IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Review On Use Of Novel Drug Delivery System In Herbal Medicine.

Shrikant Subhash Garud*, Vidya bhausaheb Nagare

College name:- Matoshri institute of pharmacy, Dhanore, Yeola (423301)

Abstract:-

A mainstay of conventional medicine, herbal medicine has become widely accepted because of its natural origin and therapeutic advantages. However, the medicinal efficacy of traditional herbal formulations is generally restricted by problems with stability, limited bioavailability, and poor solubility. Novel drug delivery systems (NDDS) are being investigated to improve the pharmacokinetic and pharmacodynamics characteristics of herbal medicines in order to solve these issues. An overview of several NDDS techniques that have demonstrated promise in enhancing the efficacy and delivery of herbal medications is given in this paper, including nanoparticles, liposomes, phytosomes, nanoemulsions, and transdermal delivery. NDDS can target particular tissues, enhance stability, and regulate release rates by encapsulating bioactive ingredients, which may lower dosage and adverse effects. In addition to outlining future research possibilities for incorporating NDDS into herbal therapy, this review summarizes recent developments in NDDS for herbal medicine and examines their benefits and drawbacks. The promise of NDDS to make herbal therapy a more effective, dependable, and generally recognized treatment strategy is emphasized.

Key words:- Herbal medicine, phytosomes, liposome , Nanoparticles, bioavailability , Targeted delivery.

Introduction:-

Herbal medicine, recognised for its natural origin and medicinal potential, has been an essential component of traditional healthcare systems around the world. Though herbal therapy has many advantages, its effectiveness is frequently constrained by problems such poor solubility, instability, and decreased bioavailability of active phytochemicals, which can jeopardise therapeutic results.[1]These drawbacks have brought attention to the necessity of cutting-edge delivery systems that can improve the efficacy of herbal remedies. Researchers have been investigating innovative drug delivery systems (NDDS) to address these problems. These systems include nanoparticles, liposomes, phytosomes, and nanoemulsions, and they have the potential to improve the pharmacokinetic and pharmacodynamic profiles of herbal substances.

These systems have demonstrated the ability to enhance bioavailability, control release rates, and offer targeted delivery of herbal actives, ultimately increasing therapeutic efficacy.[2] Encapsulating bioactive herbal components not only protects them from environmental degradation but also facilitates controlled and sustained release, potentially leading to better patient compliance and reduced dosing frequency. New possibilities for incorporating contemporary drug delivery techniques into herbal therapy have been made possible by recent

developments in NDDS. According to studies, NDDS can greatly enhance the therapeutic effects of herbal components by facilitating more accurate transport to target tissues, improving stability, and reducing side effects[3-4.]

Type of Novel Drug Delivery Systems in Herbal Medicine:-

1. **Liposomes:-**
   Artificially produced spherical vesicles made of one or more lipid bilayers are called liposomes. Since their first discovery in the 1960s, they have become important carriers in medication delivery systems. They are useful for encapsulating medications, genes, and other therapeutic substances because of their distinct composition and structure, which increases their efficacy and reduces their adverse effects.

- **Composition and Structure Phospholipids,**
  which are molecules with hydrophilic (which attract water) and hydrophobic (which repel water) heads and tails, make up the majority of liposomes. They may form bilayers in an aquatic environment, forming a spherical structure with an interior watery core, thanks to their amphiphilic nature. Liposomes fall into two primary categories and range in size from 20 nanometres to several micrometres:
  1. **Unilamellar Liposomes**: These have an aqueous core surrounded by a single lipid bilayer. Usually smaller, they have an easier time penetrating tissues.
  2. **Multilamellar Liposomes:** Capable of encasing greater quantities of aqueous solutions, these have many concentric bilayers. They might be more stable and are often larger.
- **Advantages of Liposomes:-**
  The benefits of liposomes When it comes to drug distribution, liposomes have a number of noteworthy benefits:
  I. Better Solubility: A lot of medicinal substances aren't very soluble in water. Their solubility and bioavailability can be improved by encapsulating them in liposomes.
  II. Controlled Release: By enhancing therapeutic results and lowering the frequency of administration, liposomes can be engineered to deliver a controlled or sustained release of the encapsulated medications.
  III. Biocompatibility: Liposomes can be used in people since they are typically non-toxic and biocompatible. It is possible to modify their composition to improve safety and lessen immunogenicity.
  IV. Targeted distribution: By altering the liposomes' surface characteristics with particular ligands, tailored distribution to particular tissues or cells can be accomplished, increasing the therapy's efficacy.[5]

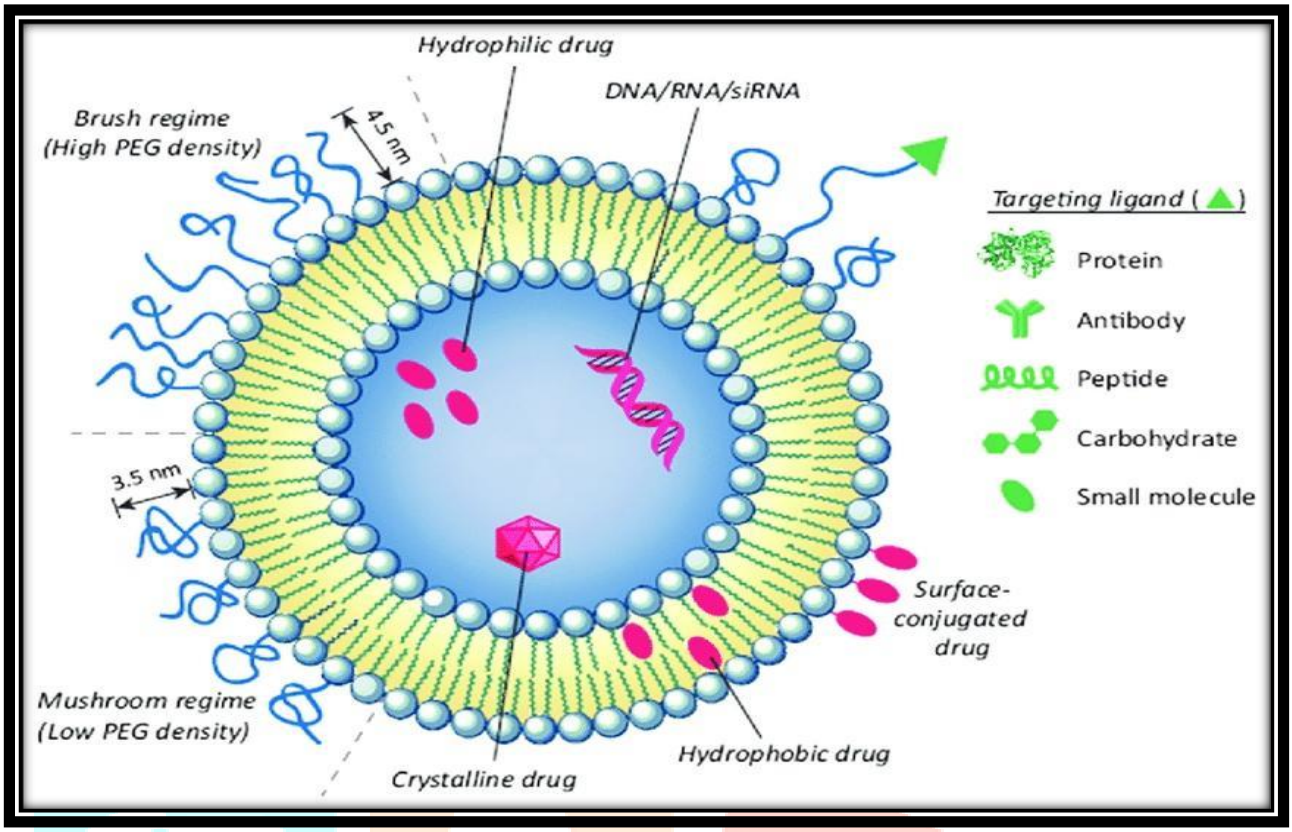

Fig.:-Liposomes

2. **Phytosomes:-**

Phytosomes are sophisticated drug delivery vehicles that improve the therapeutic efficacy and bioavailability of phytochemicals and herbal extracts. These are complexes made up of bioactive substances from plants and phospholipids, which are mostly generated from soy lecithin. By enhancing the solubility, stability, and absorption of phytochemicals, this cutting-edge technique seeks to increase their suitability for medicinal uses.

- **Structure and Composition**

Phospholipids make up the heart of phytosomes, forming a bilayer structure that can enclose active phytochemicals like terpenes', flavonoids, and polyphenols. These compounds are frequently found in resveratrol, curcumin, and quercetin. Under carefully regulated conditions, phospholipids are combined with herbal extracts to create phytosomes, which enable the phytosome complex to self-assemble.

- **Advantages of phytosomes :-**

I. Enhanced Bioavailability: The capacity of phytosomes to greatly increase the bioavailability of phytochemicals is one of their main benefits. This improvement increases the active ingredient's therapeutic potential by ensuring that a greater percentage of it gets absorbed into the bloodstream.

II. Stability: Phytochemicals are shielded from deterioration by external elements including light, heat, and oxygen by being encapsulated within the phospholipid bilayer. For the active components to continue to be effective over time, this stability is essential.

III. Controlled Release: By enabling a regulated release of the active ingredients, phytosomes extend the duration of therapeutic benefits and lower the need for frequent dosage.

IV. Enhanced Solubility: The inability of many phytochemicals to dissolve well in water restricts their absorption. These chemicals' solubility is increased by phytosomes, which also improves their bioavailability and intestinal absorption.[6-7-8]

- In the preparation of Phytosome, Phytochemicals are mixed with phospholipids to make phytochemical-phospholipid complex. This complex is mixed with cholesterol in suitable solvent to make phytosomes.
- In case of transferosomes preparation, phospholipid is mixed first with lipids to make the liposomal vesicle. Then, the phytochemical is incorporated in the liposome later.

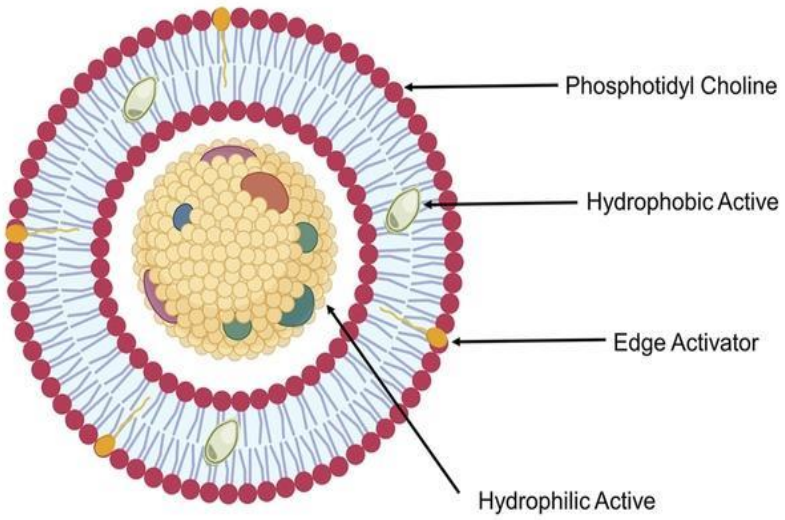

Fig:-Phytosomes

3. **Nanoparticles and Nanoemulsions:**

Nanotechnology has become a game-changing field with many applications across many industries, especially in food science, cosmetics, and medicine. Two important applications of nanotechnology are nanoparticles and nanoemulsions, which both have special benefits that improve the performance and effectiveness of active ingredients.

i. **Nanoparticles**:- A nanoparticle is an ultrafine particle with a size between one and one hundred nanometres. They may be made of lipids, ceramics, polymers, metals (such as gold and silver), and other substances. The material selection influences its chemical and physical characteristics, which can be adjusted for certain uses.

- **Types of Nanoparticles:-**
  - **a) Metallic Nanoparticles:-**These are frequently employed due to their optical and catalytic qualities. For example, silver and gold nanoparticles are widely used in medical imaging and antibacterial applications.[9]
  - **b) Polymeric Nanoparticles:** These nanoparticles are intended for medication delivery and are composed of biodegradable polymers. They increase the stability of medications and offer regulated release.[10]
  - **c) Liposomes and Solid Lipid Nanoparticles:-**These lipid-based nanoparticles encapsulate medications, increasing their bioavailability and solubility, which qualifies them for a range of therapeutic uses.[11]

ii. Nanoemulsions:-

Nanoemulsions are oil-and-water mixes stabilised by surfactants, with droplet sizes ranging from 20 to 200 nanometres. Their compact size provides them with unique optical features and a large surface area, increasing their stability and bioavailability.[12]

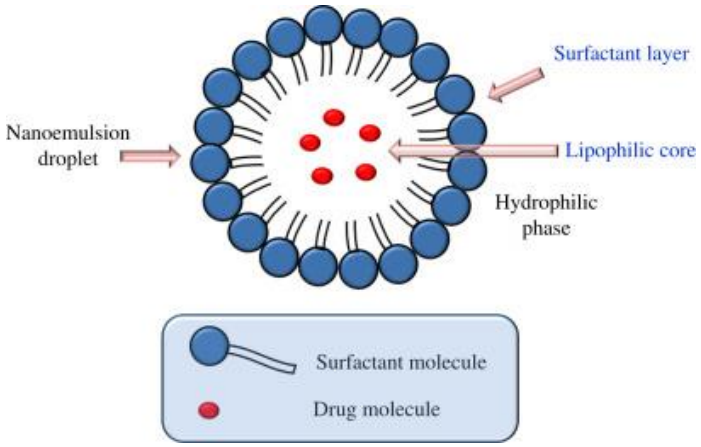

Fig:-Nanoemulsions

- **Types of Nanoemulsions:-**
  - **a) . Oil-in-Water (O/W) Nanoemulsions:**
    Oil droplets are distributed throughout the aqueous phase of these emulsions. They are frequently found in dietary supplements and pharmaceutical preparations.[13]
  - **b) Water-in-Oil (W/O) Nanoemulsions:**
    Water droplets are scattered throughout this greasy phase. These emulsions are frequently used in topical treatments and cosmetics to improve skin penetration.[14]
- **Advantages of Nanoparticles and Nanoemulsions:**
  I. Enhanced Bioavailability: They are very useful for drug administration because of their tiny size, which improves absorption and dispersion throughout the body.
  II. Targeted Delivery: By designing them to deliver therapeutic substances only to sick tissues, adverse effects and systemic exposure can be reduced.
  III. Improved Stability: Nanoparticles and nanoemulsions often exhibit enhanced stability over traditional formulations, protecting sensitive compounds from degradation.[15]

4. Transdermal and Mucoadhesive Systems:-

Pharmaceutical technology has advanced significantly with the development of transdermal and Mucoadhesive drug delivery systems, which are intended to improve medication absorption and produce long-lasting therapeutic effects. These cutting-edge devices efficiently administer drugs by utilising the skin and mucosal surfaces, two of the body's inherent barriers.[16]

I. Transdermal Drug Delivery Systems:-

When a pharmacological formulation is applied topically, it can pass through the epidermis and reach th e bloodstream. This process is known as transdermal drug delivery. By avoiding the gastrointestinal tra ct, this technique lowers firstpass metabolism, which frequently breaks down medications before they e nter the bloodstream, and greatly increases bioavailability.[16]

- **Formulations:-**
  I. Transdermal Patches: These are adhesive patches placed directly to the skin that have a matrix system or a drug reservoir. These patches provide controlled dosage by releasing the medication gradually. Fentanyl patches for managing chronic pain and nicotine patches for quitting smoking are typical examples.[17]
  II. Microneedles : These are minuscule needles that make microscopic punctures in the skin to deliver macromolecules that are unable to pass through the skin barrier, such peptides and

vaccinations. Microneedle arrays are a minimally invasive medication delivery method that can be applied painlessly.[18]

III. Gel and Cream Formulations: Topical gels and creams that contain permeation enhancers, which momentarily break down the skin barrier to improve the penetration of the active components, can improve drug absorption via the skin.[19]

II. Mucoadhesive Drug Delivery Systems:-

Mucoadhesive drug delivery devices are made to stick to mucosal tissues, as those in the vaginal, gastrointestinal, nasal, or oral cavities. These systems can improve drug absorption and therapeutic benefits by extending the drug's residence duration at the application site.

- **Formulations**:-

I. Mucoadhesive Tablets: These tablets enable a prolonged release of the medication since they are made with mucoadhesive polymers, which encourage adherence to mucosal surfaces. They are frequently administered buccally or sublingually, offering quick bloodstream absorption.

II. Mucoadhesive Gels: Mucoadhesive gels can be applied to mucosal surfaces to provide a barrier that protects and promotes drug absorption. When treating vaginal infections or oral ulcers, when localised drug administration is essential, these formulations are utilised.

III. Nasal Sprays: Mucoadhesive nasal sprays enhance the absorption of drugs through the nasal mucosa, enabling rapid systemic effects. This is particularly beneficial for peptides and proteins that typically have low oral bioavailability.[20-21]

- **Advantages of Transdermal and Mucoadhesive Systems:**

I. Controlled Release: By enabling the prolonged, continuous, and regulated release of medication, transdermal devices preserve steady plasma drug levels and enhance therapeutic effectiveness.

II. Decreased First-Pass Metabolism: Transdermal devices minimise the breakdown of medications that frequently takes place during first-pass metabolism by delivering medications straight into the systemic circulation, avoiding the gastrointestinal tract and liver.

III. Better Patient Compliance: Patients are more likely to follow their prescription regimens since transdermal distribution is non-invasive. The simplicity of once-daily dosage or even less frequent administrations is advantageous to patients.

IV. Steady Drug Delivery: These systems can provide a consistent release profile, reducing peak-and-trough fluctuations in drug levels, which is particularly beneficial for drugs with narrow therapeutic windows.

V. Non-Invasive: Transdermal delivery eliminates the discomfort associated with injections, making it suitable for patients who are needle-averse.[17-21]

Challenges and Limitations of NDDS in Herbal Medicine:-

I. Complex Formulation Development: It might be challenging to create NDDS that efficiently release and encapsulate herbal ingredients. It necessitates knowledge of the chemical and physical characteristics of the employed nanocarriers as well as the herbal materials . The selection of materials, preparation procedures, and characterisation methods are only a few of the factors that are frequently involved in the formulation process.

II. Expanding Challenges: Even while NDDS may be successfully produced in laboratories, commercialising these formulations can be extremely difficult. When moving from the lab to the production scale, factors like cost-effectiveness, quality control, and reproducibility must be taken into consideration.

III. Regulatory Obstacles: The NDDS regulatory environment is still developing, particularly with regard to herbal medicine. Since thorough safety and efficacy data are required for regulatory approval, which may not always be easily accessible for herbal substances, the procedure can be drawn out and complicated.

IV. Stability Issues: Environmental elements like light, heat, and humidity can cause many herbal components to degrade. Although NDDS can improve stability, they must be made to endure these circumstances while being transported and stored.

V. Biocompatibility and Toxicity: Since certain synthetic nanocarriers may be cytotoxic or trigger an immunological reaction, the selection of materials for NDDS is crucial. In the context of herbal medicine, it is crucial to assess these materials' biocompatibility to make sure patient safety.

VI. Limited Research and Knowledge: Extensive studies on the pharmacokinetics and pharmacodynamics of NDDS in herbal medicine are still lacking. This knowledge gap may make it more difficult to apply these technologies effectively and comprehend how they interact with herbal substances.

VII. Production Cost: The materials and procedures needed to create NDDS might be expensive, which could restrict their availability, especially in underdeveloped areas. The broad use of NDDS in herbal medicine may be hampered by this expense concern.

VIII. Public Perception and Acceptance: Traditional practitioners and customers who favour traditional herbal treatment methods may harbour doubts about the safety and effectiveness of NDDS in herbal therapy. Establishing mutual respect and understanding is crucial to these creative.

IX. Targeting Issues: Although NDDS are intended for targeted distribution, biological obstacles like the blood-brain barrier and fluctuating physiological circumstances can make it difficult to achieve exact targeting in vivo. Thorough preclinical research and meticulous design are necessary to guarantee that NDDS reach the target site of action .

X. Environmental Impact: The usage of nanoparticles, especially if they are not biodegradable, raises questions about their potential effects on the environment. Comprehensive evaluations of synthetic nanomaterials' environmental safety are necessary since their buildup in the environment may endanger ecosystems and human health .[22-30]

Future Directions:-

In order to increase the specificity and effectiveness of herbal therapies, future directions for Nano drug delivery systems (NDDS) in herbal medicine will concentrate on improving formulation techniques, creating intelligent and responsive nanocarriers, and investigating targeted delivery systems. Researchers can look into combination treatments that take advantage of the complementary benefits of both conventional and herbal medications. In addition to carrying out thorough clinical research to confirm their safety and effectiveness, it is imperative to establish clear regulatory frameworks to enable the safe integration of NDDS in herbal medicine. By creating biodegradable nanocarriers from natural sources, sustainability is also becoming more and more important. While combining traditional methods with contemporary technologies can promote wider acceptance of NDDS in herbal treatments, an understanding of the toxicological profiles of nanoparticles will guarantee patient safety. These initiatives seek to enhance the therapeutic benefits of NDDS, making them a viable option in the realm of herbal medicine.

Conclusion:-

In summary, a revolutionary step towards improving the therapeutic efficacy of herbal formulations is the application of innovative drug delivery systems (NDDS) in herbal medicine. NDDS, which encompass technologies like liposomes, nanoparticles, and nanoemulsions, are essential for enhancing the stability, controlled release, and bioavailability of herbal constituents. In order to maximise therapeutic results, these developments assist in overcoming important drawbacks of conventional herbal medicines, such as their poor solubility and quick disintegration. NDDS's targeted delivery capabilities make it possible to administer herbal medicines more precisely, reducing side effects and increasing patient compliance—especially for complicated and chronic conditions. But even with their promise, there are still a number of difficulties. Concerns about safety, scale-up for commercial production, regulatory compliance, and formulation complexity require in-depth research and cooperation between regulatory agencies, industry participants, and scientists. With prospects for additional innovation in formulation techniques, personalised therapy, and sustainable practices, the future of NDDS in herbal medicine appears to be promising. NDDS can help create herbal medicines that are safer, more effective, and easier to obtain by bridging the gap between contemporary nanotechnology and ancient herbal techniques. The acceptability and use of NDDS in herbal medicine will increase with further research and validation of these systems, which will ultimately lead to better global health outcomes and a more integrated approach to healthcare.

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