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A Review on Novel Herbal Drug Delivery System

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Abstract

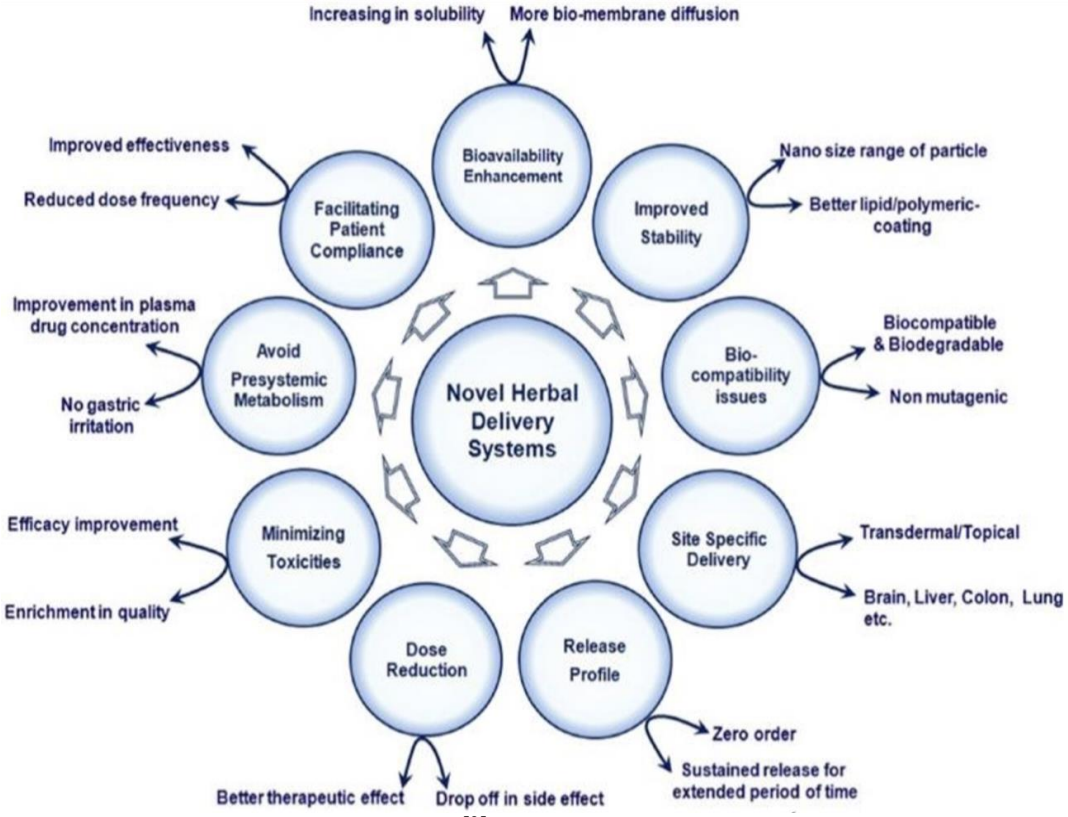
To improve the therapeutic potential of traditional herbal medicines, there has been a notable upsurge in interest in and development of innovative herbal drug delivery systems (NDDS) in recent years. Herbal medications have long encountered difficulties such low absorption, stability problems, and irregular dosage, despite being widely available and frequently acknowledged for their low side effects. Modern pharmaceutical techniques have been used with herbal formulations to overcome these constraints, leading to the development of sophisticated drug delivery systems that improve the safety and effectiveness of herbal medications. Innovative herbal drug delivery systems enhance the pharmacokinetics and targeted distribution of active herbal ingredients by utilizing technologies such as liposome's, nanoparticles, phytosomes, and microspheres. For example, liposome's and phytosomes have weakly water-soluble herbal compounds' bioavailability, and solid lipid nanoparticles' sustained release that lowers dosage frequency and adverse effects. These systems can also be customized to target particular tissues or organs, providing an effective and individualized course of treatment. Herbal medications have the potential to significantly help treat a variety of diseases, such as cancer, diabetes, cardiovascular diseases, and neurodegenerative disorders, thanks to developments in NHDDS. To position NHDDS as a trustworthy substitute in contemporary treatments, future research should concentrate on regulatory standardization, formulation process optimization, and clinical translation. The amalgamation of conventional herbal knowledge and contemporary drug delivery systems signifies a propitious avenue for augmenting the medicinal effectiveness of natural items

Keywords - herbal treatments; Phytosomes, liposome's, nanoparticles new and traditional medication delivery techniques; drug carriers.

INTRODUCTION

Because of its natural bioactive ingredients and ability to treat a wide range of illnesses, herbal medicines have long been a mainstay of therapeutic practices in many cultures. Traditional herbal preparations, however, frequently encounter serious problems that limit their therapeutic potential and efficacy, such as variable bioactive content, poor solubility, quick disintegration, and low bioavailability.[1] Novel Herbal Drug Delivery Systems (NHDDS) have become a viable strategy to get over these restrictions. To increase the stability, solubility, and bioavailability of herbal actives, NHDDS makes use of cutting-edge pharmaceutical technologies such liposome's, Phytosomes, nanoparticles, and microemulsions by enabling targeted and regulated distribution, these cutting-edge devices improve the therapeutic efficacy of herbal medicines and lessen their

adverse effects. [2] Worldwide, herbal treatments have been utilized extensively since more recent ancient times. The use of "herbs" to cure a wide range of illnesses with fewer adverse effects has increased significantly Phytoconstituents are the parts of plants that make up herbal treatments



and are in charge of their biological effects [3]

***Figure 1*:** *Novel Herbal Drug Delivery System*

Uses of novel herbal drug delivery system

Linn. Motherwort charantia Usually, medications are used to treat diabetes. Making and evaluating Momordica charantia Linn transdermal patches was the aim of the current study. Transdermal films containing an ethanolic extract of Charantia fruits and the herbal medication component were created using hydroxypropyl methyl cellose as a polymer. We examined folding durability, thickness, weight variation, medication content, biochemical studies, rat skin irritation, stability, research, and subacute antihyperglycemic activity in diabetic rats. We also looked at in vitro diffusion experiments.[4]

Types of Novel Herbal Drug Delivery System

Innovative techniques that enhance the effectiveness, safety, and controlled release of herbal medications are known as novel herbal drug delivery systems. Here are a few of the main categories:

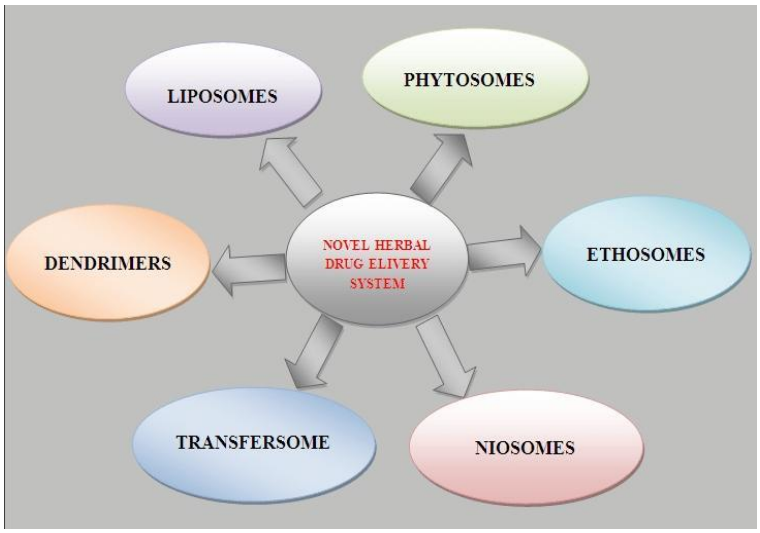


Figure 2*: *Types of Novel Herbal Drugs Delivery System

Liposomes

Liposomes are small, spherical vesicles that resemble cell membranes and are made of lipid bilayers, usually phospholipids that encapsulate medicines or aqueous solutions. Since their initial description by Alec Bangham in 1965, liposome's have developed into a variety of drug delivery vehicles that provide enhanced stability, tailored release, and bioavailability. Because liposomes are biocompatible and biodegradable, they have been investigated for use in gene therapy, cancer treatment (e. g. Embosomed, Doxil), vaccine distribution, and cosmetics.[5]

Advantages

Improvement in the drug's therapeutic index and efficacy.
The encapsulation increases the stability of the medicine or compounds.
Nonimmunogenic, biocompatible, biodegradable, flexible, and non-toxic.
A decrease in the encapsulated drugs' toxicity lowering the amount of hazardous medication exposure in delicate tissues.
The effect of site avoidance – Better pharmacokinetic outcomes. [6]

Disadvantages

Poor solubility.
A brief half-life.
The potential for phospholipids oxidation and a process resembling hydrolysis.
Drug or molecular fusion and leakage from encapsulation.
Exorbitant production expenses.
A reduction in stables. [7]

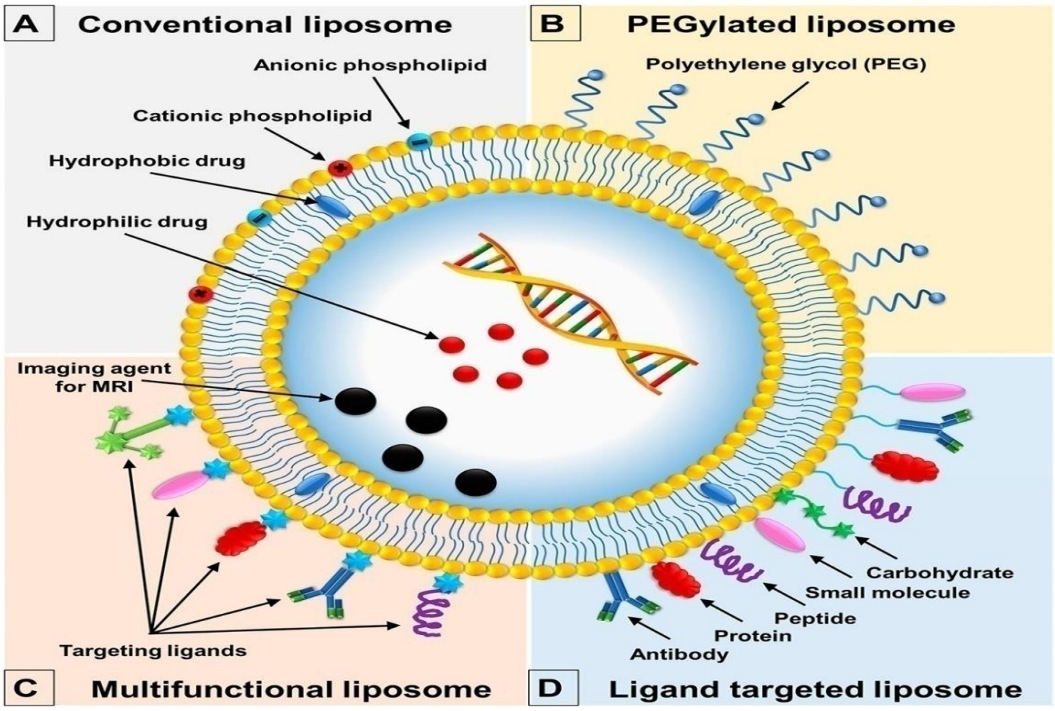


Figure 3*: *Liposome structure

Phytosomes:

Phytosomes are sophisticated drug delivery vehicles that improve the therapeutic effectiveness and bioavailability of phytochemicals and herbal extracts. In contrast to traditional herbal formulations, these complexes, which are created when plant extracts interact with phospholipids—mainly phosphatidylcholine—enable superior absorption and cellular uptake. Phytosomes overcome the drawbacks of active phytoconstituents' low bioavailability by encasing them in a lipid bilayer, which increases the chemicals' solubility and stability. Phytosomes are a prospective substitute in the fields of herbal medicine and Nutraceuticals because of this novel method, which not only shields delicate phytochemicals from deterioration but also improves their pharmacokinetic characteristics. [8]

Advantages

Better Bioavailability

In comparison to traditional extracts, phytosomes improve the bioavailability of plant components, enabling greater absorption and efficacy.

Improved Stability

They shield delicate phytochemicals against deterioration by improving their stability.

Lower Dosage Requirements

Effective doses are frequently lower as a result of increased absorption, which lowers the possibility of adverse effects.

Targeted transport:

By enhancing transport to particular tissues or organs, phytosomes might boost effectiveness. [9]

Disadvantages

High Production Costs

Phytosome preparation can be expensive, which raises the price of the finished product.

Complex Formulation Process

Manufacturing calls for certain tools and methods, which may restrict mass manufacturing.

Limited Research

Because Phytosomes are a relatively new product, there aren't as many research on their long-term safety and effectiveness as there are on conventional formulations.

Possible Stability Problems

Even with improved stability, some Phytosomes might still be susceptible to oxidation, heat, or light, which could shorten their shelf life.[10]

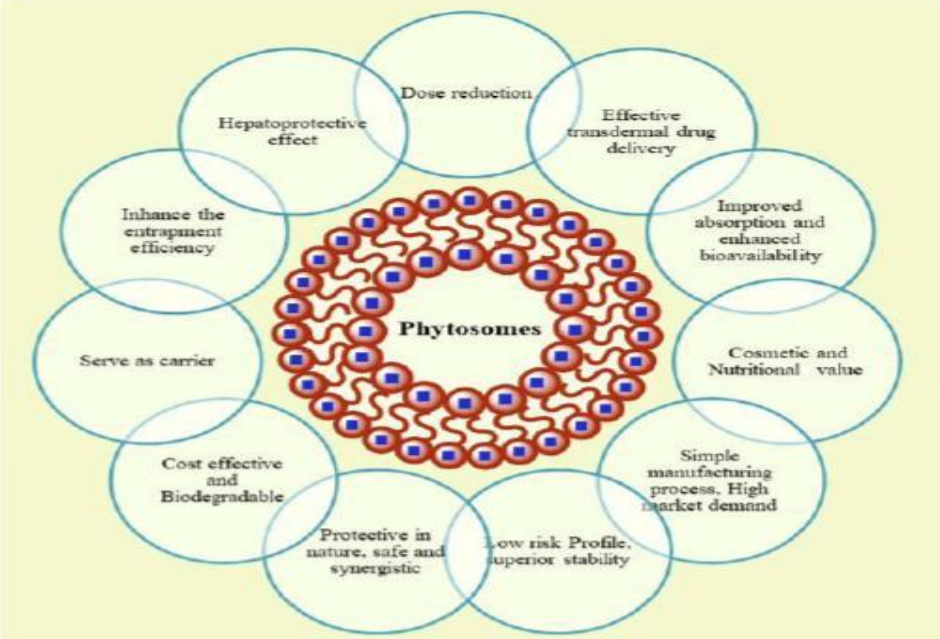


Figure 4*: *Benefits of Phytosomes over conventional dosage form

Ethosomes

The soft, flexible bilayer architectures of ethersomes, a new lipid-based drug delivery technology, improve the transdermal distribution of a variety of medicinal drugs. Ethamomes, which are mostly made of phospholipids and ethanol, are intended to enter the stratum cornea more successfully than traditional liposomes since ethanol can break down the skin barrier, allowing for deeper skin penetration and increased bioavailability. Because of this special characteristic, ethosomes are very useful for administering macromolecules, vaccinations, and medications that are poorly soluble, increasing the potential for non-invasive therapeutic interventions.[11]

Advantages

Enhanced Skin Permeability

Because ethanol makes lipid membranes more fluid, allowing for deeper drug penetration, ethosomes are very successful at entering the skin.

Better Drug Delivery

They are adaptable for a variety of pharmaceuticals since they can efficiently distribute both hydrophilic and lipophilic substances.

Non-Invasive Delivery

Ethosomes, a transdermal delivery system, can improve patient compliance by offering a non-invasive substitute for injections for some medications.

Controlled Release

Drugs can be released via ethosomes in a sustained and regulated manner, increasing therapeutic efficacy and lowering adverse effects.

Biocompatibility and Safety

Ethosomes are generally well-tolerated by the skin and reduce the possibility of negative reactions because they are made of natural phospholipids.[12]

Disadvantages

Problems with Stability

Because of their high ethanol content, ethersomes can become unstable and degrade over time, thereby reducing their shelf life.

High manufacturing Cost

Ethosomes preparation calls for specific tools and supplies, which could raise manufacturing prices.

Limited Drug Loading

Drugs that are poorly soluble in ethanol or phospholipids may have a limited ability to be loaded into ethosomes.

Possible Irritation

Some patient populations may not be able to utilize ethanol since it might occasionally irritate or dry out delicate skin.

Complex production Process

The preparation of ethersomes necessitates exacting conditions and controls, which can make scalability and production more difficult.[13]

Niosomes

As an alternative to traditional liposome's, niosomes are vesicular systems based on non-ionic surfactants that function as efficient drug delivery vehicles. Niosomes, which have a bilayer membrane composed of water, cholesterol, and non-ionic surfactants, are distinguished by their capacity to encapsulate hydrophilic and lipophilic medications, improving their stability and bioavailability. Because they enable targeted distribution and regulated release, these vesicles are very useful for enhancing the pharmacokinetics of poorly soluble medications. This can result in decreased toxicity and increased therapeutic efficacy. Niosomes have attracted a lot of attention for a variety of therapeutic uses, such as cancer treatment and vaccine delivery, because of their biocompatibility and adaptability. [14]

Advantages

Increased Stability

Because niosomes include non-ionic surfactants that reduce their susceptibility to oxidation, they are often more stable than liposome's.

Controlled and Sustained Release

They are able to provide medications a controlled release, which extends their duration of effect.

Biocompatibility

Because of their biocompatibility, they are less harmful and safer to administer within the body.

Better Drug Solubility

By encasing hydrophilic and lipophilic medications, niosomes can increase the solubility of medications that are not very soluble.

Increased Bioavailability

By enhancing absorption and decreasing degradation, they can raise a drug's bioavailability. [15]

Disadvantages

Leakage Potential

During storage or administration, encapsulated medications, particularly smaller compounds, may escape from niosomes.

Production Difficulties

Their preparation techniques can be intricate, necessitating exact formulation control to guarantee consistency and stability.

Storage Stability Problems

Over time, they could experience problems with physical stability, like vesicle fusion and aggregation.

Production Cost

Because industrial manufacturing requires specialized tools and supplies, it can be expensive.

Drug Loading Limitations

The maximum quantity of medication that can be encapsulated may not be sufficient to provide the necessary therapeutic dosage for some medications.[16]

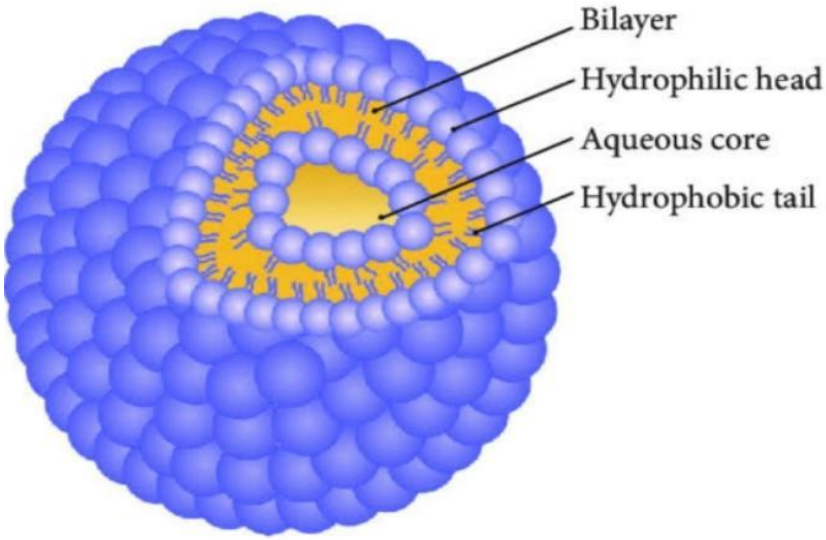


Figure 5*: *Niosomes

Transferosomes

Phospholipids and surfactants combine to form transfersomes, which are specialized vesicular drug delivery systems that improve drug penetration across biological membranes, especially the skin. The transdermal transport of both hydrophilic and lipophilic substances is greatly enhanced by transfersomes' ultra-deformable nature, which allows them to readily deform and navigate tight junctions in the stratum cornea. Transfersomes are a desirable alternative for administering a range of medications, such as hormones and vaccinations, because of their capacity to promote deeper penetration, which enables improved bioavailability and regulated release of medicines. Their increasing interest in the pharmaceutical industry is a result of their adaptability and biocompatibility.[17]

Advantages

Improved Drug Delivery

The variety of medications that can be administered transdermally is expanded by the ability of transfersomes to transport both hydrophilic (water-soluble) and lipophilic (fat-soluble) medications.

Better Penetration

Because of their deformability, transfersomes can better distribute drugs to deeper layers of the skin by slipping through the skin's tight connections.

Less Side Effects

Compared to oral or injectables approaches, transfersomes may lessen systemic side effects because they more precisely target the medication delivery location.

Non-Invasive

Patients who need frequent doses or are needle phobic can particularly benefit from the non-invasive medication administration method provided by transfersomes.

Controlled Release

To guarantee a consistent flow of medicine to the body, transfersomes can be made to release medications over a predetermined time frame.[18]

Disadvantages

Stability Problems

Transfersomes may deteriorate and lose their efficacy due to their sensitivity to environmental elements like pH, light, and temperature.

High Production Cost

Transfersomes preparation is difficult and frequently expensive, which makes large-scale production more difficult.

Limited Drug Load Capacity

Despite their effectiveness, transfersomes are not appropriate for medications that need high dosages due to their limited drug loading capacity.

Potential for Skin Irritation

Depending on the makeup of the lipids employed, certain transfersomes formulations may result in allergic responses or skin irritation.

Regulatory Difficulties

Because transfersomes are a relatively new technology, they must adhere to strict guidelines in order to receive clinical approval. [19]

Mouth dissolving tablet

Orally disintegrating tablets (ODTs), sometimes referred to as mouth dissolving tablets (MDTs), are solid dosage forms made to dissolve rapidly in the oral cavity without the need for water, giving the medication a speedy start of action. MDTs, which are made with superdisintegrants and other excipients, dissolve quickly in the mouth, releasing the active pharmaceutical ingredient (API) for swallowing or absorption through the buccal mucosa. This novel medicine administration method improves patient compliance, especially for people with dysphagia, the elderly, and children who have trouble swallowing traditional pills. Because of their ease, MDTs are also perfect for circumstances that call for prompt drug administration, including emergencies or when traveling. [20]

Advantages

Convenient for All Ages

Perfect for kids, the elderly, and anyone with dysphagia or other conditions that make it difficult for them to swallow pills.

No Water Needed

MDTs don't require water, which is advantageous when water isn't easily accessible.

Quick Onset of Action

Direct oral dissolution promotes faster absorption and a speedier start to the therapeutic effects.

Better Patient Compliance

MDTs improve adherence to recommended therapies since they are simpler to take, particularly for patients who have a pill phobia.

Lower danger of Choking

MDTs make them safer for groups that have trouble swallowing since they lower the danger of choking. [21]]

Disadvantages

Difficulties with Taste Masking

Some medications have a bitter taste, and it can be difficult to successfully cover up offensive flavors in MDT formulations.

Limited Dosage

Because of their small size, which restricts the amount of active ingredient, MDTs are not appropriate for medications that need high dosages.

Fragile and Sensitive to Moisture

MDTs need particular handling and packing since they are more brittle than regular tablets and may be sensitive to humidity.

High Production Costs

MDTs are frequently more expensive to produce because to their unique production method and materials.

Limited Drug Compatibility

Some medications, particularly those that have a foul taste or are unstable in the oral cavity, are not appropriate for MDT formulation. [22]

Controlled release formulation

In order to minimize adverse effects and maintain therapeutic drug levels over time, controlled release formulations are made to administer active pharmaceutical ingredients (APIs) at a predefined rate. By offering a slow release of the pharmaceutical, this technology seeks to optimize the pharmacokinetics and pharmacodynamics of medications. This can improve patient compliance, increase efficacy, and decrease the frequency of dose. Using a variety of polymeric materials and formulation techniques, controlled release systems can be customized for oral, transdermal, and injectables forms, among other routes of delivery. Because of this, the pharmaceutical industry makes extensive use of these formulations to treat chronic illnesses, offer targeted therapy, and enhance the overall therapeutic profile of drugs.[23]

Advantages

Increased Efficacy

Offers a constantblood drug level and a predictable drug release rate, which can improve therapeutic efficacy.

Decreased Dosing Frequency

This makes it unnecessary for patients to take their medications frequently, which can enhance adherence.

Reduced adverse Effects

Consistent medication levels lessen toxicity and adverse effects associated with peak use of immediate-release formulations.

Better Patient Compliance

Patients are more compliant with less frequent dose schedules, particularly for chronic disorders.

Improved Stability

By releasing the drug gradually over time, controlled release can shield delicate medications against deterioration. [24]

Disadvantages

Complex Manufacturing

Compared to immediate-release formulations, these formulations are more expensive and complex to make.

Higher Initial Costs

Because of the increased complexity of production, these costs are frequently higher for patients or healthcare systems.

Amount Dumping Risk

Any formulation flaw, such shattering a tablet, could result in the entire amount being released all at once, which could be dangerous.

Limited Suitability

Not all medications are appropriate for controlled release; medications that need a quick onset or have a short half-life could not work.

Individual Variation

Medication release may be impacted by patient differences in pH or gastrointestinal transit periods, which could result in variations in medication levels. [25]

Emulsion

In herbal medicine, emulsions have become a promising new medication delivery method that improves the stability and bioavailability of plant-based active ingredients. Hydrophobic herbal extracts can be dissolved in these systems, which are made up of a dispersion of one liquid in another, making it easier for the gastrointestinal tract to absorb them. By choosing the right stabilizers and emulsifiers to optimize the formulation, emulsions can minimize adverse effects, decrease patient response variability, and increase the therapeutic efficacy of herbal medications. Emulsions are a desirable alternative for the delivery of herbal medicines in both conventional and contemporary healthcare settings because of their capacity to regulate the release profile of bioactive ingredients, which permits long-lasting therapeutic benefits.[26]

Advantages

Improved Bioavailability

By facilitating improved absorption in the gastrointestinal tract, emulsions can improve the bioavailability of medications, especially for lipophilic (fat-soluble) medications.

Controlled and Sustained Release

Emulsion-based NDDS enhances therapeutic efficacy and lowers dosage frequency by enabling controlled or sustained release of medications.

Better Drug Solubility

Emulsions, particularly oil-in-water varieties, improve the solubility of medications that are not very soluble in water, allowing for the formulation of a wider variety of medications.

Less Toxicity

Emulsions can lessen adverse effects by encasing the medicine in droplets, which shields delicate bodily tissues from potentially harmful substances.

Ease of Administration

Emulsions are versatile and simple to use, as they can be administered orally, topically, or intravenously.[27]

Disadvantages

Complex Manufacturing

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Nanoparticles

In recent years, nanoparticles have attracted a lot of interest as a flexible drug delivery system platform, especially in the biomedical and pharmaceutical industries. Because of their small size—typically between 1 and 100 nanometers—nanoparticles have special physicochemical characteristics that improve the stability, solubility, and bioavailability of medicinal substances. They can be designed to enable targeted drug delivery, which minimizes systemic side effects while enabling the precise release of medications at particular bodily locations. This feature is especially helpful for biologic delivery and cancer treatments, since conventional distribution techniques frequently fail. Additionally, the pharmacokinetics of medications can be improved by using nanoparticles, which results in sustained release profiles and increased therapeutic efficacy.[29]

Advantages

Greater Surface Area

Nanoparticles are perfect for catalytic applications because of their high surface-to-volume ratio, which increases their strength and reactivity.

Improved Properties

In contrast to bulk materials, they frequently display special optical, electrical, and magnetic properties. Gold nanoparticles, for instance, have special light-scattering qualities that make them useful in imaging.

Medical Applications

Drug delivery, cancer treatment, and imaging can all benefit from the ability of nanoparticles to be designed to target particular cells.

Environmental Applications

Because of their reactivity and capacity to absorb toxins and heavy metals, they can be utilized to eliminate pollutants and contaminants from air and water.

Material Strengthening

Nanoparticles can be used in manufacturing to increase the flexibility, strength, and durability of materials such as polymers and ceramics without significantly increasing their weight.[30]

Disadvantages

Health Risks

Due to their ability to cross biological membranes and build up in organs, certain nanoparticles, particularly those that are inhaled or consumed, can be poisonous and may harm cells or the respiratory system.

Environmental Concerns

When discharged into the environment, nanoparticles have the potential to be hazardous to microorganisms, plants, and animals as well as damage aquatic and soil ecosystems.

High Production Costs

The synthesis and processing of nanoparticles can be costly and frequently call for advanced technology, which restricts their wider use.

Absence of control and Long-Term Data

There is a lack of thorough control on the manufacturing and use of nanoparticles, and the effects of prolonged exposure to them are not entirely understood.

Potential for surprising Behaviour

Nanoparticles' size and reactivity might cause them to behave in surprising ways, particularly in biological systems. This could have unanticipated consequences for applications in the environment or medicine. [31]

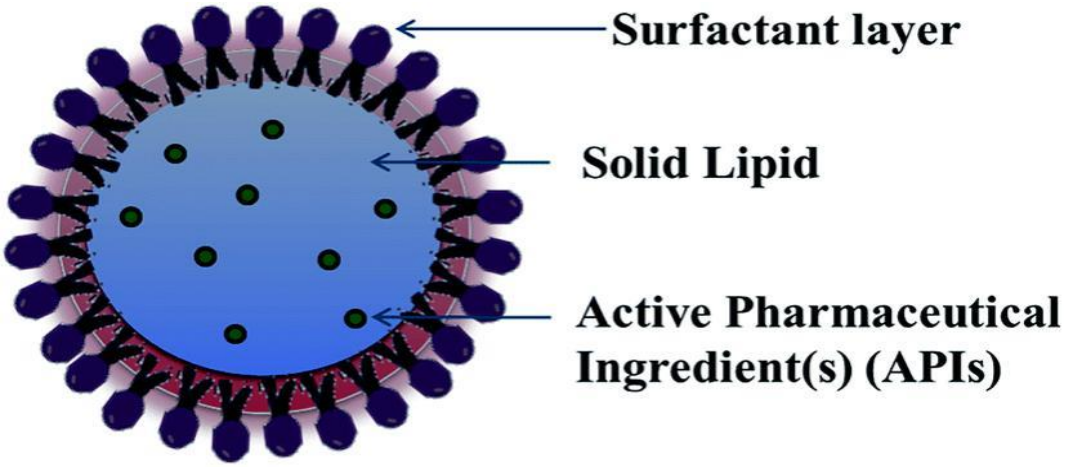

***Figure 6*:** *Nanoparticles*

Proniosomes

Proniosomes are a promising drug delivery method that improves the solubility and bioavailability of hydrophobic medications by acting as a flexible substitute for traditional liposomes. Proniosomes, which are made up of cholesterol, non-ionic surfactants, and other additives, are usually in the form of a dry, free-flowing powder that readily transforms into niosomes (non-ionic surfactant vesicles) when hydrated. Compared to conventional liposomal formulations, this special characteristic enables better stability and storage conditions. Proniosomes are very helpful in the treatment of cancer, chronic illnesses, and transdermal drug delivery applications because they can encapsulate a range of therapeutic substances upon reconstitution, enabling targeted distribution and controlled release. [32]

Advantages

Improved Stability

Because Proniosomes are dry, they are less prone to deterioration and storage problems thanniosomes and liposomes.

Better Bioavailability

Because of their structure, which can encapsulate both hydrophilic and hydrophobic medicines, they can improve the bioavailability of poorly soluble medications.

Ease of Storage and Handling

Unlike liquid niosomes and liposomes, Proniosomes are easy to store and manage because they are in a dry powder state.

Easy Preparation Process

They are made with straightforward techniques, such as the slurry method, which makes the manufacturing process reasonably simple and economical.

Controlled Drug Release

Proniosomes allow for the sustained or regulated release of medications, which can decrease the frequency of doses and increase therapeutic efficacy.[33]

Disadvantages

Limited Drug Encapsulation

Some medications may have less effective encapsulation than other vesicular systems, which may affect the dosage that is administered.

Hydration Requirement

It might be cumbersome to hydrate proneosomes prior to use, especially in immediate-release applications.

Aggregation Potential

Niosomes may aggregate over time after being hydrated to produce them, which may have an impact on the stability and release profile of the drug.

Size Control Issues

The hydrated niosomes' particle size can be difficult to regulate, which could affect medication distribution and release.

Stability with Temperature

Despite being more stable than niosomes, proneosomes may still experience stability problems at high temperatures, which may result in medication loss or leakage. [34]

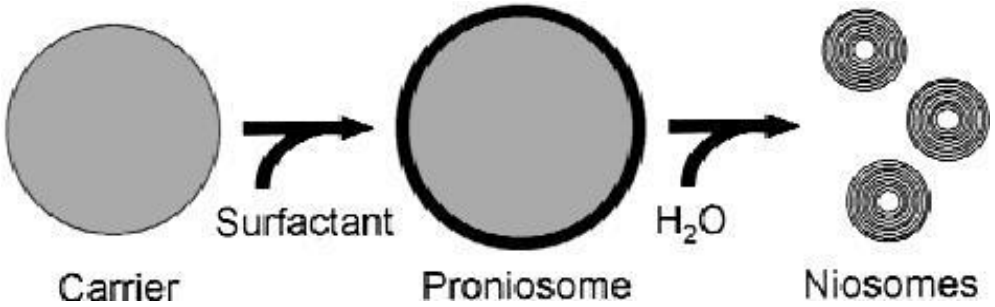

Figure 7*: *Formation of Niosomes from Proniosomes

Microspheres

Microspheres are tiny, spherical particles that can range in size from a few micrometers to several hundred micrometers. They are frequently used in a variety of applications, including tissue engineering, medication administration, and diagnostics. They can be made of a variety of materials, such as metals, polymers, and ceramics, which enable the encapsulation of medications or bimolecular to improve their controlled release and bioavailability. Microspheres' special qualities, including their size, drug-loading capacity, and surface features, make them appropriate for focused therapy and better therapeutic results. Furthermore, the adaptability of their production and design procedures allows for the creation of customized microsphere formulations to satisfy

particular clinical requirements, making them a crucial instrument in contemporary biomedical and pharmaceutical applications.[35]

Advantages

Restricted Release

Because they may release medications at a regulated rate over time, microspheres are frequently employed in drug delivery. This allows for better control of drug concentrations in the bloodstream and lowers the frequency of dosage.

Specific Drug Administration

They can be made to target particular organs or tissues, reducing adverse effects and enhancing the therapeutic effectiveness of medications.

Active Compound Protection

Proteins, peptides, and enzymes are examples of sensitive materials that microspheres can enclose and shield from deterioration, increasing their stability and bioavailability.

Increased bioavailability

Because microspheres have a wide surface area and optimize the drug release profile, they can assist increase the bioavailability of poorly soluble medicines.

Diminished Harmfulness

By delivering pharmaceuticals locally, microspheres can lessen toxicity by minimizing systemic side effects and enabling lower dosages of medications.[36]

Disadvantages

A complicated manufacturing procedure

Microsphere preparation is frequently difficult and calls for specialized tools, which raises the cost of manufacturing.

Minimal Drug Absorption

High medication dosages can be difficult to administer with certain microspheres due to their restricted drug-loading capacity, which can also compromise their therapeutic efficacy.

The possibility of a burst release

Sometimes the microspheres will burst release a lot of the medicine at first, which can cause toxicity and decreased efficacy over time.

Problems with Stability

The shelf life of some microspheres may be impacted by stability problems that arise during storage, particularly for those composed of biodegradable components.[37]

Transdermal drug delivery system

Innovative pharmaceutical formulations known as transdermal drug delivery systems (TDDS) are intended to transfer active pharmaceutical ingredients (APIs) through the skin for systemic therapeutic effects. Compared to conventional techniques, this non-invasive mode of administration has a number of benefits, including as increased patient compliance, prolonged drug release, and avoiding first-pass metabolism, which can increase bioavailability. To help the medication pass through the stratum cornea, the outermost layer of the skin, TDDS usually consists of a backing layer, a permeation enhancer, and a drug reservoir. Different kinds of transdermal patches, gels, and micro needle systems have been developed as a result of recent developments in formulation technology and materials. These products further enhance drug delivery and offer customized treatment options for a variety of medical ailments. [38]

Advantages

Controlled Drug Release

Offers a consistent and regulated release of the medication, which can enhance effectiveness and lessen adverseeffects.

Increased Bioavailability

Avoids the first-pass metabolism by skipping the liver and digestive tract, which may increasethedrug's bioavailability.

Non-Invasive and Convenient

Provides a non-invasive administration route that, in contrast to injections or oral drugs, may increase patient compliance.

Lower dosage Frequency

Because medications release gradually over time, a lower dosage frequency may improve patient compliance.

Better Stability

Transdermal administration can extend the effectiveness of some medications that are prone to hepatic metabolism or unstable in the gastrointestinal tract.[39]

Disadvantages

Limited Drug Suitability

The skin barrier can only be successfully penetrated by medications with particular molecular weights, potencies, and lipophilic properties.

Skin Irritation

Prolonged usage of transdermal patches may result in allergic reactions, skin irritation, or discomfort where the patches are applied.

Expensive Production

Because of the materials and technology required to construct patches and drug formulations, transdermal devices can be costly to produce.

Slow Onset of Action

Because the delivery mechanism releases the medicine gradually, it is less appropriate for medications that require quick or instantaneous effects.

Dose Dumping Risk

If the patch is broken, the medication may accidentally leak out, which could result in an overdose. [40]

Controlled release formulations

Sr. No.	Brand Name	Active Ingredient	Delivery System
1.	Procardia XL	Nifedipin	Extended-release tablet
2.	Concerta	Methylphenidate	Extended-release tablet
3.	Effexor XR	Venlafaxine	Extended-release tablet
4.	Oxycontin	Oxycodone	Controlled release tablet

Table 1*: *Marketed preparation of Controlled release tablet [41]

Targeted delivery formulations

Sr. No.	Brand Name	Active Ingredient	Delivery System
1.	Doxil	Doxorubicin	Liposomal delivery
2.	Ambisome	Amphotericin B	Liposomal delivery
3.	Depocyt	Cytarabin	Liposomal delivery
4.	Eligard	Leuprolide	Polymer based delivery

Table 2*: *Marketed Preparations of Target delivery formulation [42]

Transdermal delivery formulations

Sr. No.	Brand Name	Active Ingredient	Delivery System
1.	Nicotrol	Nicotine	Transdermal patch
2.	Estraderm	Estradiol	Transdermal patch
3.	Testoderm	Testosterone	Transdermal patch
4.	Catapres-TTS	Clonidine	Transdermal patch

Table 3**:** *Marketed preparation of Transdermal delivery system* [43]

Nanoparticles delivery formulations

Sr. No.	Brand Name	Active Ingredient	Delivery System
1.	Abraxane	Paclitaxel	Nanoparticles albumin-bound
2.	Rapamune	Sirolimus	Nanoparticles-based coating
3.	Emend	Aprepitant	Nanoparticles-based delivery
4.	Megace	Megestrol	Nanoparticles-based delivery

Table 4**:** *Market preparation of Nanoparticles delivery system* [44]

Microsphere based formulations

Sr. No.	Brand Name	Active Ingredient	Delivery System
1.	Lupron depot	Leuprolide	Microsphere based delivery
2.	Sandostatin LAR	Octreotide	Microsphere based delivery
3.	Trelstar	Triptorelin	Microsphere based delivery
4.	Zoladex	Goserelin	Microsphere based delivery

Table 5**:** *Marketed preparations of Microsphere formulation* [45]

Liposomal based formulations

Sr. No.	Brand Name	Active Ingredient	Delivery System
1.	Daunoxome	Daunorubicin	Liposomal delivery
2.	Myocet	Doxorubicin	Liposomal delivery
3.	Visudyne	Verteporfin	Liposomal delivery

Table 6**:** *Marketed preparations of Liposomal based formulations* [46]

Storage and preservation of NHDDS

Large-scale medication storage can be quite difficult. However, like the cannabis plant and sarsaparilla, buckthorn bark deteriorates even when held too firmly, and it makes a noise when stored for an extended period of time, which is frequently unavoidable. According to research, the amount of paclitaxel in yew tree leaves and extract rose after intense competition for no more than a year. The amount of paclitaxel in the extract from yew tree leaves, even when stored in bright, dark sunlight Additionally, it can be lowered by 30–40%. Likewise, the most widely used anti-inflammatory medication, Echinacea orientalism, has lipophilic alkamides that break down quickly in storage. According to reports, drying has Compared to medications kept in commonly used containers (such as sacks, bales, or wooden boxes), 64 weeks of storage at 24°C can produce 80% moisture with minimal impact on alkylamine.[47]

CONCLUSION

A novel drug delivery system combines cutting-edge technology with innovative dosage forms that outperform traditional dose forms. The necessary dosage at the appropriate time and place, efficient use of pricey medications and excipients, and a reduction in production costs are all

advantages of the novel drug delivery system. Patients also benefit from better therapy, more comfort, and higher living standards. Typical innovative drug delivery methods include controlled drug delivery systems and targeted drug delivery. A novel approach utilized in the pharmaceutical industry is delivery targeting and Novel Drug delivery systems. Such as targeted delivery targeting, gene therapy, vaccine therapy, and new carrier commercial development. Within an organism's intricate cellular functioning, the delivery of a medication molecule to its precise location is a challenging task in and of itself. It has outgrown its early stages and is currently experiencing the fastest rate of growth in the domains of clinical and pharmaceutical research and development. Nowadays, patient compliance is emphasized, and part of the development of NDDS is aimed at achieving this goal. These herbal excipients have the potential to be biodegradable and chemically compatible with other excipients in drug delivery systems because they are biodegradable materials. Furthermore, herbal excipients are less expensive than their synthetic counterparts, readily available, and non-toxic. Their influence in the pharmaceutical sector is significant. As a result, there will be interest in natural excipients as a source of drug material in the future.

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