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NOVEL HERBAL DRUG DELIVERY SYSTEM: AN OVERVIEW

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Abstract

The kind of novel herbal formulations such as polymeric nanoparticles, nanocapsules, liposomes, phytosomes, animations, microsphere, transfersomes, and ethosomes has been reported using proactive and plant selections. The novel formulations are described to have remarkable advantages over conventional formulations of plant actives and extracts which include enhancement of solubility, bioavailability, and protection from toxicity, enhancement of pharmacological activity, enhancement of stability, improved tissue macrophages distribution, sustained delivery, and protection from physical and chemical degradation. Phytosome is a patented technology developed by a leading maker of drugs and nutraceuticals, to incorporate standardized plant extracts or water-soluble phytoconstituents into phospholipids to produce lipid-compatible molecular complexes. The herbal drugs can be used in a more upright course with enhanced efficacy by incorporating them into moderndosage forms. This can be accomplished by designing novel drug delivery systems for herbal ingredients. 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 medicines, Green tea phytosome ,liposome, microsphere, microemulsion , ethosomes, noisome ,transferosomes, herbal excipient, Targeted Herbal drug delivery system.

Introduction

Necessity of NDDS in herbal drugs-

- Novel drug delivery system is a novel approach to drug delivery that addresses the limitation of the traditional drug delivery systems.
- Our country has a vast knowledge base of Ayurveda whose potential is only being realized in recent years.
- However, the drug delivery system used for the administrating the herbal medicine to the patient is traditional and out of date resulting in reduce efficacy of the drug.
- If the novel drug delivery technology in applied herbal medicine, it may help in increasing the efficacy and reducing the side effect of various herbal compounds and herbs.
- This is the basic idea behind the incorporating novel method of drug delivery in herbal medicines.
- The limitations behind the conventional drug delivery methods are addressed by a novel drug delivery system, which is a novel method of drug administration.
- By precisely locating the diseased location within a patient's body then delivering the drug there, modern medicine may treat a specific condition.
- A drug delivery system is a way to supply the right amount of a medicine to the patient so that it precisely reaches the "site of action" and gets to work right away.
- The drawbacks of traditional drug delivery techniques all are addressed in novel drug delivery technologies. There are numerous methods for achieving novel drug delivery.[1]

Physicochemical and biological properties of herbal drug-[2]

Physicochemical properties	Biological properties
Solubility	Antioxidant
Partition coefficient	Antimicrobials
Surface activity	Anti-inflammatory
Protein binding	Anti-cancer activity
Complexation	Wound healing
Isomerism	Anti nociceptive
Hydrogen bonding	
Ionization of drug	

Selection of herbal drug and novel drug delivery system-[3]

Phytosomes-

Product name	Disease treated
Ginseng, Phytosome	Nutraceutical, Immunomodulator.
Green tea Phytosome	Nutraceutical, systemic antioxidant, anticancer.

Transferosomes and Ethosomes-

Product name	Disease treated
Capsaicin Transferosomes.	Analgesic
Colchicine Transferosomes.	Anti gout

Nanoparticles-

Product name	Disease treated
Cuscuta Chinensis	Hepatoprotectives and Antioxidant effects
Glycyrrhizic acid-Loaded nanoparticles	Anti- inflammatory, Antihypertensive

Advantages and disadvantages of NDDS in herbal drug-[2]

Advantages

- The novel herbal drug delivery system can be used to achieve site specificity.
- The enhanced penetration of nanoparticles through the Blood Brain Barrier (BBB).
- Providing high efficacy.
- Enhanced stability.
- Reduce undesirable effects and toxicity.
- Long-term stability by protecting plant activities from degradation.
- Decrease allergic potential of herbal substances.
- Improved solubility & bioavailability.
- Controlled drug delivery.

Disadvantages

- Physical instability.
- Leaking of entrapped drugs.
- There are limits on bio acceptability.
- Effects may be unpredictable.
- Lack of regulation.
- Takes longer time to show results.
- If you are on medicine some can cause adverse effects.

Current challenges in modernization of herbal formulations-[4]

- According to WHO, herbal dosage form are the physical form like liquid, solid, semisolid Products produce from herbs, with or without excipient, in a particular formulation (such as decoctions, tablets, ointment, etc.).
- The toxicology, epidemiological and other data available regarding herbal formulation is confusing.
- Authentication of herbal material is difficult.
- Pharmacology, toxicology and clinical documentation is tedious task.
- It is difficult to follow pharmacovigilance guideline in case of herbal formulations.

- There is need to study herbal-drug interaction
- Standardization, safety and efficacy are big challenges.
- There are various hurdles in a condition of clinical trials of herbal formulation.
- Quality issue
- Processing and harvesting issue
- Quality control related issue
- Administrative issue
- Infrastructure related issue
- Pharmacovigilance
- Clinical trials
- IPR and biopiracy
- Irrational issue
- R and D

Approaches in Novel Herbal Drug Delivery System

Different types of novel herbal formulations currently available in market[3]

Phytosome

Product ingredients-

Ingredients	Amount Per Serving
Green Tea Phytosome Contains standardized Green Tea extract (Camelli sinensis Leaves) bound to phosphatidylcholine (from soy lecithin) in a 1:2 ratio	**50mg**
Catechins	**10mg**
Epigallocatechin-3-0 gallate (EGCg)	**7mg**

Other Ingredients-

- Microcrystalline cellulose, Gelatin capsule, Magnesium stearate (vegetable grade).

Suggested Usage

- One capsule 1-2 times per day or as directed by a health profession.
- Keep out of reach of children.
- Green Tea Phytosome is the result of a unique, patented process that binds Green Tea and key actives to phosphatidylcholine (from soy lecithin) resulting in superior bioavailability.

Product description-

- Green Tea Phytosome is the result of a unique, patented process that binds Green Tea to phosphatidylcholine (from soy lecithin).
- Green Tea is well known as a protective antioxidant. Antioxidants preserve cell health, which may lead to improved longevity and well-being.
- The Phytosome complex increases the absorption, biological activity, and delivery of Green Tea, making it the most beneficial form of Green Tea Extract.

Product pharmacology-

- It reduces toxic effects, increases drug bioavailability, and regulates drug distribution by either incorporating the drug into the carrier system or altering the molecular structure of the drug. Green tea phytosome is composed of green tea extract and phospholipids.

Liposomes

Introduction-

- Liposomes based drug delivery system offer the potential to raise the therapeutic index of anticancer agents, by increasing the drug concentration in tumor cell or by lessening in the exposure in normal tissue exploiting enhanced permeability and retention effect phenomenon or by utilizing targeting strategies.
- The use of herbal extracts as a food supplement or a drug constituent instead of synthetic drugs become essential day by day due to the side effects of synthetic chemicals.

Physical properties-

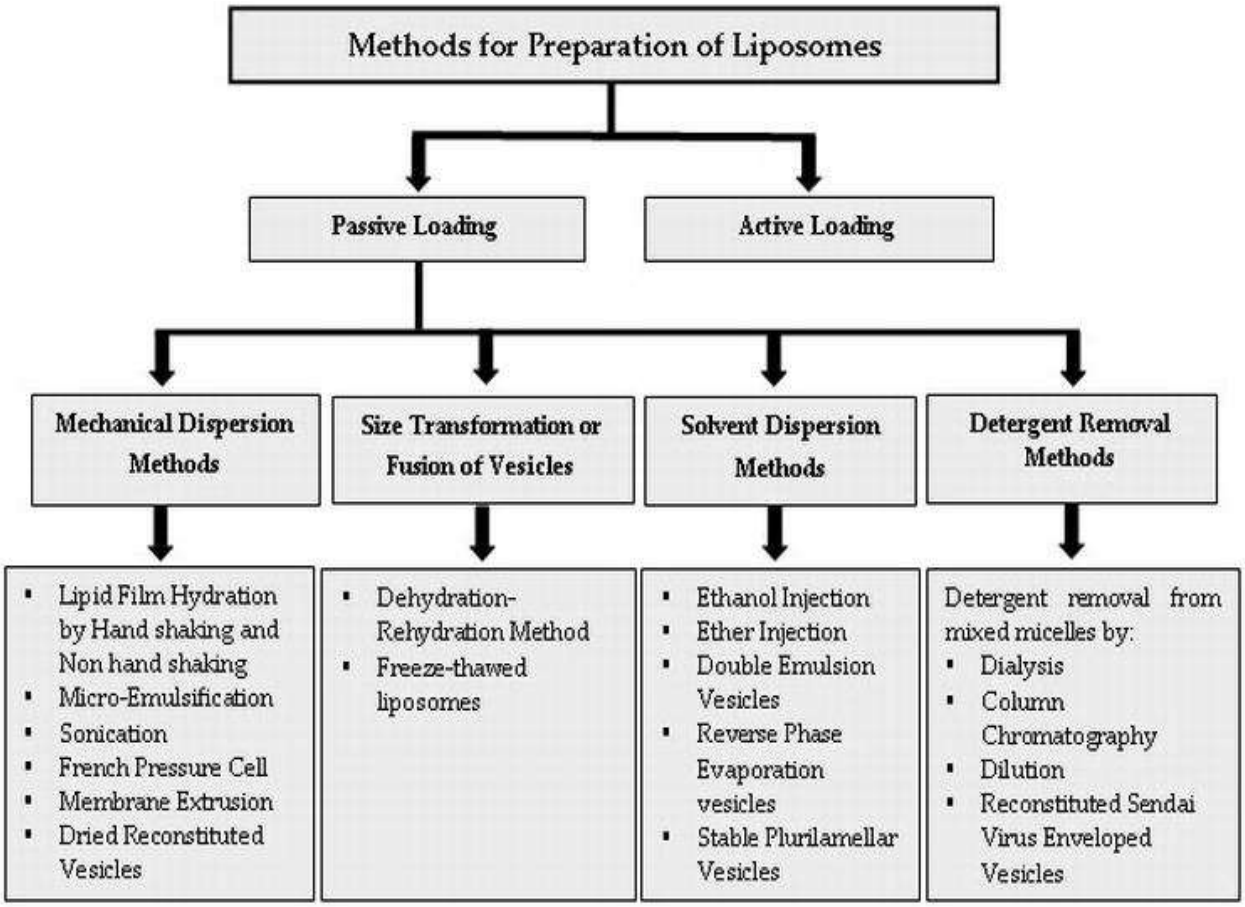
- Entrapment efficiency
- Vesicle shape and morphology
- Lamellarity
- Particle size and size distribution
- Surface charge
- Drug release

Chemical properties-

- Phospholipid concentration
- Cholesterol concentration
- Lysolecithin concentration
- Phospholipid peroxidation
- Phospholipid hydrolysis and cholesterol autooxidation
- Ph of liposomal dispersion

- Osmolarity.

Method of preparations-



Advantages-

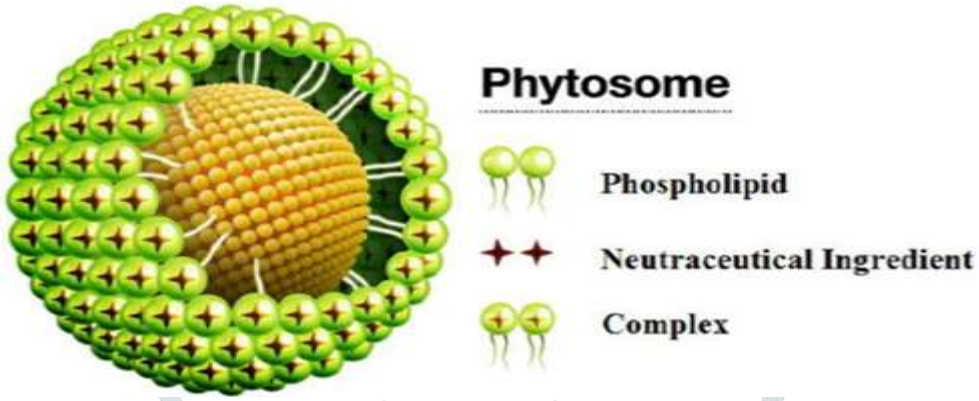
- Suitable for delivery of hydrophobic, hydrophilic and amphipatic drugs and agents
- Chemically and physically well characterized entities Biocompatible Use as carrier for suitable for controlled release drug delivery.
- Suitable to give localized action in particular tissues. Suitable to administer via various routes.
- Increased efficacy and therapeutic index.
- Reduction on toxicity of the encapsulation agent.
- Improved pharmacokinetic properties. Can be made into Varity of drug.
- Minimum antigenicity.

Disadvantages-

- Their rapid clearance from circulation due to uptake.
- Leakage of encaptulation drug delivery during storage.
- Difficult in large scale manufacture and sterilization.
- Physical /chemical stability
- Very high production cost.
- Possibility of dumping due to faulty administration. [4]

Phytosome

- Phytosomal complexes their first investigated for cosmetics applications, but mounting evidence of potential for drug delivery has been amassed over the past few years, with beneficial activity in the realms of cardiovascular, anti-inflammatory, hepatoprotectives and anticancer application.
- The phytosomes provide a coating around the active constituent of drug and due to this main constituent of herbal extract remain safe from degradation by digestive secretion and bacteria.



Advantages-

- Enhanced absorption of herbal constituent.
- As the absorption of active constituents is improved, its dose requirement is also reduced.
- Its shows better stability profile.
- Entrapment efficiency is high.
- Phytosome are also superior to liposomes in skin care products.
- Better bioavailability.
- Nutrition benefit.

Disadvantages-

- When administered orally or topically they limit their bioavailability.
- Phytoconstituents is quickly eliminated from phytosomes
- Stability problems.

Niosomes

- A non-ionic surfactant-based liposome is known as a niosome. Cholesterol is primarily used as an excipient in the formation of niosomes. Excipients can also be used in other ways.
- Niosomes are more capable of penetrating than earlier emulsion formulations. While they share a bilayer with liposomes architecturally, niosomes are more stable due to the materials employed in their preparation, and as a result, they have many more benefits than liposomes.
- Niosome sizes are minuscule and fall into the nanometric range. The range of particle sizes is 10 nm to 100 nm.

Advantages of niosomes

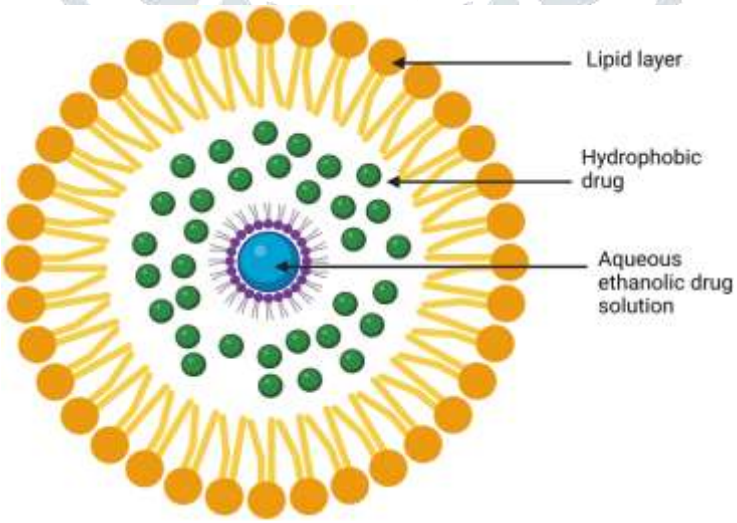
- As compared to liposomes niosomes offer more chemical stability, osmotic activity and longer shelf life.
- Because of the presence of a functional group on the hydrophilic head, the surface of niosomes can be easily formed and modified.
- Niosomes are less toxic and more compatible since they do not carry any charge.
- Niosomes are degradable by the biological systems and do not initiate immunogenic reactions.

Disadvantages of niosomes

- May require specialized equipment.
- High production cost
- Inefficient drug loading
- Fusion
- Aggregation
- Leaking of entrapped drugs
- The demerits of hydrolysis on the encapsulated drugs results into limiting the shelf life of the paticular formulation.

Ethosomes

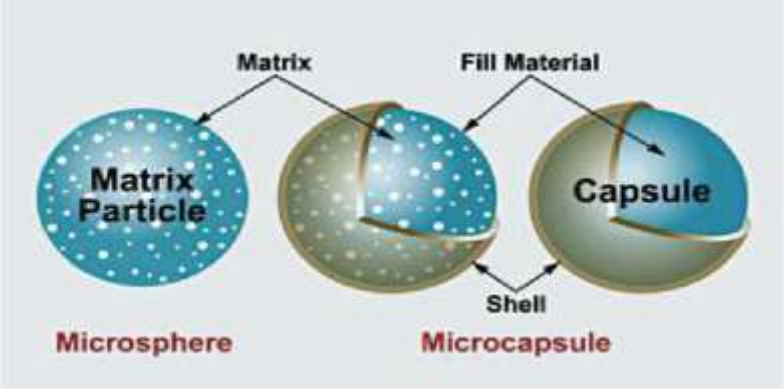
- Alcohol (ethanol or isopropyl alcohol) is present in relatively high concentrations (20–45%) in phospholipids, water, and soft, flexible lipid vesicles called ethosomes.
- Touitou and her associates created ethosomes for the first time in 1997. Due to its great degree of deformability, this carrier exhibits intriguing characteristics that are connected with its capacity to pass intact through human skin.



- These vesicular phospholipids are the vesicle-formingpart of the ethosomal system according to the physicochemical properties of ethosomes. In quantities ranging from 0.5-10%, phospholipids with different chemical structures, such as phosphatidylcholine (PC), hydrogenated PC, and phosphatidylethanolamine (PE), are utilised.

Microspheres

- Small, spherical particles known as microspheres generally have diameters between one and one thousand micrometres.



- Microparticles are another name for microspheres. Many organic and synthetic materials can be used to make microspheres.
- Commercially accessible microspheres include glass, polymer, and ceramic ones. Microspheres, both solid and hollow have a wide range of densities and are employed in many applications. Since they make procedures like cell sorting and immune precipitations easier, polystyrene microspheres are often employed in biomedical applications.

Microemulsion

- Microemulsion is defined as the clear, thermodynamically stable, Isotropic liquid mixture of oil, water, and surfactant. Ex. Microemulsion based hydrogel for the dermal delivery system.
- The novel of the study is to formulate the microemulsion based poly-herbal sunscreen cream.
- The size of the microemulsion is less and better solubility of herbal component motivated for the formulation of microemulsion based sunscreen.
- The plant selected for study was Nardostachys Jatamansi, it reduces the burning sensation and improved skin texture.
- Rubia cordifolia is antioxidant, antifungal, and anti-inflammatory.
- Solanum Lycopersicum contains unsaturated compound (Lycopene) absorbs UV radiation and increases Sun protection factor.

Herbal excipients

Introduction to herbal excipients-

According to the International Pharmaceutical Excipients Council, The excipients are defined as " Substance other than the active drug substances of finished dosage forms, which have been appropriately evaluated for safety and are included in drug delivery system to either aid the processing of the drug delivery system during its manufacture, protect, support or enhance stability, bioavailability or patient acceptability, assist in product identification or enhance any other attributes of the overall safety and effectiveness of the drug delivery system during storage or use".[5]

Ideal Properties of Excipients-

- They can be used practically.
- They should be non-toxic and non-irritant in nature
- They should be non-volatile in nature
- They should not be affected by temperature, light and hydrolysis.
- They should be easily available and cheap.
- They should not have specific colour, odour, and taste.
- They should possess good water and lipid solubility.
- They should be pharmacologically inert.

Functions of Excipients-

- Add bulk to the formulation.
- During manufacturing it helps to handle Active Pharmaceutical Ingredients.
- Assist in drug administration.
- Enhance patient compliance.
- Enhance drug solubility and bioavailability of Active Pharmaceutical Ingredients.
- Prevents drug aggregation and helps in drug particles dispersion.
- Helps to mask unpleasant taste, color and odour.
- Helps to maintain stability.

Classification of Herbal Excipients-

1. **Fillers-**

   Plant Cellulose, Gelatin, Lactose, Sucrose, Glucose.

2. **Binders-**

   Acacia, Alginic Acid, Corn Starch, Alginate, polymers.

3. **Disintegrants-**

   Silicone, Gellan gum, Agar.

4. **Coating Agent-**

   Gelatin, Arabi, Natural polymers.

5. **Lubricants -**

   Castor oil, Mineral oil, Paraffin oil.

6. **Glidants-**

   Vitamin D, Talc.

7. **Preservatives-**

   Clove oil, Cumin seeds, Neem oil, Cayenne pepper.

8. **Antioxidents-**

   Clove oil, Cinnamon, Turmeric, Cocca.

9. **Sweating Agents-**

   Glucose, Lactose, Honey.

10. **Flavouring Agents-**

    Ginger, Raspberry, Lemon, Orange, Peppermint.

11. **Colouring Agents-**

    Caramel, Chlorophylls, Carotenoids, Red beetroot, Turmeric, Saffron.

12. **Solvent -**

    Purified water, oils.

13. **Chelating Agents-**

    Onions, Garlics, Chlorella, Brazil nuts.

14. **Buffering Agents-**

    Lemon juice.

15. **Surface Active Agents-**

    Ski waxes, Tea saponins.

16. **Viscosity Imparting Agents-**

    Gelatin, Aloe mucilage, Gums, Tragacanth.

17. **Emulsifing Agents-**

    Acacia gum, Gum Ghatti.[6]

Advantage of herbal excipients [7]

- **Biodegradable-**

  Naturally occurring polymers produced by all living organisms. They show no adverse effects on the environment or human beings.

- **Biocompatible and non-toxic-**

  Synthetically, all most all these plant materials are carbohydrates in nature and composed of repeating monosaccharide units. Hence, they are non-toxic.

- **Economic-**

  They are inexpensive and their manufacturing cost is less than synthetic material.

- **Safe and devoid of side effects-**

  They are from a natural origin and hence, safe and without aftereffects.

- **Easy availability-**

  In many countries, they are produced due to their application in many industries.

Disadvantages of herbal excipients

- **Microbial contamination** – During production, they are exposed to the external environment, and hence, there are chances of microbial contamination.
- **Variation –** Synthetic manufacturing is a controlled procedure with fixed quantities of ingredients while the production of natural polymers is dependent on the environment and various physical factors.
- **The uncontrolled rate of hydration**- Due to differences in the collection of natural materials at different times, as well as differences in region, species, and climate conditions the percentage of chemical constituents existing in a given substance may differ.
- **Slow Process**- As the production rate depends upon the environment and many other factors, it cannot be changed. So natural polymers have a slow rate of construction.
- **Heavy metal contamination**- There are chances of Heavy metal contamination often associated with herbal excipients.

Application of herbal excipients [8]

- **Tamarind Gum -**

  Tamarind tree, Tamarindus indica, a member of the 21 enduring families. Tamarind xyloglucanis acquired from the Endosperm of the seed of the Tamarind Gum, also known as Tamarind Kernel Powder (TKP) is extracted from the seeds Microspheres formed was in the size range of 230 - 460μm. The tablets produced by the wet granulation technique were evaluated for its drug release characteristics.

- **Guar gum-**

  Guar gum comes from the endosperm of the nut of the legume plant Cyamopsis tetragonolobus. Refined guar splits are acquired when the fine layer of fibrous substance, which forms the husk, is detached and separated from the endosperm halves by polishing. Strong acids cause hydrolysis and overlooking of viscosity, and alkalies in strong concentration also tend to decrease viscosity. It is insolvable in most hydrocarbon solvents.

- **Locust bean gum-**

  Locust Bean Gum (LBG) (also known as Carob Gum) is acquired from the refined endosperm of seeds from the carob tree Ceretonia siliqua L. It is an evergreen tree of the legume family.

- **Honey locust gum -**

  It is familiar, botanically as Gleditsia triacanthos, and belongs to the order Leguminosea (suborder Mimoseae). The gum is acquired from the seeds.

- **Khaya gum -**

  Khaya gum is a polysaccharide acquired from the engraved trunk of the tree Khaya grandifoliola (family Meliaceae). The fact that the gum is naturally available, inexpensive, and non-toxic has also fostered an interest in growing the gum for pharmaceutical use.

- **Aloe mucilage -**

  It is obtained from the leaves of Aloe barbadensis Miller. The aloe parenchyma tissue or pulp has been appearing to carry proteins, lipids, amino acids, vitamins, enzymes, inorganic compounds, and small organic compounds in adding to the different carbohydrates.

- **Hakea Gum -**

  Hakea gum dried exudates from the plant Hakea gibbosa family Proteaceae. Gums that are acidic arabinogalactans (type A).

- **Pectin -**

  Pectins are non-starch, linear polysaccharides extracted from the plant cell walls 19. In the food production, folic acid included microcapsules were produced using alginate and mixtures of alginate and pectin polymers to enhance the stability of folic acid.

- **Alginates -**

  Alginates offer different entreaties in drug delivery, for example in matrix type alginate gel beads, in liposomes, in modulating gastrointestinal transit time, for local applications, and to deliver the biomolecules in tissue engineering applications.

Difference between herbal excipients and synthetic excipients

Synthetic Drugs	Herbal Drugs
Synthetic drugs having many more side effect and adverse reaction. Resistance also can be observed.	Mostly herbal drugs are safe and having less sides effects than synthetic.
For short period of treatment usually synthetic drug are more preferred.	Longer period of treatments may be required while using herbal drugs.
Synthetic drug generally act on symptoms caused by specific disease.	Herbal or ayurvedic preparations having high patient compliance.
In emergency and chronic condition synthetic drug are more preferred medicines	Herbal medications generally act direct towards aiding the body's own healing process.

Analytical aspect of novel herbal formulation [9,10]

Visualization-

- The size and shape of phytosomes and visual appearance are done by different microscopic techniques like scanning electron microscopy and transmission electron microscopy.
- Various factors affect and alter the size and shape of phytosomes like the shape and size of phytosomes can be affected by lipid purity grade.

Zeta potential and particle size-

- In phytosomes size and size, distribution is an important variable as they directly affect in absorption, bioavailability, and stability of the drug.
- The zeta potential is determined by using laser doppler velocimetry whereas zeta potential and particle analysis can be determined by various methods but the most commonly used method is by photon correlation spectroscopy and dynamic light scattering.

Entrapment efficiency-

- The drug entrapment efficiency of phytosomal preparation is measured by the ultracentrifugation technique.
- The drug phytosomal complex is centrifuged and the phytosomes are separated from non-entrapped drugs and the drug concentration is usually quantified by ultraviolet spectroscopy.
- Entrapment efficiency (%) is calculated by using the formula.

Transition Temperature-

- The differential scanning calorimetry thermal analysis apparatus is used to measures the temperature variation of physical properties of a sample against time and this method is used to determine transition temperature.

Surface tension activity measurement-

- The surface tension is measured using the ring method Du Nouy ring tensiometer

Vesicle stability-

- Vesicle stability is determined by molecular size, polydispersity index (PDI) and zeta potential describe the vesicle stability.
- PDI value of phytosomes is determined and phytosomes with a PDI value of less than 0.5 are stable, while those with a zeta potential greater than 30 mV are considered stable complexes.

In vitro drug release study by suitable dissolution apparatus -

- In vitro drug release study using USP XXII type 2 dissolution apparatus set the temperature at 37.5°C with a rotation speed of 100 rpm. And the pipette out samples at specific time intervals and pour the same amount of fresh dissolution medium, analyze the sample at the appropriate wavelength of the drug sample using UV spectrophotometry.

Excipient comparability study -

- Isothermal stress testing method is used to assess the compatibility of drug-drug/drug-excipient.

Spectroscopic evaluations-

- To confirm the formation of a complex or to study the reciprocal interaction between the phytoconstituent and the phospholipids, the following spectroscopic methods are used.

Applications of novel herbal drug delivery system [11,12]

Application of novel herbal drug delivery system in Diabetes mellitus-

- Due to the challenges of pharmacological therapy faced and the superiorities of nanoparticles (NPs) in drug delivery and researches have put increasing interest in nano carriers in the treatment and management of diabetes mellitus.
- The composition of systems for drug delivery mainly includes liposome, polymer-based NPs, and inorganic NPs.
- Among them, diverse polymer-based NPs including nanospheres, nanocapsules, micelles, and dendrimers are developed as suitable drug carriers. contains several types of nano carriers used for loading insulin and other antidiabetic drugs and summarizes their reported effects in vivo.

- These nano carriers have been found to be potentially beneficial in many aspects, such as protecting drugs from enzymatic degradation, improving their stability, overcoming different biological barriers in vivo, and increasing bioavailability.
- Moreover, they have great performance in more precisely delivering drugs to the targeted sites and sustaining and controlled release of drugs within targeted sites over a long period, which could minimize the undesirable side-effects.
- Therefore, it is quite necessary and significant to develop appropriate NP delivery systems for effective diabetes treatment.

Application of novel herbal drug delivery system in Hepatoprotective -

- Silymarin is a polyphenolic flavonoid isolated from seeds of the milk thistle Silybum marianum (Family Asteraceae).
- It has been used to treat liver and gallbladder disorders, including hepatitis, cirrhosis, and jaundice, and to protect the liver against poisoning from chemical and environmental toxins, including snake bites, insect stings, Amanita phalloides mushroom poisoning, and alcohol.
- Silymarin has also been reported to provide liver protection against CCl4 and paracetamol-induced liver damage in rat models. Silymarin's effects are accomplished via several mechanisms.
- It prevents lipid peroxidation, protects the cell membrane from radical-induced damage, blocks the uptake of toxins such as Amanita phalloides toxin and stimulates ribosomal RNA polymerase thereby increases protein synthesis.
- Other mechanisms include antiinflammation, antifibrosis and anticarcinogenesis. These approaches include complexation of silymarin with phosphatidylcholine (Siliphos), complexation with cyclodextrins, complexation with phospholipids, provision of silymarin in the form of salts of polyhydroxyphenyl chromanones and othermore.

Application of novel herbal drug delivery system in Antioxidant-

- The application of inorganic chemistry to medicine is a rapidly developing field, Novel therapeutics and diagnostic metal complexes are now having an impact on medical practice.
- Advances in bio-coordination chemistry are crucial for improving the design of compounds to reduce toxic side effects and understand their mechanisms of action. The clinical success of cisplatin and other platinum complexes is limited by significant side effects acquired or intrinsic resistance.
- Strategies for developing new anticancer agents include the incorporation of carrier groups that can target tumor cells with high specificity.
- Also of interest is to develop complexes that bind to DNA in a fundamentally different manner than cisplatin, in an attempt to overcome the resistance pathway that has evolved to eliminate the drug. This review focuses on recent advancement in developing lanthanide coordination complexes.

Application of novel herbal drug delivery system in Coronary Artery Disease-

- Treatments for coronary artery disease have taken very different approaches that focus on models attacking atherosclerosis and restenosis, and gene therapy.
- Atherosclerosis models combine extended-release niacin formulations with statins.

- The emphasis on extended-release niacin is to decrease flushing, while the statin component is usually simvastatin, available as a generic, put into a combination drug to allow for branded patent extension.

Application of novel herbal drug delivery system in Angina-

- Drug therapy models to treat angina have not been productive with regard to producing new therapies.
- Angina is caused by the imbalance of oxygen supply versus demand to the myocardium, leading to myocardial hypoxemia.
- Supply-side models directed toward treating coronary artery vasospasm, fixed stenotic lesions or thrombus have been addressed over the past decade with anticoagulants and antithrombotic that are now generally mature, with few new options.

Targeted Herbal drug delivery system

Importance and Approaches in targeted herbal drug delivery systems specifically for cancer treatment. [13]

Immunotherapy-

- The cancer-fighting ability of the immune system is enhanced by immunotherapy. This is often referred to as biological therapy since it activates the body's natural defences against sickness to combat malignancy.
- Numerous studies have been done on the use of monoclonal antibodies, which teach the defence mechanism to recognise and cause the death of cancer cells and to treat cancer.
- These antibodies disrupt a specific protein's activity by attaching to cancer cells. This therapy approach is secure.

Targeted therapy -

- Due to their superior effectiveness and safety compared to conventional chemotherapy drugs, targeted therapeutic drugs have gained popularity as cancer treatments.
- Since the US Food and Drug Administration (FDA) approved the first tyrosine kinase inhibitor, imatinib, for sale in 2001, an increasing number of small-molecule targeted drugs for cancer treatment have been developed.
- Targeted medications can roughly be divided into two groups: macromolecules and small molecules (e.g, monoclonal antibodies, polypeptides, antibody–drug conjugates, and nucleic acids).

Nanocarrier-

- In cancer therapy, nanotechnology-based treatments are widely utilised to improve drug solubility, stability, and multidrug resistance as well as to increase the safety and effectiveness of cancer treatment. Exosomes, polymersomes, dendrimers.

Liposomes-

- A centre aqueous area is encircled by an outer lipid bilayer in liposomes, which are self-assembled, closed colloidal entities made of lipid layers.
- By applying various techniques, these lipid-based systems are now useful for the operation of a variety of cancer treatments.
- The use of Immunoliposomes, which have enhanced drug delivery selectivity, is a prospect for liposomes.

Phytosomes-

- The plant extracts complexed with phosphatidylcholine that forms a new drug delivery system known as phytosome, which showed better phytopharmacological profiles of many plant medicines.
- The phytosome showed promising bioavailability of various phytomedicine present in milk thistle, grape seed, green tea, olive, and turmeric.

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