NOVEL DRUG DELIVERY SYSTEM IN HERBAL’S

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ABSTRACT

Novel drug delivery system is a novel approach to drug delivery that addresses the limitations of the traditional drug delivery systems. Our country has a vast knowledge base of Ayurveda whose potential is only being realized in the recent years. If the novel drug delivery technology is applied in herbal medicine, it may help in increasing the efficacy and reducing the side effects of various herbal compounds and herbs. Development as novel formulations owing to lack of scientific justification and processing difficulties, such as standardization, extraction and identification of individual drug components in complex polyhedral systems. Determination of pharmacokinetics, mechanism of action, site of action, accurate dose required etc.) Of herbal medicines to be incorporated in novel drug delivery system, such as nanoparticles, microemulsions, matrix systems, solid dispersions, liposome, solid lipid nanoparticles and so on. The method by which a drug is delivered can have a significant effect on its efficacy. Some drugs have an optimum concentration range within which maximum benefit is derived, and concentrations above or below this range can be toxic or produce no therapeutic benefit at all. Many herbal compounds including quercetin, genistein, naringin, sinomenine, piperine, glycyrrhizin and nitrile glycoside have demonstrated capability to enhance the bioavailability.

1. INTRODUCTION

To minimize drug degradation and loss, to prevent harmful side effects and to increase drug bioavailability and the fraction of the drug accumulated¹.

1.1 Novel drug delivery system

The method by which a drug is delivered can have a significant effect on its efficacy. Some drugs have an optimum concentration range within which maximum benefit is derived, and concentrations above or below this range can be toxic or produce no therapeutic benefit at all. From this, new ideas on controlling the pharmacokinetics, pharmacodynamics, non-specific toxicity, immunogenicity, biorecognition, and efficacy of drugs were generated².

A novel drug delivery system is a system that offers multiple drug delivery solutions such as

5. Transdermal and Topical Drug Delivery.
7. Drug Delivery Pipelines.
8. Drug Delivery Deals.

Fig. 1.1: Pharmaceutical carriers
Novel drug delivery system is a novel approach to drug delivery that addresses the limitations of the traditional drug delivery systems. Modern medicine cures a particular disease by targeting exactly the affected zone inside a patient's body and transporting the drug to that area. Determination of pharmacokinetics, mechanism of action, site of action, accurate dose required etc.

1.2 Types of novel drug delivery systems
1. Sublingual that is, a drop under the tongue.
2. Self adhesive patch on skin.
3. Pump e.g. Insulin pump.
4. Special pervious plastic injected below skin e.g. Norplant.

1.3 Recent developments
In the recent years, nanostructured carrier system like polymeric nanoparticles, liposomes, SLNs, polymeric micelles, nanoemulsions, etc., have been investigated for their potential to deliver anticancer drugs by oral route. Moreover, the oral route offers great potential for delivery of cytotoxic agents and therefore the attention has focused on the development of oral chemotherapy in oncology.

1.4 recent developments in novel drug delivery system of herbals
1.4.1 Phytosome
1.4.2 Liposome
1.4.3 Nanoparticles
1.4.4 Emulsions
1.4.5 Microsphere
1.4.6 Ethosome
1.4.7 Solid lipid nanoparticles
1.4.8 Controlled Drug Delivery System
1.4.9 Other novel vesicular herbal formulations
1.4.10 Proprietary novel drug delivery system of plant actives and extracts
1.4.11 Niosomes
1.4.12 Proniosomes
1.4.13 Transdermal Drug Delivery System
1.4.14 Dendrimers
1.4.15 Liquid Crystals
1.4.16 Hydrogels

1.4.1 phytosome
Phospholipids-based drug delivery system has been found promising for valuable and efficient herbal drug delivery. Complexing the polyphenolic phytoconstituents in the molar ratio with phosphatidyl choline results in a new herbal drug delivery system, known as “Phytosome.” Most of the phytosomal studies are focused on Silybum marianum, which contains premier liver-protectant flavonoids. The fruit of the milk thistle plant (S. marianum, family: Asteraceae) contains flavonoids known for their hepatoprotective effects.

![Fig. 1.2: Difference between liposome and phytosome](image-url)

**Advantages of phytosome formulation**
1. Phytosome increases the absorption of active constituents, so its dose size required is small.
2. There is appreciable drug entrapment and improvement in the solubility of bile to herbal constituents, and it can target the liver.
3. In Phytosome, chemical bonds are formed between phosphatidylcholine molecules, so it shows good stability.
4. Phytosome improves the percutaneous absorption of herbal phytoconstituents.

1.4.2 liposome
Liposome is concentric bi-layered vesicles in which aqueous volume is entirely enclosed by a membranous lipid bi-layer mainly composed of natural or synthetic phospholipids. The liposome is spherical particles that encapsulate the solvents which are freely floating in the interior. The liposomes are spherical particles that encapsulate a fraction of the solvent, in which they freely diffuse (float) into their interior.
1.4.3 Nanoparticles
Nanoparticles are nano- or sub-nano-sized structures composed of synthetic or semi-synthetic polymers. They are colloidal systems with particles varying in size from 10 nm to 1000 nm. It is an effective system as the formulation is encapsulated in it easily and can easily reach the effective site. Microencapsulation of herbal extract in nanoparticulate is an effective way used to protect drug or food ingredients against deterioration, volatile losses, or premature interaction with other ingredients.

Advantages of herbal nanoparticle delivery system
1. Nanoparticulate system delivers the herbal formulation directly to the site of action.
2. Increased efficacy and therapeutic index.
3. Increased stability via encapsulation.
4. Improved pharmacokinetic effect.
5. Producible with various sizes, compound surface properties.

Disadvantages
1. Include their tendency to be taken up by cells of retico-endothelial system and the slow release of the drug when the liposomes are taken up by phagocytes.

Advantages of liposomes
1. The high biocompatibility.
2. The easiness of preparation.
3. The chemical versatility that allows the loading of hydrophilic, amphiphilic, and lipophilic compounds.
4. The simple modulation of their pharmacokinetic properties by changing the chemical composition of the bilayer components.

1. Fig. 1.3: Cross-section of a liposome
2. Fig. 1.4: The liposome structure
3. Fig. 1.5: Drug encapsulation in liposomes
4. Fig. 1.6: Nanoemulsion
5. Fig. 1.7: Biopolymeric nanoparticle
through endocytosis, fusion, surface adsorption or lipid exchange.

2. Stabilizing the formulated liposomes is also difficult, but many approaches are now used for their stabilization.

1.4.4 Emulsions

Emulsion is a biphasic system in which one phase is intimately dispersed in the other phase in the form of minute droplets ranging in diameter from 0.1 μm to 100 μm. In emulsion, one phase is always water or aqueous phase, and the other phase is oily liquid, i.e., non-aqueous. Among them, the micro-emulsion is also called nanoemulsion, and the sub-micro-emulsion is called lipid emulsion. Micro-emulsion (ME) is a clear, thermodynamically stable, isotropic mixture of oil, water and surfactant, frequently in combination with a co-surfactant.

Advantages of emulsion-based formulations

1. It can release the drug for a long time because it is packed in the inner phase and makes direct contact with the body and other tissues.
2. As a result of the lipophilic drugs being made into o/w/o emulsion, the droplets of oil are phagocytosised by macrophages and increase its concentration in liver, spleen and kidney.

1.4.5 Microsphere

Microsphere comprises of small spherical particles, with diameters in the micrometer range, typically 1 μm to 1000 μm (1 mm). Glass microspheres, polymer microspheres and ceramic microspheres are commercially available. Microspheres are classified as biodegradable or non-biodegradable. Biodegradable microspheres include albumin microspheres, modified starch Microspheres, gelatin microspheres, polypropylene dextran microspheres, polyactic acid microspheres, etc.

Advantages of microsphere formulations

1. Administration of medication via microparticulate system is advantageous because microspheres can be ingested or injected, and they can be tailored for desired release profiles and used for site-specific delivery of drugs and in some cases can even provide organ-targeted release.
2. Drug can be easily released from the formulation.

1.4.6 Ethosomes

Ethosomes are phospholipids-based elastic nano-vesicles having high content of ethanol (20%-45%). Ethosomes were developed as novel lipid carriers composed of ethanol, phospholipids and water and to improve the delivery of various drugs to the skin. It enables drugs to reach the deep skin layers and/or systemic circulation.

Advantages of ethosomal drug delivery

1. Ethosomes enhance transdermal permeation of drug through skin.
2. Ethosomes are a platform for the delivery of large amounts of diverse groups of drugs.

1.4.7 Solid lipid nanoparticle

It is a technique developed in the 1990s. It is a colloidal carrier used especially for the delivery of lipophilic compounds. The average mean size of solid lipid nanoparticles ranges from 50 nm to 1000 nm. Solid lipid nanoparticles are composed of lipid matrix, which becomes solid at room temperature and at the body temperature.

Advantages of snl herbal formulation

1. It provides controlled release and site-specific drug targeting.
2. Large-scale production can be done.
3. In this formulation, both lipophilic and hydrophilic drugs can be loaded.

1.4.8 Controlled drug delivery system

Herbal gastrointestinal controlled drug delivery dosage forms including pellets and process for their preparation described is novel oral dosage form for administration of an herbal extract and Process for preparing the same, wherein a herbal extract is coated on pellets and the said pellets are either filled into a capsule or compressed into a tablet.

1.4.9 Other novel vesicular herbal formulations

Transferosomes are applied in a non-occluded method to the skin, which permeate through the stratum cornea lipid lamellar regions because of the hydration or osmotic force in the skin. It can be applicable as drug carriers for a range of small molecules, peptides, proteins and herbal ingredients which shows the better topical absorption in comparison to pure capsaicin.

Ethosome, as a novel liposome, is especially suitable as a topical or transdermal administration carrier.
1.4.10 proprietary novel drug delivery system of plant actives and extracts
Cosmetochem International AG is a Swiss-based company, specialized in the production of high quality, customized botanical extracts and actives, launch botanical, standardized, liposomal powders named Liposome Herbasec a novel range of standardized botanical extracts in a liposomal-based powder form19.

1.4.11 Niosomes
Niosomes are multilamellar vesicles formed from non-ionic surfactants of the alkyl or dialkyl polyglycerol ether class and cholesterol. Earlier studies, in association with L’Oreal have shown that, in general, niosomes have properties as potential drug carriers similar to liposomes. Niosomes are different from liposomes in that they offer certain advantages over liposomes11.

1.4.12 Proniosomes
Proniosome gel system is step forward to niosome, which can be utilized for various applications in delivery of actives at desired site. Proniosomal gels are the formulations, which on in situ hydration with water from the skin are converted into niosomes13.

1.4.13 Transdermal drug delivery system
Transdermal drug delivery system has been an increased interest in the drug administration via the skin for both local therapeutic effects on diseased skin (topical delivery) as well as for systemic delivery of drugs. But immense potential lies in transdermal drug as future smart drug delivery devices18.

1.4.14 Dendrimers
Dendrimers are nanometer-sized, highly branched and monodisperse macromolecules with symmetrical architecture while their stability and protection from the Mononuclear Phagocyte System (MPS) is being achieved by functionalization of the dendrimers with polyethylene glycol chains (PEG)6.

1.4.15 Liquid crystals
Liquid Crystals combine the properties of both liquid and solid states. They can be made to form different geometries, with alternative polar and non-polar layers (i.e., a lamellar phase) where aqueous drug solutions can be included19.

1.4.16 Hydrogels
Hydrogels are three-dimensional, hydrophilic, polymeric networks capable of imbibing large amounts of water or biological fluids. They are used to regulate drug release in reservoir-based, controlled release systems or as carriers in swellable and swelling-controlled release devices2.

Fig. 1.8: Pegylated and pH sensitive micro- or nanogels

1.5 Advantage of novel drug delivery system3
1. Protection from physical and chemical degradation.
2. Sustained delivery.
3. Improved tissue macrophages distribution.
5. Enhancement of pharmacological activity.
6. Protection from toxicity.
7. Increased bioavailability.

1.6 advantage of herbal drug3
2. Lack of regulation.
3. Poison risk associated with wild herbs
4. Lack of dosage instruction.
5. Not suitable for many disease.
7. Widespread availability.
8. Lower cost.
10. Low risk of side effect.

2. HERBS USED AS NOVEL DRUG DELIVERY SYSTEM
2.1 herbal drugs
Herbal formulation a dosage form consisting of one or more herbs or processed herb in specified quantities to provide specific nutritional, cosmetic benefits, and other benefits meant for use to diagnose treat or to alter the structure or physiology of human beings or animals. Herbal preparations are obtained by subjecting whole plants, fragmented or cut plants, plants part to treatment such as extraction, distillation, expression fractionation, purification, concentration or fermentation. This
includes comminuted or powdered herbal substances, extracts. Essential oils, expressed juices etc. Many herbal drugs and herbal extracts despite of their extraordinary potential in vitro finding, demonstrate less or no in vivo actions due to their poor lipid solubility or improper molecular size or both, ultimately resulting in poor absorption and poor bioavailability. Phytochemical and phytopharmacological studies have long been established overall health boosting capacities of various plant products but there is a great interest and medical need for the improvement of bioavailability of a large number of herbal drug and plant extract which are poorly lipid soluble and so are less bioavailable.

2.2 Herbal novel drug delivery systems
As herbal novel drug delivery systems have lot of potential, several researchers are working towards developing novel drug delivery systems like mouth dissolving tablets, sustained and extended release formulations, mucoadhesive systems, transdermal dosage forms, microparticles, microcapsules, nanoparticles, implants etc. of herbs. Some of them are at the laboratory stage and some have reached to the marked.

2.3 There are three main reasons for the popularity of herbal media
1. There is a growing concern over the reliance and safety of drugs.
2. Modern medicine is failing to effectively treat many of the most common health conditions.
3. Many natural measures are being shown to produce better results than drugs or surgery without the side effects.

Herbal medicines have been widely used all over the world since ancient times and have been recognized by physicians and patients for their better therapeutic value as they have fewer adverse effects as compared with modern medicines. Phytotherapeutics need a scientific approach to deliver the components in a sustained manner to increase patient compliance and avoid repeated administration. This can be achieved by designing novel drug delivery systems (NDDS) for herbal constituents. NDDSs not only reduce the repeated administration to overcome non-compliance, but also help to increase the therapeutic value by reducing toxicity and increasing the bioavailability. Hence, integration of the nanocarriers as a NDDS in the Traditional medicine system is essential to combat more serious diseases. For a long time herbal medicines were not considered for development as novel formulations owing to lack of scientific justification and processing difficulties, such as standardization, extraction and identification of individual drug components in complex polyherbal systems.

2.4 Need for novel drug delivery system “nanocarrier” for “herbal remedies”
Herbal remedies were selected as feasible drug candidate for delivery through a nano delivery system because of the following properties:

1. Effective chloroform, petrol, acetone, and methanolic extracts are available which may not be suitable for delivery as such.
2. These are the bulk drugs so dose reduction is intended.
3. Currently marketed formulations lack target specificity for various chronic diseases.
4. Some other side effects are associated with currently marketed formulations.
5. Patient non-compliance due to large doses and less effectiveness with the available formulations.

2.5 Importance of novel drug delivery systems in herbal medicines
Novel drug delivery system is a novel approach to drug delivery that addresses the limitations of the traditional drug delivery systems. Our country has a vast knowledge base of Ayurveda whose potential is only being realized in the recent years. However, the drug delivery system used for administering the herbal medicine to the patient is traditional and out of date, resulting in reduced efficacy of the drug. If the novel drug delivery technology is applied in herbal medicine, it may help in increasing the efficacy and reducing the side effects of various herbal compounds and herbs. This is the basic idea behind incorporating novel method of drug delivery in herbal medicines. Thus it is important to integrate novel drug delivery system and Indian Ayurvedic medicines to combat more serious diseases. For a long time herbal medicines were not considered for development as novel formulations owing to lack of scientific justification and processing difficulties, such as standardization, extraction and identification of individual drug components in complex polyherbal systems. However, modern phytopharmaceutical research can solve the scientific needs (such as determination of Pharmacokinetics, mechanism of action, site of action, accurate dose required etc.) of herbal medicines to be incorporated in novel drug delivery system, such as nanoparticles, microemulsions, matrix systems, solid dispersions, liposomes, solid lipid nanoparticles and so on.
2.6 herbal plants

2.6.1 Rauwolfia beddomei
The instrumental in manufacturing and supplying a wide range of Herbal Extracts to our esteemed customers. We offer our range of herbal extracts is either in liquid or dry powder form. These extracts are highly acclaimed across the globe for their customized extraction as per the specifications provided by our clients.

2.6.2 Holarrhena antidysenterica
The rich industry experience, we have an expertise in offering a wide range of Holarrhena Antidysenterica Herbs. These herbs are the best cure for nervous disorders, throat infections, cough, bronchitis, tuberculosis, and dyspepsia, scalding of urine, general debility and tumors. Clients can avail these herbs at affordable prices.

2.6.3 Aloe vera
Biological Source
Dried juice of leaves of Aloe vera, Aloe barbadensis, and Aloe ferox.

Family
Liliaceae

Chemical Constituents
Amino acids, anthraquinones, enzymes, hormones, lignin, minerals, aloe emodin.

Importance
Aloe will bring cooling relief to fleabites, reducing itching and scratching and is safe to use on dogs and cats. It also has immune-stimulating and anti-inflammatory compounds. Acemannan, a chemical compound found in Aloe Vera as a powerful immunostimulant in animals, particularly in cats.

Medicinal Uses
Acne, Ayurvedic, Beauty, Burns, Constipation, Cuts, Wounds, Facial Care, Analgesic, Anti-inflammatory, Antibacterial, Antifungal.

2.6.4 Nettle
Biological Source
Urtica dioica

Family
Urticaceae

Chemical Constituents
formic acid, mucilage, ammonia, carbonic acid, water.

Importances
Nettle is one of nature’s best nutraceuticals, containing protein, calcium, phosphorus, iron, magnesium, beta-carotene, along with vitamins A, C, D, and B complex, all in a form that is easy for the body to use. Extracts of nettle roots are reliable diuretics that encourage excretion of uric acid, but simultaneously discourage nighttime bathroom urges, making this remarkable plant useful for such disparate problems as gout, and the overnight incontinence of benign prostate enlargement and weak and irritated bladder. Frequent use of nettle leaf tea, a cup or more daily, rapidly relieves and helps prevent water retention. Nettle is a superb nourisher of the kidneys and adrenals.

Medicinal Uses
Analgesic, Anodyne, AntiCancer, Astringent, Depurative, Diuretic, Tonic.

2.6.5 Indian senna
Biological Source
Dried leaflets of Cassia angustifolia.

Family
Leguminosae.

Chemical Constituents
Sennosides A and B (not less than 2.5%).

Importance
Indian Senna or Tinnevelly senna is a shrub very highly esteemed in India for its medicinal value. The leaves are useful in constipation, abdominal disorders, leprosy, and skin Diseases, leucoderma, splenomegaly, hepatopathy, jaundice, helminthiasis, dyspepsia, cough, Bronchitis, typhoid fever, anaemia, tumours and vitiated conditions of pitta and vata. It is used in Ayurvedic preparations; “Pancha Sakara Churna”, “Shat Sakara Churna” and “Madhu Yastyadi Churna” used for constipation. Its use is widespread in Unani system and some of the important products of this system containing senna are “Itrifal Mulayyin”, “Jawarish Ood Mulayyin”, “Hab Shabyar”, “Sufuf Mulliyin”, “Sharbat Shahi”, etc. used as a mild laxative.

Medicinal Uses
purgative, irritate and stimulate the colon, therapeutic action.

2.6.6 Brahmi
Biological Source
It is the herb of Centella asiatica.
Family
Umbelliferae

Chemical Constituents
Amycin, Asiatic acid, madecassic acid, isobrahmic acid, arabinose, glucose, rhamnose.

Importance
Brahmi or Thyme leaved gratiola is an important drug in Ayurveda for the Improvement of intelligence and memory and revitalisation of sense organs. It clears voice And improves digestion. It is suggested against dermatosis, anaemia, diabetes, cough, dropsy, Fever, arthritis, anorexia, dyspepsia, emaciation, and insanity. It dispels poisonous affections, splenic disorders and impurity of blood. It is useful in vitiated conditions of kapha and vata, Biliousness, neuralgia, ascites, flatulence, leprosy, leucoderma, syphilis, sterility and general Debility. The whole plant is used in a variety of preparations like Brahmihtailam, Misrakasneham, etc. In unani Majun Brahmi is considered As a brain tonic.

Medicinal Uses
Nervine tonic, sedative, spasmolytic.

2.6.7 Liquorice

Biological Source
Dried, peeled, unpeeled, root and stolon of Glycyrrhiza glabra.

Family
Leguminosae.

Chemical Constituents: Triterpenoids saponin, glycyrrhizinic acid, potassium, calcium salt, glycyrrhetic acid glucose(4%), sucrose(2.5 to 6.5%).

Importance
Liquorice or Muleti is a perennial herb or shrub about 1m high. Its dried peeled or unpeeled underground stems and roots constitute the drug which is an important constituent of all cough and catarrh syrups, throat lozenges and pastilles. This has been used in medicine for more than 4000 years. Hippocrates (400 BC) mentioned its use as a remedy for ulcers and quenching of thirst. Dioscorides, the father of Greek medicine described this drug in detail and considered it useful for maintaining shape of arteries and in burning stomach, trouble of liver and kidney, scabies, healing of wounds and as a remedy for eye diseases. It has been used in Arab system of medicine for more than 600 years from where it has been adopted to Modern medicine.

Medicinal Uses
Expectorant, demulcent, cough mixture, peptic ulcer, anti-inflammatory, anti-spasmodic.

2.6.8 Indian ginseng

Biological Source
Dried root of panax ginseng.

Family
Araliaceae

Chemical Constituents
Ginsenosides, panaxosides, chikusetsusaponin.

Importance
Indian ginseng or Winter cherry is an erect branching perennial undershrub which is considered to be one of the best rejuvenating agents in Ayurveda. Its roots, leaves and seeds are used in Ayurvedic and Unani medicines, to combat diseases ranging from tuberculosis to arthritis. The pharmacological activity of the plant is attributed to the presence of several alkaloids and withaniols. Roots are prescribed in medicines for hiccups, several female disorders, bronchitis, rheumatism, dropsy, stomach and lung inflammations and skin diseases. Its roots and paste of green leaves are used to relieve joint pains and inflammation. It is also an ingredient of medicaments prescribed for curing disability and sexual weakness in male. Leaves are used in eye diseases. Seeds are diuretic. It is a constituent of the herbal drug ‘Lactare’ which is a galactagogue.

Medicinal Uses
Immunomodulatory, aphrodisiac, stimulant, sedative, adrenal & thyroid dysfunctioning.

2.6.9 Shatavari

Biological Source
Dried root and leaves Asparagus racemosus.

Family
Liliaceae

Chemical Constituents
Shatavaril-4(0.2%), shatavari1 contain3glucose & rhamnose, shatavari4 contain2glucose & one rhamnose. Asparagus roots contain protein 22%, fat 6.2%, Carbohydrate 3.2%, Vitamin B 0.36%, Vitamin C 0.04% and traces of Vitamin A.

Importance
Asparagus is a climbing undershrub with widespread applications as diuretic, cooling agent and an excellent safe herbal medicine for ante-natal care. It is useful in nervous disorders,
dyspepsia, diarrhoea, tumours, inflammations, vitiated conditions of vata and pitta, burning sensation, hyperdipsia, ophthalmopathy, nephropathy, hepatopathy, stranguary, Scalding of urine, throat infections, tuberculosis, cough, bronchitis, gleet, gonorrhoea, leucorrhoea, leprosy, epilepsy, fatigue, hyperacidity, colic haemorrhoids, hypertension, abortion, agalactia, cardiac and general debility (Warrier et al., 1993). Shatavari is described in Rigveda and Atharvaveda. In Ayurvedic classics it is prescribed as a cooling agent and uterine tonic.

**Medicinal Uses**
Galactogogue, tonic, diuretic, antioxytocic, rheumatism and nerve disorders.

**3. FORMULATION / DOSAGE FORMS AVAILABLE AS NOVEL DRUG DELIVERY SYSTEM IN HERBALS**

**3.1 Novel drug delivery system based herbal formulations**
Herbal drugs are becoming more popular in the modern world for their application to cure variety of diseases with less toxic effects and better therapeutic effects. In phytoformulation research, developing nano dosage forms (polymeric nanoparticles and nanocapsules, liposomes, solid lipid nanoparticles, phytosomes and nanoemulsion etc.)(2) have a number of advantages for herbal drugs, including enhancement of solubility and bioavailability, protection from toxicity, enhancement of pharmacological activity, improvement of tissue macrophages distribution, sustained delivery, protection from physical and chemical degradation etc. Thus the nano sized novel drug delivery systems of herbal drugs have a potential future for enhancing the activity and overcoming problems associated with plant medicines. Herbal preparations are obtained by subjecting whole plants, fragmented or cut plants, plants part to treatment such as extraction, distillation, expression, fractionation, purification, concentration or fermentation. This include comminuted or powdered herbal substances, extract, essential oils, expressed juices etc.

**3.2 Techniques in formulation**
The techniques commonly used for the formulation are

**3.2.1 High-pressure homogenization method**
In this method, the lipid is pushed with high pressure (100 to 2000 bar) through a very high shear stress, which results in disruption of particles down to the submicrometer or nanometer range. High-pressure homogenization method is a very reliable and powerful technique for the large-scale production of nanostructured lipid carriers, lipid drug conjugate, SLNs, and parenteral emulsions.

**3.2.2 Complex coacervation method**
This is a spontaneous phase separation process of two liquid phases in colloidal systems, which results by the interaction of two oppositely charged polyelectrolyte’s upon mixing in an aqueous solution.

**3.2.3 Co-Precipitation method**
This method is a modification of the complex coacervation method for the preparation of nanoscale core-shell particles. This method has been reported to provide good dispersion stability to poorly water-soluble drugs.

**3.2.4 Salting-out method**
This method is based on the phenomenon that the solubility of a non-electrolyte in water is decreased upon addition of an electrolyte.

**3.2.5 Nanoprecipitation method or solvent displacement method**
This method is based on interfacial deposition of a polymer after displacement of a semipolar solvent miscible with water from a lipophilic solution, thereby resulting in a decrease in the interfacial tension between the two phases, which increases the surface area with a subsequent formation of small droplets of organic solvent even without any mechanical stirring.

**3.2.6 Solvent emulsification–diffusion method**
The method involves preparation of an o/w emulsion using oil phase containing polymer and oil in an organic solvent, which is emulsified with the aqueous phase, containing stabilizer, in high shear mixer, followed by addition of water to induce the diffusion of organic solvent, thus resulting in formation of nanoparticles.

**3.2.7 Supercritical fluid methods**
This method can be used to prepare submicrometer-sized and nano-sized formulations. A supercritical fluid (SCFs) can either be a liquid or gas and used above its thermodynamic critical point of temperature and pressure. The most commonly used SCFs are carbon dioxide and water.
3.2.8 Self-assembly methods
Self-assembly is the physical process wherein pre-existing disordered components, atoms, or molecules organize themselves.

3.3 Formulation of NDDS in herbas

Table 3.3.1: Phytosomal herbal formulations

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Active ingredients</th>
<th>Applications of Phytosomal formulations</th>
<th>Biological activity</th>
<th>Method of preparation</th>
<th>Dose</th>
<th>Route of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ginkgo biloba phytosomes</td>
<td>Flavonoids</td>
<td>Flavonoids of GBP stabilize the ROS</td>
<td>Cardioprotective, antioxidant activity</td>
<td>Phospholipid complexation</td>
<td>100 mg</td>
<td>Subcutaneous</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200 mg/kg</td>
<td>Subcutaneous</td>
</tr>
<tr>
<td>Silybin phytosome</td>
<td>Flavonoids</td>
<td>Absorption of silybin phytosome from silybin is approximately seven times greater</td>
<td>Hepatoprotective, antioxidant for liver and skin</td>
<td>Silybin-phospholipid complexation</td>
<td>120 mg</td>
<td>Oral</td>
</tr>
<tr>
<td>Ginseng phytosome</td>
<td>Ginsenosides</td>
<td>Increase absorption</td>
<td>Nutraceutical, immunomodulating</td>
<td>Phospholipid complexation</td>
<td>150 mg</td>
<td>Oral</td>
</tr>
<tr>
<td>Curcumin phytosomes</td>
<td>Curcumin</td>
<td>Increase bioavailability</td>
<td>Antioxidant, anticaner</td>
<td>Curcumin–phospholipid complexation</td>
<td>360 mg/kg</td>
<td>Oral</td>
</tr>
<tr>
<td>Grapeseed lipid based systems</td>
<td>Epigallocatechin</td>
<td>Increases absorption</td>
<td>Systemic antioxidant</td>
<td>Phospholipid complexation</td>
<td>50-100 mg</td>
<td>Oral</td>
</tr>
<tr>
<td>Hawthorn lipid based systems</td>
<td>Procynidins</td>
<td>The blood TRAPn significantly elevated</td>
<td>Cardio-protective and anti-hypertensive</td>
<td>Phospholipid complexation</td>
<td>100 mg</td>
<td>Oral</td>
</tr>
<tr>
<td>Ybin Phytosome</td>
<td>Flavonoids</td>
<td>Absorption of silybin phytosome from silybin is approximately seven times greater</td>
<td>Hepatoprotective, antioxidant for liver and skin</td>
<td>Silybin-phospholipid complexation</td>
<td>-</td>
<td>Oral</td>
</tr>
<tr>
<td>Quercetin Phytosome</td>
<td>Quercetin</td>
<td>Exerted better therapeutic efficacy</td>
<td>Antioxidant, Anticaner</td>
<td>Quercetin–phospholipid complexation</td>
<td>Oral</td>
<td>-</td>
</tr>
<tr>
<td>Naringenin Phytosomes</td>
<td>Naringenin</td>
<td>Prolonged duration of action</td>
<td>Antioxidant Activity</td>
<td>Naringenin–phospholipid complex</td>
<td>Oral</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 3.3.2: Liposomal herbal formulation

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Active ingredients</th>
<th>Applications of Liposome formulations</th>
<th>Biological activity</th>
<th>Method of preparation</th>
<th>% Entrapment efficiency</th>
<th>Route of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liposomes encapsulated silymarin</td>
<td>Silymarin</td>
<td>Improve bioavailability</td>
<td>Hepatoprotective</td>
<td>Reverse evaporation technique</td>
<td>69.22 ± 0.6%</td>
<td>Buccal</td>
</tr>
<tr>
<td>Ampelopsin liposome</td>
<td>Ampelopsin</td>
<td>Increase efficiency</td>
<td>Anticancer</td>
<td>Film-ultrasound method</td>
<td>62.30%</td>
<td>In vitro</td>
</tr>
<tr>
<td>Curcumin liposome</td>
<td>Curcumin</td>
<td>Long-circulating with high entrapment efficiency</td>
<td>Anticancer</td>
<td>Ethanol injection method</td>
<td>88.27 ±2.16%</td>
<td>In vitro</td>
</tr>
<tr>
<td>Garlicin liposome</td>
<td>Garlicin</td>
<td>Increase efficiency</td>
<td>Lungs</td>
<td>Reverse-phase evaporation method</td>
<td>90.77 %</td>
<td>-</td>
</tr>
</tbody>
</table>
**Table 3.3.3: Nano structured herbal formulations**

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Active ingredients</th>
<th>Applications of nanostructured formulations</th>
<th>Biological activity</th>
<th>Method of preparation</th>
<th>% Entrapment efficiency</th>
<th>Route of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triptolide-loaded solid lipid nanoparticle</td>
<td>Triptolide</td>
<td>Decreasing the toxicity</td>
<td>Anti-inflammatory</td>
<td>Emulsification-ultrasound</td>
<td>–</td>
<td>Oral</td>
</tr>
<tr>
<td>Artemisinin nanocapsules</td>
<td>Artemisinin</td>
<td>Sustained drug release</td>
<td>Anticancer</td>
<td>Self-assembly procedure</td>
<td>90–93%</td>
<td>In vitro</td>
</tr>
<tr>
<td>Berberine-loaded nanoparticles</td>
<td>Berberine</td>
<td>Sustained drug release</td>
<td>Anticancer</td>
<td>Ionic gelation method</td>
<td>65.40 ± 0.70%</td>
<td>In vitro</td>
</tr>
<tr>
<td>Glycyrrhizic acid-loaded nanoparticles</td>
<td>Glycyrrhizic acid</td>
<td>Improve the bioavailability</td>
<td>Anti-inflammatory, antihypertensive</td>
<td>Rotary-evaporated filmultrasonication method</td>
<td>91.76%</td>
<td>–</td>
</tr>
</tbody>
</table>

**Table 3.3.4: Emulsion herbal formulations**

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Active ingredients</th>
<th>Applications of emulsion formulations</th>
<th>Biological activity</th>
<th>Method of preparation</th>
<th>Size in nm</th>
<th>Drug loading</th>
<th>Route of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Docetaxel submicron emulsion</td>
<td>Docetaxel</td>
<td>Improve residence time</td>
<td>Anticancer</td>
<td>High pressure Homogenization method</td>
<td>166.00 nm</td>
<td>90%</td>
<td>Intravenous</td>
</tr>
<tr>
<td>Berberine nanoemulsion</td>
<td>Berberine</td>
<td>Improve residence time and absorption</td>
<td>Anticancer</td>
<td>Drawing ternary phase diagram</td>
<td>56.80 nm</td>
<td>0.50%</td>
<td>Oral</td>
</tr>
<tr>
<td>Silybin nanoemulsion</td>
<td>Silybin</td>
<td>Sustained release formulation</td>
<td>Hepatoprotective</td>
<td>Emulsification method</td>
<td>21.20 nm</td>
<td>–</td>
<td>Intramuscular</td>
</tr>
<tr>
<td>Quercetin microemulsion</td>
<td>Quercetin</td>
<td>epidermis</td>
<td>Antioxidant</td>
<td>High speed Homogenization method</td>
<td>10–100 nm</td>
<td>0.3% solution</td>
<td>Topical</td>
</tr>
</tbody>
</table>

**Table 3.3.5: Microspheres encapsulated herbal formulations**

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Active ingredients</th>
<th>Applications of formulations</th>
<th>Biological activity</th>
<th>Method of preparation</th>
<th>Size in µm</th>
<th>Route of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zedoary oil microsphere</td>
<td>Zedoary oil</td>
<td>Sustained release and Higher bioavailability</td>
<td>Hepatoprotective</td>
<td>Quasi-emulsion-solvent diffusion method</td>
<td>100–600</td>
<td>Oral</td>
</tr>
<tr>
<td>CPT loaded microspheres</td>
<td>Camptothecin</td>
<td>Prolonged-release of camptothecin</td>
<td>Anticancer</td>
<td>Oil-in-water evaporation method</td>
<td>10</td>
<td>Intrapertioneally and intravenously</td>
</tr>
<tr>
<td>Quercetin microspheres</td>
<td>Quercetin</td>
<td>Significantly decreases the dose size</td>
<td>Anticancer</td>
<td>Solvent evaporation</td>
<td>6</td>
<td>In vitro</td>
</tr>
<tr>
<td>Cynara scolymus microspheres</td>
<td>Cynara scolymus extract</td>
<td>Controlled release of neurtaceuticals</td>
<td>Nutritional supplement</td>
<td>Spray-drying technique</td>
<td>6–7</td>
<td>Oral</td>
</tr>
</tbody>
</table>

**Table 3.3.6: Other novel vesicular herbal formulations**

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Active ingredients</th>
<th>Applications</th>
<th>Biological activity</th>
<th>Droplet size</th>
<th>Route of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capsaicin transferosomes</td>
<td>Capsaicin</td>
<td>Increase skin penetration</td>
<td>Analgesic</td>
<td>150.6 nm</td>
<td>Topical</td>
</tr>
<tr>
<td>Colchicine transferosomes</td>
<td>Colchicine</td>
<td>Increase skin penetration</td>
<td>Antitumor</td>
<td>–</td>
<td>In vitro</td>
</tr>
<tr>
<td>Vincristine transferosomes</td>
<td>Vincristine</td>
<td>Increase entrapment efficiency</td>
<td>Anticancer</td>
<td>120 nm</td>
<td>In vitro</td>
</tr>
<tr>
<td>Matrine ethosome</td>
<td>Matrine</td>
<td>Improve the percutaneous permeation</td>
<td>Anti-inflammatory</td>
<td>110 ± 8 nm</td>
<td>Topical</td>
</tr>
</tbody>
</table>
Table 3.3.7: Some herbal drug nanoparticles

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Active ingredients</th>
<th>Biological activity</th>
<th>Method of preparation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artemisin nanocapsules</td>
<td>Artemisin</td>
<td>Anticancer</td>
<td>Self assembly procedure.</td>
</tr>
<tr>
<td>CFT encapsulated nanoparticles</td>
<td>Camptothecin</td>
<td>Anticancer</td>
<td>Dialysis method.</td>
</tr>
<tr>
<td>Berberine-loaded nanoparticles</td>
<td>Berberine</td>
<td>Anticancer</td>
<td>Ionic gelation method.</td>
</tr>
<tr>
<td>Curcuminoids solid lipid</td>
<td>Curcuminoids</td>
<td>Anticancer and</td>
<td>Micro-emulsion technique.</td>
</tr>
<tr>
<td>nanoparticles</td>
<td></td>
<td>antioxidant</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.3.8: Transfersomes

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Active ingredient</th>
<th>Application</th>
<th>Biological activity</th>
<th>Droplet size</th>
<th>Route of administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capsaicin transferosomes</td>
<td>Capsaicin</td>
<td>Increase skin penetration</td>
<td>Analgesic</td>
<td>150.6 nm</td>
<td>Topical</td>
</tr>
<tr>
<td>Colchicine transferosomes</td>
<td>Colchicine</td>
<td>Increase skin penetration</td>
<td>Antigout</td>
<td>-</td>
<td>In-vitro</td>
</tr>
<tr>
<td>Vincristine transferosomes</td>
<td>Vincristine</td>
<td>Increase entrapment efficiency and skin penetration</td>
<td>Anticancer</td>
<td>120 nm</td>
<td>In-vitro</td>
</tr>
</tbody>
</table>

Table 3.3.9: Recent patents on herbal controlled release formulations

<table>
<thead>
<tr>
<th>US patent No.</th>
<th>Active ingredients</th>
<th>Novel system incorporate</th>
</tr>
</thead>
<tbody>
<tr>
<td>US 5948414</td>
<td>Opioid analgesic and aloe</td>
<td>Nasal spray</td>
</tr>
<tr>
<td>US 6340478 B1</td>
<td>Ginsenosides</td>
<td>Microencapsulated and controlled release formulations</td>
</tr>
<tr>
<td>US 6890661 B1</td>
<td>Isoflavones</td>
<td>Microencapsulated formulation</td>
</tr>
<tr>
<td>US 6896898 B1</td>
<td>Alkaloids ofaconitum species</td>
<td>Transdermal delivery system</td>
</tr>
<tr>
<td>US patent 2005/0142232 A</td>
<td>Oleaginous oil of Sesamum indicum and alcoholic extract of Centella asiatica</td>
<td>Brain tonic</td>
</tr>
<tr>
<td>US patent 2007/0042062 A1</td>
<td>Glycine max containing 7s globulin protein extract curcumin, Zingiber officinalis</td>
<td>Herbal tablet dosage form</td>
</tr>
<tr>
<td>US patent 2007/007284A1</td>
<td>Opioid analgesic (phenanthrene gp)</td>
<td>Transdermal patch</td>
</tr>
<tr>
<td>US patent 7569236132</td>
<td>Flavonoids (such as quercetin) and terpenes (ginkgolide A, B, C and J)</td>
<td>Microgranules</td>
</tr>
</tbody>
</table>

3.4 applications of novel drug delivery system for herbal formulations
Over the past several years, great advances have been made on development of novel drug delivery systems (NDDS) for plant actives and extracts. The variety of novel herbal formulations like polymeric nanoparticles, nanocapsules, liposomes, phytosomes, nanoemulsions, microsphere, transfersomes, and ethosomes has been reported using bioactive and plant extracts. The novel formulations are reported to have remarkable advantages over conventional formulations of plant actives and extracts which include enhancement of solubility, bioavailability, protection from toxicity, enhancement of pharmacological activity, enhancement of stability, improved tissue macrophages distribution, sustained delivery, and protection from physical and chemical degradation.

4. CURRENT STATUS OF NDDS MARKET IN DIFFERENTNATION
4.1 herbal marketed preparations
4.1.1 Ocuser (Pilocarpine - Dr. Winzer Pharma, Ocuser - Allergan; ALZA; Janssen)
Ocuser is a long-acting sustained-delivery system used as ocular insert for the treatment of open-angle glaucoma. Ocuser consists of pilocarpine as miotic drug. Pilocarpine is obtained from the leaves of Pilocarpus microphyllus and other species. A soft contact lens soaked in pilocarpine solution also provides sustained delivery.
4.1.2 hair-growth herbal spray (Kunming Runyantang Cosmetics Co., Ltd.)
Hair-growth herbal spray contains pure, natural traditional Chinese medicine including ginseng extract, Chinese angelica extraction, and Polygonum multiflorum extraction. It is made with efficient active constituent extracted by advanced super-critical fluid-extract (SFE) technology with high-tech bioengineering CO$_2$ super-critical fluid. Hair-growth herbal spray contains pure, natural TCM enhancer Angelica naphtha. Its functions are
1. Influence the keratodermia hydration.
2. Dissolve sebum within sebaceous gland duct.

4.1.3 herbal treatment for frozen shoulder (XIAFLEX in the U.S.)
Frozen shoulder, or adhesive capsulitis, afflicts people in three distinct stages, each lasting weeks or months. The first stage, “freezing,” consists of the onset of pain and gradual loss of motion in the arm and shoulder. During the second period, the “frozen” stage, pain recedes but stiffness becomes pronounced. In the final weeks or months, “thawing” finally sets in. Herbal therapy can be effective part of managing the initial pain.

4.1.4 Herbal ointment (Harvest Healthcetical Pvt.Ltd.)
To combat the inflammation of the connective tissue surrounding your shoulder joints and muscles, make the massage cream developed by herbalist Jeanne Rose. In a double boiler, bring to a gentle bubble one quart olive oil, 8 ounces fresh cayenne or habenero chili peppers, 3 ounces fresh (or 4 ounces dried) rosemary and 2 ounces dried comfrey root that has been soaked in Boiling water for 20 minutes. Blend contents for 20 seconds, and heat and cool one more time. Strain the mixture; add 6 to 8 ounces beeswax or cocoa butter, and 20 drops each of the Following essential oils: lavender, marjoram, frankincense and eucalyptus. Pour into several small jars and allow solidifying before use.

4.1.5 Herbal treatments for acne (HERBALmax™, Admark Herbals Limited, India)
An acne breakout is annoying for some but for others, it’s a source of deep embarrassment. The shelves of cosmetic counters feature every new chemical, ointment and peel, promising to heal your pimples. If you’re looking for something more natural and in tune with your body, try using herbal treatments in your quest for blemish-free skin.

4.1.6 Herbal treatment for colon cancer (National Libarary of Medicine U.S.-BethesdaMD)
Colon cancer is the most common cancer of the digestive track. It mainly affects older people and there may be a genetic link. Since tumors can grow quite large without obstructing the bowel, the cancer can go undetected for quite a while and is not usually diagnosed until it has spread. There are many natural treatments that complement the standard course of treatment.

Causes
Colon cancer is closely linked with a high-fat and low-fiber diet. Animal fat restricts oxygen available to the good bacteria in a healthy colon. When deprived of oxygen, the bacteria produce Toxins. The lack of fiber slows down the rate at which toxins leave the body through the stool. Other possible causes are heredity, calcium deficiency, and chronic diarrhea and constipation.

Symptoms
The most notable symptom of colon cancer is blood in the stool. In addition, there may be a change in bowel habits, pain in the abdomen, acid stomach, and muscle tension and twitching in the stomach.

4.2 novel drug delivery systems market (NDDS) formulations (oral & injectable)
Novel drug delivery systems (NDDS) offer many more advantages, which include improved therapy by increasing the efficacy and duration of drug activity, increased patient compliance through decreased dosing frequency and convenient routes of administration, and improved targeting for a specific site to reduce unwanted side effects. The challenge for both drug and drug delivery companies is to deliver both existing and emerging drug technologies in a manner that improves the current benefits enjoyed by the patients.
4.3 Marketed novel drug delivery formulations of plant active and extracts

Table 4.3: Marketed novel drug delivery formulations of plant active and extracts

<table>
<thead>
<tr>
<th>S.No</th>
<th>Brand name</th>
<th>Plant active/extracts</th>
<th>Type of NDDS</th>
<th>Company name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>White tea liposome Herbasec</td>
<td>Camellia sinensis extract</td>
<td>Liposome</td>
<td>Cosmotechm</td>
</tr>
<tr>
<td>2</td>
<td>Green tea liposome Herbacec</td>
<td>Camellia sinensis Extract</td>
<td>Liposome</td>
<td>Cosmotechm</td>
</tr>
<tr>
<td>3</td>
<td>White hibiscus liposome Herbacec</td>
<td>White hibiscus extract</td>
<td>Liposome</td>
<td>Cosmotechm</td>
</tr>
<tr>
<td>4</td>
<td>Aloe vera liposome Herbacec</td>
<td>Aloe vera Extract</td>
<td>Liposome</td>
<td>Cosmotechm</td>
</tr>
<tr>
<td>5</td>
<td>Guarana liposome Herbacec</td>
<td>Guarana extract</td>
<td>Liposome</td>
<td>Cosmotechm</td>
</tr>
<tr>
<td>6</td>
<td>Centella Phytosome</td>
<td>Triterpenes from Centella asiatica leaf</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>7</td>
<td>Crataegus Phytosome</td>
<td>Vitexin-2-O-rhamnoside from Hawthorn flower</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>8</td>
<td>Escin B-sitosterol Phytosome</td>
<td>Escin B-sitosterol from horse chestnut fruit</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>9</td>
<td>Ginkgoselect Phytosome</td>
<td>Ginkgolavoglucosides, ginkgolides, bilobalide from Ginkgo biloba leaf</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>10</td>
<td>Ginselect Phytosome</td>
<td>Ginsenosides from Panax ginseng rhizome</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>11</td>
<td>Ginkgo biloba terpenes Phytosome</td>
<td>Ginkgolides and bilobalide from Ginkgo biloba leaf</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>12</td>
<td>Ginkgo bilobadimeric flavonoids Phytosome</td>
<td>Dimeric flavonoids from Ginkgo bilobaleaf</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>13</td>
<td>Greeenselect Phytosome</td>
<td>Polyphenols from green tea leaf</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>14</td>
<td>Meriva</td>
<td>Curcuminoids from turmeric rhizome</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>15</td>
<td>PA2 Phytosome</td>
<td>Proanthocyanidin A1 from horse chestnut bark</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>16</td>
<td>Sericoside Phytosome</td>
<td>Sericoside from Terminalia sericea bark root</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>17</td>
<td>Siliphos</td>
<td>Silybin from milk thistle seed</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>18</td>
<td>Silymarin Phytosome</td>
<td>Silymarin from milk thistle seed</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>19</td>
<td>Virtiva</td>
<td>Ginkgolavoglucosides, ginkgolides, bilobalide from Ginkgo biloba leaf</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
<tr>
<td>20</td>
<td>18β-glycyrrhetinic acid Phytosome</td>
<td>18β-glycyrrhetinic acid from licorice rhizome</td>
<td>Phytosome</td>
<td>Indena</td>
</tr>
</tbody>
</table>

4.4 Current status of novel drug delivery technology for phytotherapeutics

Herbal drugs constitute a major share of all the officially recognised systems of health in India viz. Ayurveda, Yoga, Unani, Siddha, Homeopathy and Naturopathy, except Allopathy. More than 70% of India’s 1.1 billion populations still use these non-allopathic systems of medicine17. Currently, there is no separate category of herbal drugs or dietary supplements, as the Indian Drugs Act. However, there is a vast experiential-evidence base for many of the natural drugs22.

5. CONCLUSION

This review gives information about Novel drug delivery system in herbals, their types, formulation, herbal drugs used and current market status of Novel drug delivery system in herbals. This information useful in the form of base for the further research work, isolation of chemical entities from Novel drug delivery system in herbals, formulation of Novel drug delivery system in herbals. An extensive research is going on in the area of novel drug delivery and targeting for plant actives and extracts. However, research in this area is still at the exploratory stage. Many problems in the research, production and application need to be solved. In addition, more attention should be paid to the research on the carrier materials in order to develop more suitable carriers which can reduce the toxicity of drugs, enhance their activity and improve the overall quality of the agents. Herbal drugs have enormous therapeutic potential which should be explored through some value added drug delivery systems. Lipid solubility and molecular size are the major limiting factors for drug molecules to pass the biological membrane to be absorbed systematically following oral or topical administration. Several plant extracts
and phytomolecules, despite having excellent bio-activity in vitro demonstrate less or no in vivo actions due to their poor lipid solubility or improper molecular size or both, resulting poor absorption and poor bioavailability. Standardized plant extracts or mainly polar phytoconstituents like flavonoids, terpenoids, tannins, xanthones when administered through novel drug delivery system show much better absorption profile which enables them to cross the biological membrane, resulting enhanced bioavailability. Hence more amount of active constituent becomes present at the site of action (liver, brain, heart, kidney, etc.) at similar or less dose as compared to the conventional plant extract or phytomolecule. Hence, the therapeutic action becomes enhanced, more detectable and prolonged. Several excellent phytoconstituents have been successfully delivered using NDDS. Hence there is a great potential in the development of novel drug delivery systems for the plant actives and extracts. Today the stress is on patient compliance and to achieve this objective there is a spurt in the development of NDDS. As the herbal excipients are promising biodegradable materials, these can be chemically compatible with the excipients in drug delivery systems. In addition herbal excipients are non-toxic, freely available, and less expensive compared to their synthetic counterparts. They have a Major role to play in pharmaceutical industry. Therefore, in the years to come, there is going to be continued interest in the natural excipients to have better materials for drug delivery systems. Herbal medicines have been widely used all over the world since ancient times and have been recognized by physicians and patients for their better therapeutic value as they have fewer adverse effects as compared with modern medicines. The drugs of ayurvedic origin can be utilized in a better form with enhanced efficacy by incorporating in modern dosage forms. However, phytotherapeutics need a scientific approach to deliver the components in a novel manner to increase patient compliance and avoid repeated administration. This can be achieved by designing novel drug delivery systems for herbal constituents.

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