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A Brief Review on Novel Drug Delivery System

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Abstract: *A novel drug delivery system represents an innovative strategy for administering medications, effectively overcoming the shortcomings associated with traditional methods. These new formulations exhibit significant benefits compared to conventional formulations of plant-based active ingredients and extracts. These advantages encompass improved solubility, increased bioavailability, reduced toxicity, enhanced pharmacological efficacy, greater stability, better distribution to tissue macrophages, sustained release, and protection against both physical and chemical degradation. The present review highlights the current condition of the development of novel herbal formulations and summarizes their type of active components, biological activity, and applications of novel formulations.*

Keywords: herbal, nature, Novel drug delivery

I. INTRODUCTION

Herbal medicines likely date back to the dawn of humanity. The utilization of plants and their components for medicinal purposes has been prevalent since ancient times. Even today, phytomedicine remains widely practiced among a significant portion of the global population. The popularity of herbal drugs can be attributed to their effectiveness in treating various ailments with reduced toxicity and enhanced therapeutic benefits.
Efforts are made to minimize drug degradation and loss, prevent adverse side effects, and improve drug bioavailability and the amount of the drug that is retained in the body.

There are three main reasons for the popularity of herbal medicine:

- They are is a growing concern over the reliance and safety of drugs and surgery.
- Modern medicine is failing to effectively treat many of the most common health conditions
- Many natural measures are being shown to produce better results than drugs or surgery without the side effects.

Novel Drug delivery system

It is advantageous in delivering the herbal drug at predetermined rate and Delivery of drug at the site of action which minimizes the toxic effects with increase in Bioavailability of drugs The method by which a drug is delivered can Have a significant effect on its efficacy. Some have an optimum concentration range Within which maximum benefit is derived, and Concentrations above or below this range can be Toxicity produce no therapeutic benefit at all.From this, new ideas on controlling the Pharmacokinetics, pharmacodynamics, non-Specific toxicity, immunogenicity, Biorecognition, and efficacy of drugs

Types of novel herbal drug delivery system:

- Liposome
- Phytosomes
- Ethosomes
- Niosomes
- Transfersome

Advantages of novel drug delivery systems

- Enhancement of solubility
- Increased bioavailability.

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- Protection from toxicity.
- Enhancement of pharmacological ac
- Enhancement of stability.
- Improved tissue macrophages distribution.

Approaches in Novel herbal drug delivery system

NOVEL DRUG DELIVERY APPROACHES

Various drug delivery and drug targeting systems are currently under development to minimize drug degradation and loss, to Prevent harmful side-effects and to increase drug bioavailability And the fraction of the drug accumulated in the required zone.

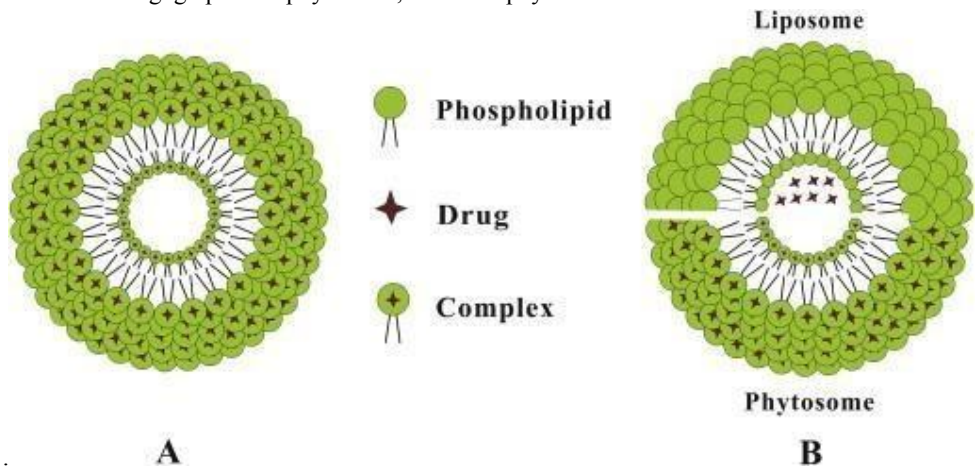
- Among drug carriers one can name soluble polymers, Microparticles made of insoluble or biodegradable natural and Synthetic polymers,
- microcapsules, cells, cell ghosts, lipoproteins, Liposomes and micelles. The carriers can be made slowly Degradable, stimuli-reactive (e.g. pH- or temperature-sensitive) And even targeted (e.g. by conjugating them with specific Antibodies against certain characteristic components of the area Of interest)

Types of Novel herbal drug delivery systems

Different strategies for novel herbal drug delivery systems encompass a variety of formulations, including liposomes, photosomes, niosomes, transfersomes, and ethosomes.

Phytosomes:

The term "Phyto" means plant while „Some" means cell-like. Phytosome is vesicular drug delivery system in which phyto constituents of herb extract surround and bound by lipid (one phyto-constituent molecule linked with at least one phospholipid molecule. E.g. grape seed phytosome,Green tea phytosome



Liposomes:

Liposomes are spherical entities that enclose a portion of the solvent, allowing it to diffuse or remain suspended within their interior. These carriers, which can be classified as micro-particulate or colloidal, typically range from 0.05 to 5.0 µm in diameter and are formed spontaneously when specific lipids are hydrated in an aqueous environment. They may possess one or multiple concentric membranes.

Nanoparticles :

Nanoparticles are efficient delivery systems for hydrophilic and hydrophobic drugs. Nanoparticles are submicron particles ranging in size from 10 to 1000 nm. The main goal in the development of nanoparticles as delivery systems is

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to control the particle size, surface properties, and release of pharmacologically active substances in order to achieve site-specific effects of the drug, as well as the therapeutically optimal rate and dose reached. In recent years, biodegradable polymeric nanoparticles have attracted considerable attention as potential drug delivery systems.

Microspheres:

Microspheres are individual spherical particles with an average diameter of 1-50 micrometers. Particulate drug delivery systems have been shown to be reliable and capable of delivering drugs to the target site and maintaining desired concentrations at the target site without undesirable side effects. Microencapsulation is a useful method to significantly extend the duration of drug action and improve patient compliance.

Ethosome:

Ethosomes are phospholipid-based elastic nanovesicles with a high ethanol content (20–45%). Ethanol is known to be an effective penetration enhancer and has been reported to be added to vesicle systems to generate elastic nanovesicles.

Niosome

Niosomes are multicellular vesicles formed from non-ionic surfactants of the alkyl or dialkylpolycerol ether class and cholesterol. Liposomes are associated with the following problems: B. They are expensive, chemically unstable due to the susceptibility of components such as phospholipids to oxidative degradation, require special storage and handling, and the purity of the phospholipids varies.

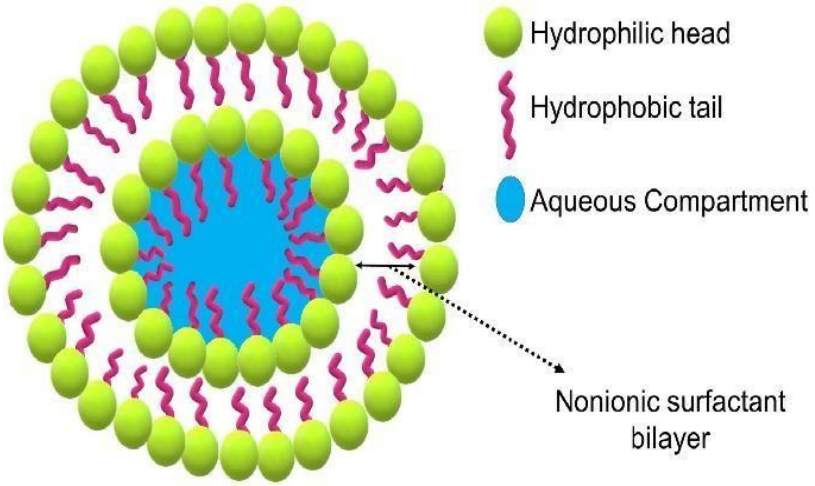

Figure 1:. A typical structure of niosome

Characteristics of Niosomes:

- Biodegradable
- Non-toxic &non immunogenic
- Non carcinogenic
- The ability of non ionic surfactants to form bilayer vesicles is dependent on HLB value of surfactant.

Advantages of Niosomes:

- Targeted drug delivery can be achieved using Niosomes the drug is delivered directly to the body part where the therapeutic effect is required
- Reduced dose is required to achieve to desire effect
- Subsequent decrease in side effect

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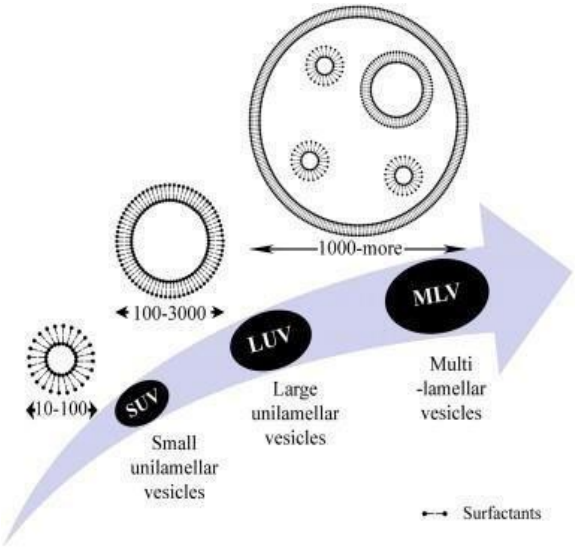
Disadvantages:

- Aqueous suspension of niosome may exhibit fusion,aggreation , leaching or hydrolysis of entrapped drug, thus limiting the shelf life of niosome dispersion.
- Time consuming



Types of niosome:

- Small unilamellar vesicles
- Large unilamellar vesicle Multilamellar vesicles

Methods of preparation

Niosomes can be prepared by various methods, including:

- Ether injection method (EIM)
- Hand shaking method (HSM)
- Reverse phase evaporation method (REV)
- Trans membrane pH gradient
- The “Bubble” method
- Microfluidization method
- Formation of niosomes from proniosomes (Proniosome technology (PT))
- Thin-film hydration method (TFH)

Excipients defined as ‘the substance used as a medium for giving a medicament .

Herbal Excipients :

Herbal or natural excipients have significant advantages over their synthetic analogues as they are non-toxic, cheap and freely available.

Increasing awareness of these herbal excipients (mostly polymers of natural origin) has led the pharmaceutical industry to increasingly use these excipients in the development of formulations.

Pharmaceutical Excipient

Pharmaceutical excipients can be defined as inactive ingredients that are mixed with a therapeutically active compound to form a drug product.

Any ingredient that is not an active compound is considered as an excipient. Excipients have an increasingly significant impact on the function and efficacy of a drug.

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Classification of Excipients

Excipients are commonly classified according to their application and function in the drug products:

- Binder and Diluent
- Lubricants,Glidants,Disintegrants
- Polishing film former,Coating Agents
- Plasticizer,Colouring
- Suspending Agent, Preservatives
- Flavourig, Sweeteners, Taste Improving Agent
- Printing Ink, Dispersing Agent Gum

Classification of excipient based on source.

- Marine origin/algal (seaweed) gums: agar, carrageenans, alginic acid, and laminarin;
- Plant origin: Shrubs/tree exudates: gum arabic, gum ghatti, gum karaya, gum tragacanth, and Khaya and albiziagums.
- Seed gums: guar gum, locust bean gum, starch, amylose, and cellulose;
- Extracts: pectin, larchgum; •Tuber and roots: potato starch.

Advantages of Herbal Excipients

1. Biodegradable – a natural polymer produced by all living organisms. It has no adverse effects on the environment or human body.
2. Economical – cheaper than synthetic materials and less expensive to produce.
3. Safe and no side effects – derived from natural sources, it is safe and has no side effects.

Disadvantages of herbal excipients

- Microbial contamination– During production, they are exposed to external environment And hence, there are chances of microbial contamination
- Slow Process– As the production rate is depends upon the environment
- Heavy metal contamination– There are chances of Heavy metal contamination

PHARMACEUTICAL APPLICATION OF HERBAL EXCIPIENTS •

Tamarind Gum

- Tamarind xyloglucan is obtained from the endosperm of the seed of the tamarind tree, Tamarindusindica, a member of the 21 evergreen families. Tamarind Gum, also known as Tamarind Kernel Powder (TKP) is extracted from the seeds Microspheres formed was in the size range of 230 - 460µm.
- In another study Diclofenac sodium matrix tablets containing TSP was investigated. The tablets prepared by wet granulation technique were evaluated for its drug release Characteristics

Guar gum

- Guar gum comes from the endosperm of the seed of the legume plant Cyamopsistetragonolobus.
- Refined guar splits are obtained when the fine layer of fibrous material, which forms the husk, is removed and separated from the endosperm halves by polishing [28].

Locust bean gum-

- Locust Bean Gum (LBG) (also known as Carob Gum) is obtained from the refined endosperm of seeds from the carob tree Ceretoniasiliqua L.
- It is an evergreen tree of the legume family. Carob bean gum is obtained by removing and processing the endosperm from seeds of the carob tree

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Honey locust gum

- It is known botanically as Gleditsiatriacanthos, and belongs to the order Leguminosea (suborder Mimoseae). The gum is obtained from the seeds [30, 31]

Khaya gum

- Kaya gum is a polysaccharide obtained from the excised trunk of the Kaya grandifolia tree (Meliaceae).
- The fact that this gum Is naturally occurring, inexpensive and non-toxic has also prompted interest in developing the gum for pharmaceutical purposes. Further research has also demonstrated its potential as a directly compressible matrix system in the formulation of 61 controlled-release tablets.

Aloe mucilage

It is obtained from the leaves of Aloe barbadensis Miller. The aloe parenchyma tissue or pulp has been shown to contain proteins, lipids, amino acids, vitamins, enzymes, inorganic compounds and small organic compounds in addition to the different carbohydrates. Many investigators have identified partially acetylated mannan (or acemannan) as the primary polysaccharide of the gel, while others found pectic substance as the primary polysaccharide[33].

Pectin

The blended alginate and pectin polymer matrix increased the folic acid encapsulation efficiency and reduced leakage from the capsules as compared to those made with alginate alone; they showed higher folic acid retention after freeze drying and storage [36]. Alginates Alginates are natural.

Characterization studies

The characterization of niosomes includes parameters such as size, distribution, zeta potential, Morphology, EE, and in vitro release behavior. These are studied to determine the quality of The niosomes in formulation development and their applications in future clinical studies.

Niosome particle size and size distribution

- Niosome particle size and size distribution Particle size is a fundamental parameter in the characterization of niosomes as it provides Information on physical properties and stability of the formulation
- The size of niosomes Can be measured by techniques such as dynamic light scattering (DLS) and microscopy. DLS Is also known as photon correlation spectroscopy (2). This method is rapid and non-destructive, And only a small amount of sample is required. It can be used to measure particles in the size Range of 3 to 3000 nm.

Zeta potential

Zeta potential, also known as surface charge, provides important information in determining the physical stability of niosomes. Niosomes with a zeta potential above or below 30 mV are considered to be acceptably stable.

Niosome stability

The stability of the vesicle system is an issue, affecting not only the physical and chemical stability but also the biological stability.

This fundamental parameter is used to determine the potential of niosomes when used in vivo and in vitro. Stability is usually determined by monitoring particle size and zeta potential over time, and variations in these two parameters indicate:

In-vitro release

A method of in-vitro release rate study includes the use of dialysis tubing. A dialysis sac is washed and soaked in distilled water. The vesicle suspension is pipetted into a bag made up of the tubing and sealed. The bag containing the vesicles is placed in 200 ml of buffer solution in a 250 ml beaker with constant shaking at 25°C or 37°C. At various time intervals, the buffer is analyzed for the drug content by an appropriate assay method.

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In vitro methods for niosome

Dialysis tubing
Reverse dialysis
Franz diffusion cell

The Application of the Niosomes

- The following are a Few uses of niosomes which are either proven or under research.
- It is used as Drug Targeting.
- It is used as Anti8neoplastic Treatment i.e. Cancer Disease.
- It is used as Leishmaniasis i.e. Dermal and Subcutaneous
- e.g. Sodium stibogluconate
- It is used act as Delivery of Peptide Drugs.
- It is used in Studying Immune Response.
- Niosomes as Carriers for Hemoglobin.
- Transdermal Drug Delivery Systems Utilizing Niosomes
- It is used in Ophthalmic drug delivery

Protein and peptide drug

Protein and peptides such as insulin and bacitracin may function as important therapeutic agents for the treatment of 😷
It is reported that niosome was investigated for the delivery of insulin via the parenteral and vaginal routes, and that it showed a good ability to protect insulin from degradation

Targeted herbal drug delivery

Targeted drug delivery using niosomal systems can be approached in two ways. The first method is through passive targeting of the reticuloendothelial system (RES), a crucial segment of the immune system made up of phagocytic cells found in reticular connective tissue.

Drug targetting Application

One the most useful aspects of niosomes is their ability to target drugs. Niosomes can be used to target drugs to the reticuloendothelial system.
The reticulo-endothelial system (RES) preferentially takes up niosome vesicles.
The uptake of niosomes is controlled by circulating serum factors called opsonins. These opsonins mark the niosome for clearance.

Anti neoplastic treatment application of Niosome

Antineoplastic drugs often come with significant side effects. However, niosomes can enhance the metabolism of these drugs, enabling them to circulate longer in the body and extending their half-lives. This ultimately leads to reduced side effects and a slower proliferation rate of tumors, while also maintaining higher plasma levels of the drug.
Delivery of Anticancer Drugs. The primary approach for cancer treatment is chemotherapy. Unfortunately, many anticancer drugs face limitations due to their inadequate penetration into tumor tissues and the harsh side effects they impose on healthy cells.

Lycopene in niosome assessment of its anticancer activity

Lycopene, a natural bioactive compound found in Lycopersicumesculentum, has gained attention for its potential in preventing cancer and diabetes. There is ongoing research aimed at developing effective therapies that harness the power of natural products like lycopene to combat cancer. However, pure lycopene's sensitivity to light, heat, and oxidants poses challenges to its therapeutic application. This study introduces a novel method for encapsulating

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lycopene through the use of glass wool via an adsorption-hydration technique. Additionally, a niosome formulation has been developed to protect the activity of lycopene and enhance its bioavailability.

II. CONCLUSION

This review explores the innovative approaches in novel drug delivery systems specifically within herbal medicine. It covers various types, formulations, and the herbal drugs utilized, along with the current market landscape of these systems. The insights provided here serve as a foundational resource for further research, especially in the isolation of chemical entities and the development of advanced formulations in herbal applications.

There is significant ongoing research focused on enhancing the delivery and targeting of active components from plants and herbal extracts. Notably, herbal excipients present numerous advantages: they are non-toxic, readily available, and typically more affordable than synthetic alternatives. Their importance in the pharmaceutical industry cannot be overstated.

Looking ahead, we anticipate a sustained interest in natural excipients, aiming to improve materials for drug delivery systems. Herbal medicines are increasingly employed to treat a range of diseases, including diabetes, cancer, and other genetic disorders, highlighting their crucial role in contemporary therapeutic strategies.

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