqueous environment which facilitate better drug interaction and release from the Nanogel. The drug molecule's orientation is such that, the hydrophilic moieties are exposed to the polar or aqueous medium, and the hydrophobic regions are secured within the core of the assembly.

APPLICATION OF NANOGEL

1.Medicine

- Drug delivery: Polymeric nanoparticles are used to deliver drugs because they are biodegradable and biocompatible.
- Biomedical imaging: Iron oxide nanoparticles are used in biomedical imaging because of their magnetic properties.
- Antimicrobial properties: Nanoscale nanocomposites have antimicrobial properties against microbes.
- Manufacturing
- Household products: Nano-engineered materials are used in degreasers, stain removers, air purifiers, and more.
- Paints: Self-cleaning paints use nanoparticles to resist dirt and marks.
- Semiconductor devices: Nanoparticles are used in semiconductor devices like quantum dot technology and thin-film deposition.

2.Agriculture

- Disease detection and control: Nanotechnology can detect and control pests and diseases in agriculture.
- Nutrient absorption: Nanotechnology can enhance the ability of plants to absorb nutrients.
- Food preservation: Nanotechnology can be used to preserve food.

3.Other applications

- Petroleum refining

Nanoparticles are used in petroleum refining to speed up chemical reactions.

4.Automotive catalytic converters

- Nanoparticles are used in automotive catalytic converters to speed up chemical reactions

CHALLENGES AND OPPORTUNITI

Nanogel formulated with herbal drugs opens a multi-billion-dollar market for the growing pharmaceutical industry. However, there remain significant challenges for implementation of herbal drugs in the clinical trials As per a report by the World health organization (WHO), 80% of the world population will highly rely on herbal-based drugs to meet their health needs. Despite the market potential of allopathic drugs, people continue looking for alternative medicine complimentary medicinal practice Therapeutic application of the herbal drug is highly diminished due to the significant changes in the social, political and economic values of the people. Nanogel can significantly help herbal medicines to come into much applicable clinical practice through effective research programmes. New opportunities always exist for Nanogel due to its fascinating properties such as biocompatibility and degradability, swelling property in aqueous media, higher drug loading capacity, permeability and particle siaz, non-immunologic response, and colloidal stability [65] Nanogel facilitates in designing the delivery system responding to the external stimuli factor that controls the drug release at the site of action.

CONCLUSION

Nanogel formulation is a versatile platform for augmenting herbal drug properties. Due to its flexibility and versatility Nanogel have several opportunities in herbal formulations a drug carrier. Di sulphide cross-linked polymeric Nanogel have excellent features to be developed as bio-responsive delivery systems. Perhaps herbal Nanogel convert the natural product into a most applicable medication for the treatment of various diseases like cancer, skin diseases, diabetes, etc. Polymers such as chitin, chitosan, PLGA, PEG are widely used in the synthesis cross-linked herbal Nanogel. These cross-linked Nanogel have excellent potential in delivering the drugs through the transdermal route, and this influences the patient compliance of the herbal drugs with little side effects compared to that oral drug administration. Consequently, there is a better drug bioavailability and an increased penetration capacity in transdermal delivery. The non-toxic and biocompatible herbal Nanogel can be further modified to possess multiple therapeutic properties with different herbal formulation.

Though many natural medicinal products have been developed, but not all of them safe; some are highly toxic, can interact with conventional drugs and have adverse side effects. For an herbal product to be accepted in the modern system of medicine, the quality of the herbal product needs to be assessed. The lack of quality control profiles for Phyto materials and their formulations acts as an obstacle in in product development. The department of AYUSH (Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homeopathy) is an initiative by the Indian Government to develop a pharmaceutical standard and to regulate Ayurveda preparations through modern technologies like nanotechnology. Herbal Nanogel formulations are the prospective scope of the current pharmaceutical industry which can provide the desired synergistic effect at low drug concentrations and with little side effects. Overall, the herbal Nanogel product can be a novel drug system for practical use.

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How to cite this article:
Vedika V Khulpe et al. Jcpr.Human, 2025; Vol. 21 (3): 7-12.

Conflict of Interest Statement:
The authors have no conflicts of interest to declare.