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Research Article

Phytosome Drug Delivery of Natural Products: A Promising Technique for Enhancing Bioavailability

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ABSTRACT
The phytosome technology was developed by Indena markedly enhancing the bioavailability of selected phytomedicines, by incorporating phospholipids into standardized plant extract, which improve their absorption and utilization. Phytosome are advanced form of herbal extract that shows better absorption profile than conventional herbal extract. The present review focus on the preparation and characterization techniques of phytosomes, merits and various landmarks in the field of phytosomes.

Keywords: Bioavailability, Natural Products, Phospholipids, Phytosome, Quercetin.

INTRODUCTION

Since the dawn of history traditional medicines have proved their effectiveness for health management[1]. Most of the bioactive plant constituent such as terpenoids, flavonoids, phenolic glycosides and anthocyanins are of highly polar nature (water soluble) i.e hydrophilic in nature. This nature poses great hindrance in absorption of drug as GI membrane (Highly lipophillic) does not permit the passage of highly water soluble substance across it and finally result in poor bioavailability[2]. Bioavailability is the extent and rate at which the active constituent i.e drug or metabolite reaches in the blood and proves clinical efficacy and also minimises the dose. For a drug to be bioavailable, it should have proper hydrophillicity as well as lipophillicity[2]. In addition, other factors like like poor lipid solubility, improper molecular size, destruction in gut, highly distributed throughout the body, have less plasma half life, poor stability and inefficient to reach the target tissue limit their bioactivity. To overcome all these limitations a number of novel drug delivery systems have been emerged for plant extracts. It includes novel herbal formulations like nanoparticles, nanocapsules, phytosomes, niosomes, transferosomes, ethosomes, proniosomes having remarkable advantage over traditional plant extracts including solubility enhancement, bioavailability improvement, targeted delivery, sustained effect etc[3]. Hebal drug delivery uses various formulation technology to improve drug absorption and provide better efficacy than conventional plant extract.

Herbosome is a synonym of Phytosome. 'Herbo' or 'Phyto' stands for herbal or plant based and 'some' means cell like. It is a patented technology in which standardised plant extract or polyphenolic compounds (like flavonoids, terpenoids and tannin etc) made to react with phospholipids to form a lipid compatible complex[4]. Phytosomes is a molecular association in which a hybrid bond formation occurs between phosphatidylcholine (PC) and polyphenol, creating a highly lipid-miscible hybrid complex having reduced polarity and ability to cross the biological membrane, Hence improving the bioavailability of polyphenol[5]. Phospholipids are the main building blocks of life and are one of the major components of biological membranes. Phospholipids are regarded as natural digestive aid, having nutritional properties like phos-phatidylserine which acts as a brain cell nutrient, phosphatidylcholine which is helpful in liver cell regeneration, lipid reducing effect and also act as carriers for both polar and non-polar active substances[6]. Various Phospholipids from different sources can be used such as soy lecithin, phosphatidylserine, and 1,2-distearoyl-Sn-glycero-3- phosphatidylcholine. Phospholipids derived from soybean oil having higher content of phosphatidylcholine offers compatibility and similarity with the biological membrane. Phytosomes are obtained by reacting 2-3 moles or 1 mole of phospholipid such as phosphatidylcholine, phosphatidyl- ethanolamine or phosphatidyl-serine with 1 mole of bioactive component (flavonoids or terpenoids) in an aprotic solvent (dioxane, acetone, methylene chloride, ethyl acetate) The solvent evaporated under vacuum or precipitation with non solvent (aliphatic hydrocarbons), lyophilization (freeze-drying) or spray drying, therefore the complex is isolated[7]. Advantages of phytosomes are better drug entrapment, enhanced absorption of polar Phytoconstituents leading to improved bioavailability. Reduced dose requirement, Better stability profile due to chemical bond formation, improved percutaneous absorption, so act as functional cosmetic. Several companies are involved in production and marketing of

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phytosomal products i.e Indena, Jamieson natural resources, Thorne Research, Natural factors, and Natures herb etc. Phytosomes exhibit better pharmacokinetic and pharmacodynamic profile than conventional herbal

Table 1: Phytosomes preparation and their relevance with activity.

Sr. No.	Phytoconstituents Phospholipid complex	Outcome/Application/ Findings	Reference
1	Silybin	Seven times greater absorption of silybin from silybin phytosome compared to the absorption of silybin from regular milk thistle extract.	[25]
2	Silybin	Effectiveness of Silybin-phosphatidylcholine complex in improving the biochemical and quantitative indices of hepatic function in patients with chronic active hepatitis.	[26]
3	Silymarin	Silymarin Phytosomes showed much higher specific activity and a longer lasting action.	[27]
4	Silymarin	Better fetoprotectant activity from ethanol-induced behavioral deficits than uncomplexed silymarin.	[28]
5	Silymarin	Antihepatotoxic activity of silymarin phytosome is better than silymarin alone and also provide protection against the toxic effects of aflatoxin B1 on performance of broiler chicks	[29]
6	Quercetin	Quercetin–phospholipid complex is superior over free quercetin in terms of better free radical scavenging activity	[30]
7	Silybin	The bioavailability of silybin in rats was improved due to an impressive improvement of the lipophilic property of silybin-phospholipid complex.	[31]
8	Hesperitin	A novel hesperetin phytosome was developed by complexing hesperetin with hydrogenated phosphatidyl choline and evaluated for antioxidant activity. The results indicated sustained release property for over 24 h, enhanced antioxidant activity, higher relative bioavailability than that of parent molecule at the same dose level.	[32]
9	Marsupsin	Better oral bioavailability and improved biological response than free form of standardized marsupsin	[14]
10	Silymarin, curcumin, green tea, and grape seed extracts	Improved bioavailability	[1]
11	Oxymatrine–phospholipid complex	Bioavailability of Oxymatrine increased due to improvement in solubility of Oxymatrine–phospholipid complex	[9]
12	Quercetin, kaempferol and isorhamnetin	A comparative pharmacokinetics and bioavailability studies of quercetin, kaempferol and isorhamnetin was conducted after oral administration of Ginkgo biloba extracts(GBE), Ginkgo biloba extract phospholipid complexes(GBP) and Ginkgo biloba extract solid dispersions(GBS) in rats and bioavailability was found to be: GBP>GBS>GBE	[21]
13	Curcumin	Potential role of curcumin phytosome (Meriva) in controlling the evolution of diabetic microangiopathy was studied.	[33]
14	Curcumin phytosome (Meriva)	Improved absorption and a better plasma curcuminoid profile of the Meriva at a dose significantly lower than unformulated curcuminoid mixture.	[34]
15	Curcumin-phospholipid complex	Phospholipid complex has more transdermal penetration than pure curcumin.	[35]
16	Curcumin-phytosome-loaded chitosan micro-spheres (Cur-PS-CMs)	New Cur-PS-CMs system combined the advantages of chitosan microspheres and phytosomes, which had better effects of promoting oral absorption and prolonging retention time of curcumin than single Cur-PSs Or Cur-CMs.`	[10]
17	Green select phytosome	Results concluded the relevance of addressing multiple factors involved in the development of metabolic syndrome with apheliotropic agent capable of improving the beneficial effects of lifestyle and dietary changes and foster the attainment of a globally improved health profile.	[36]
18	Rutin phytosomes	Phyto-phospholipid complex of Rutin can increase its skin	[12]

	(RN-P)	uptake to treat inflammatory conditions in arthritis, rheumatism, athletic aches and may able to deliver the drug for a long duration avoiding the problems associated with oral administration.	
19	Combination product containing alpha-lipoic acid, curcumin phytosome, and B group vitamins	Oral supplementation with alpha-lipoic acid, curcumin phytosome, and B-group vitamins twice a day both before and after surgery is safe and effective in CTS patients scheduled to undergo surgical decompression of the median nerve.	37
20	Folate-Targeted and PEGylated Phytosomes Loaded with a Mitomycin C−Soybean Phosphatidyhlcholine Complex	FA-PEG-MMC-loaded phytosomes were associated with enhanced cytotoxic activity in vitro and an improved antitumor effect in vivo compared to that resulting from free MMC injection. Moreover, FA-PEG-MMC-loaded phytosomes may be useful drug delivery systems for widening the therapeutic window	38
21	Quercetin loaded nano phytosome	Incorporation of cholesterol improved the physical stability of nano phytosome for over three weeks and Incorporation of Quercetin in the phospholipid bilayer reduced the phase transition temperature of bilayer in the nano phytosome structure that resulted in higher release and bioavailability.	39
22	Quercetin	Quercetin has a skin protective effect against damage caused by a variety of insults, including UV radiation, histamine, or contact with toxic chemical compounds. Also, having ability to reduce redness, itching, and inflammation of damaged skin, restore skin barrier function, increasing hydration, and reducing water loss.	40
23	Bael Phytosomes	Phytosomes has nearly same antioxidant, antiproliferative and anticancer activity as that of methanolic extract of leaves of Bael (*A.marmelos*)	19
24	Phytosomes of curcumin and naringenin	The antioxidant activity of the phospholipid complex of both curcumin as well as naringenin was found to be better than antioxidant activity of free compound and also having increased duration of action that can be due to decrease in elimination rate.	41

extracts. Bioavailability of many popular herbal extracts such as milk thistle, Ginkgo biloba, grape seed, green tea, hawthorn, ginseng etc has been improved by using phytosomal technique[8].

METHOD OF PREPARATION

Various techniques can be used for Preparation of Phytosomes like solvent evaporation method, salting out method, freeze drying or lyophilisation etc.Different solvents were used as solvent medium such as tetrahydrofuran [9,10] Dichloromethane[11-13] used n-hexane as the precipitation medium.

Antisolvent precipitation technique
Co-solvent lyophilization method
Thin layer hydration technique
Solvent evaporation method

In antisolvent precipitation technique, specific amount of drug and phospholipid are refluxed with suitable solvent. The mixture so formed is concentrated and another solvent is then added for precipitation with continuous stirring. Precipitates thus formed are then filtered and collected and stored in vacuum desiccators overnight. The example of such type of are marsupsin-phospholipid complex[14] and Ashwagandha phytosomes complex[15] has been formulated using mechanical dispersion oriented liquid antisolvent precipitation process.

In *co-solvent lyophilization method* drug and the phospholipids are dissolved in suitable solvent separately. Both are then mix by gentle agitation until formation of a clear mixture. The resultant homogeneous solution is then freeze-dried under vacuum and stored in air tight container for further use. Rutin-phospholipid complex was prepared by an anhydrous co-solvent lyophilization method[16]. The third technique is the thin layer hydration technique in which phytoconstituents and phosphatidylcholine are dissolved in methanol, while cholesterol is dissolved in dichloromethane. The mixture is then evaporated in a rotary evaporator until thin dry film is produced. Mostly, nitrogen gas is blown over the thin film for complete removal of organic solvents. Further, vacuum drying is then done to evaporate the organic solvents completely. The film is then hydrated with distilled water. The example are nano phytosomes of quercitin[17], phytosomes of lawsone[18] and phytosomes of Bael[19].

In solvent evaporation technique, generally both the drug and the phospholipids are placed in the same flask and refluxed with suitable solvent at fixed temperature for fixed time. The specific amount of phytoconstituent and soya lecithin are taken into a round bottom flask and refluxed with acetone at a temperature 50 – 60^{o}Cfor 2 h. For example Lawson phytosome have been prepared by

solvent evaporation method[19,20]. Evodiamine- rutin phytosome was prepared by this method using Phospholipid Complex to improve oral bioavailability,

Table 2: Recent Patents on phytosomes.

Title of patent	Innovation	Patent No.	Reference
Oral compositions for the treatment of cellulite	oral pharmaceutical and cosmetic compositions for the treatment of cellulite containing *Vitis vinifera* extracts, *Centella asiatica* triterpenes and dimeric *Ginkgo biloba* flavonoids, in the free form or complexed with phospholipids.	US 7691422	42
Phospholipid complexes of olive fruits or leaves extracts having improved bioavailability	Phospholipids complexes of olive fruits or leaves extracts or their compositions containing it which imparts improved bioavailability	EP/1844785	43
Compositions comprising Ginkgo biloba derivatives for the treatment of asthmatic and allergic conditions.	Compositions containing fractions deriving from Ginkgo biloba, useful for the treatment of asthmatic and allergic conditions	EP1813280	44
Phospholipid complexes of curcumin having improved bioavailability	The phospholipids complexes of curcumin provides higher systemic levels of parent agent than uncomplexed curcumin. The improved bioavailability of phospholipid complex of curcumin increases the potential scope of medical applications for curcumin as a chemopreventive agent.	WO 2007/101551	45
Treatment of skin, and wound repair, with thymosin β4	Compositions and methods for treatment of skin utilizing thymosin β4.	US/2007/0015698	46
Cosmetic and dermatological composition for the treatment of aging or photo damaged skin	Composition for topical treatment of the skin comprises a substance that stimulates collagen synthesis and a substance that enhances the interaction between extracellular matrix and fibroblasts Cosmetic or dermatological composition for topical treatment	EP1640041	47
Fatty acid monoesters of sorbityl furfural and compositions for cosmetic and dermatological use	Fatty acid monoesters of sorbityl furfural selected from two diff series of compounds in which side chain is a linear or branched C3-C19 alkyl radical optionally containing at least one ethylenic unsaturation least one ethylenic unsaturation	EP1690862	48
Soluble isoflavone compositions	Isoflavone compositions exhibiting improved solubility (e.g., light transmittance), taste, colour, and texture characteristics, and methods for making the same.	WO/2004/045541	49
An anti-oxidant preparation based on plant extracts for the treatment of circulation and adiposity problems.	Preparation based on plant extracts which has an anti-oxidant effect and is particularly useful in treatment of circulation problems such as phlebitis, varicosevein, arteriosclerosis, haemorrhoid and high blood pressure	EP1214084	50
Phospholipid complexes prepared from extracts of Vitis vinifera as anti-atherosclerotic agents	The phospholipid complex extract of vitis vinifera useful for the prevention and treatment of atherosclerotic pathological condition	US6297218	51
Complex compounds of bioflavonoids with phospholipids, their preparation and use, and pharmaceutical and cosmetic compositions containing them	Complex compounds of flavonoids with phospholipids, characterized by high lipophilia and improved bio-availability and therapeutic properties as compared with free, not complexed flavonoids.	EP 0275005	52
Complexes of neolignane derivatives with phospholipids, the use thereof and pharmaceutical and cosmetic	Complexes of lipophilic extracts from plants of Krameria or Eupomatia genus and of some neolignanes isolated from the same extracts with natural or synthetic phospholipids; said complexes	EP 0464297	53

formulations containing them	proved to have antiradical, antibacterial and antimycotic activities,		
Bilobalide phospholipide complexes, their applications and formulations containing them	Complexes between natural or synthetic phospholipids and bilobalide, a sesquiterpene extracted from the leaves of Gingko biloba, are disclosed, as well as the preparation thereof and their therapeutic application as antiinflammatory agents and as agents for the treatment of disorders associated with inflammatory or traumatic neuritic processes. These new compounds, which exhibit a different bioavailability compared with free bilobalide, are suitable for incorporation into pharmaceutical formulations for systemic and topical administration:	EP 0441279	[54]
Complexes of saponins with phospholipid and pharmaceutical and cosmetic compositions containing them.	Complexes of saponins with natural or synthetic phospholipid have high lipophilic and improved bioavailability and are suitable for use as active principle in pharmaceutical, dermatologic and cosmetic compositions	EP0283713	[55]
Complexes of flavanolignanes with phospholipids, preparation thereof and associated pharmaceutical compositions	Novel compounds comprising lipophilic complexes of silybin, silidianin, and silicristin with phospholipids, and the preparation of these complexes advantageously be used in the treatment of acute and chronic liver disease of toxic, metabolic or infective origin or of degenerative nature.	EP 0209038	[56]

dichlomethane as solvent system[12] . *Gingko biloba* phospholipid complex was also prepared by same method using anhydrous ethanol as solvent medium and poloxamer-188 as phospholipid[21].

Characterization and evaluation

Physical parameters

Characterization of phytosomes is done for various physical characteristics, i.e. shape, size, its distribution, percentage drug entrapped, entrapped volume, percentage drug release, and chemical composition[22]. Therefore, etiquette of Phytosomes, in both physical and biological systems is regulated by factors such as physical size, membrane permeability; entrapment efficiency, chemical composition, quantity and purity of the starting material[2]. Various technologies are used for the evaluation of these parameters in phytosomes. For evaluating the morphological features Transition electron microscopy (TEM), electron microscopy Scanning (SEM), Photon correlation spectroscopy (PCS) and X-ray diffraction (XRD) analysis is used to study the surface morphology. The internal environment of phytosome where the drug is encaptured and its distribution within the phospholipid structure can be clearly investigated with the help of TEM study. PCS study i.e based on DLS technique (Dynamic light scattering) is used to characterize the size of various particle or vesicles. The SEM provides photomicrograph of the phytosomes at suitable magnification. The general XRD study indicates loss of crystalline peaks of drugs which confirm the interaction and entrapment of drug within a sheath. Percent drug entrapment can be determined by ultracentrifugation technique. Other physical parameters measured for phytosomes are their transition temperature, surface tension activity measurement, vesicle stability, vesicle size and zeta potential. Transition temperature is the temperature at which a material changes from one crystal state (allotrope) to another. Therefore the transition temperature should be determined for the vesicular lipid systems whichis determined by differential scanning colorimeter. It has been observed that the crystalline drug moiety shows a sharp peak at high melting point in DSC thermogram whereas the phytosome shows a broad peak and a melting point significantly less than that of pure drug. The broad peak indicates the loss of crystallinity. For surface tension activity measurement, Du Nouy ring tensiometer can be used. The stability of vesicles can be determined by computing the size and structure of the vesicles over time. Dynamic Light Scattering (DLS) technique is used to calculate the mean diameter and structural changes are studied by Transmission Electron Microscopy (TEM). The amount of phytoconstituents in the phytosome can be measured by modified high performance liquid chromatographic method or by a suitable spectroscopic method[23]. The particle size and zeta potential can be determined by DLS using a computerized inspection system and photon correlation spectroscopy. Spectroscopic evaluation is measured by instrumental techniques such as H-NMR, C-NMR, FTIR provide major information. These technique confirm the formation of complex and also provide interaction between phytoconstituent and phospholipid moiety.

In-vitro studies

For the estimation of dynamic lipolysis models are useful in observing the effect of simulated lipid digestion on drug solubilization and release from marketed

phytosomal lipid preparations. The study is conducted in a continuously agitating dissolution vessel having a mixture of bile salts, phospho-lipids in buffered aqueous solution equilibriated at 37°C. Pancreatic lipase initiates

Table 3: Phytosomes having commercial application in market[2,6, 24,57,58].

Natural source	Family	Phytoconstituent	Phytosomal product	Pharmacological Activity
Aesculus hippocastanum (Horse chestnut tree)	Sapindaceae	Saponins	Escin β-sitosterol Phytosome™	Anti-oedema
Ammi visnaga (Khella)	Apiaceae	Visnadine	Visnadex™	Circulation Improver, Vasokinetic
Camellia sinesis (Tea)	Theaceae	Epigallocatechin, catechin, epicatechin-3-o-gallate, Epigallocatechin-3-o-gallate	Green tea Phytosome™	Neutraceutical, anticancer, antioxidant, Hepatoprotective,Anti-inflammatory
Centella asiatica (Brahmi)	Apiaceae	Asiatic acid, madecassic acid	Centella triterpenoid Phytosome™	Brain tonic, Vein and Skin Disorder
Citrus aurantium (Bitter orange)	Rutaceae	Naringenin	Naringenin Phytosome™	Antioxidant
Crateegus Oxyacanthoids (Hawthron)	Rosaceae	Hyperin, quercitin	Hawthron Phytosome™	Antihypertensive, Cardioprotective.
Cucurbita pepo	Cucurbitaceae	Curbilene	Curbilene Phytosome	Skin care, Matting Agent
Curcuma longa (Turmeric)	zingiberaceae	Curcumin	Curcumin Phytosome™ (Meriva®)	Anticancer, Osteoarthritis, Anti-inflammatory
Echniacea angustifolia (Cone flower)	Asteraceae	Echinacosides and high molecular weight polysaccharide (Inulin)	Echniacea Phytosome™	Immunomodulatory, Nutraceuticals.
Fraxinus ornus (Flowering ash)	Oleaceae	Esculoside (Esculin)	Esculoside Phytosome™	Vasoactive, Micro Circulation Improver
Gingko biloba (Maiden hair =tree)	Gingkoaceae	Gingko flavonoids,Gingoic acids of ginkgolides and bilobalide	Gingkoselect Phytosome™	Cognition enhancer Raynaud's disease, antiageing
Glycyrrhiza glabra (Mulethi)	Fabaceae	Glycyrrhetinic acid	Glycyrrhetinic acid Phytosome™	Anti-inflammatory ,Soothing
Melilotus officinalis (Sweet clover)	Fabaceae	Melilotoside, Flavonoids and terpenoids	Lymphaselect™	Hypotensive, Indicated in Insomnia
Olea europaea (olive tree)	Oleaceae	Verbascoside, tyrosol, hydroxytyrosol	Oleaselect Phytosome™	Anti–hyperlipidemic, Anti-inflammatory
Panax ginseng (Ginseng)	Araliaceae	Ginsenosides	Ginseng Phytosome™	Immunomodulator
Panicum miliaceum (Millet)	Poaceae	Mineral salts, vitamins, unsaturated fatty acids, aminoacids	Millet Phytosome™	Beauty food for skin, nails and hairs, Antistress
Radix puerariae (Kudzu root)	Fabaceae	Puerarin	Puerarin and phospholipid complex Phytosome™	Anti-inflamatory, cardiovascular disease
Ruscus aculeatus	*Asparagaceae*	Steroid saponins	Ruscogenin Phytosome	Anti-inflammatory, Improve Skin circulation

Santalum album (Sandal wood)	Santalaceae	Ximenynic acid, ethyl ximenynate	Ximilene and Ximenoil Phytosome™	Skin Smoothner, Micro Circulation Improver
Serenoa repens (Saw palmetto berrries)	Aricaceae	Phytosterols	Salbalselect Phytosome™	Anti-oxidant, Benign Prostatic hyperplasia.
Silybium maranium (Milk Thistle)	Asteraceae	Silybin, Silycristin,isosilbin, Silydianin	Silybin Phytosome™ (Siliphos®)	Hepatoprotective, Antioxidant.
Swertia alternifolia	Gentianaceae	Xanthones 26	Swertia Phytosome™	
Terminalia serica (Silver cluster leaf)	Combretaceae	Sericoside	Sericoside Phytosome™	Skin improver, Anti-Wrinkles
Vaccinium angustifolium (Blue berry)	Aricaceae	Anthocyanosides tocotrienol complex, citrus bioflavonoid, alpha lipoic acid	VitaBlue Phytosome™	Antioxidant, improve vision, memory enhancer
Vaccinum myrtillus (Bilberry)	Ericaceae	Anthocyanosides	Mirtoselect Phytosome™	Antioxidant, Improvement of Capillary Tone.
Vitis vinifera (Grapes)	Vitaceae	Resveratrol, quercitin, catechin, procyanidins, epicatechin	Biovin and leucoselect Phytosome™	Antioxidant, Anticancer.
Zanthoxylum bungeanum	Rutaceae	Zanthalene	Zanthalene Phytosome	Soothing, Anti-Irritant, Anti-Itching

the lipid digestion which causes a drop in pH due to fatty acid liberation. pH drop is quantified by pH-meter controller and is again maintained using equimolar solution of NaOH through autoburette. During this process, samples are withdrawn and ultracentrifuged to separate the digest into poorly dispersed oil phase, a highly dispersed aqueous phase and a precipitated pellet phase. This helps in quantification and gives an indication of the *in vivo* performance of phytosomal formulations[24].

Pharmacological significance

Plethora of research work on phytosome suggest that preparation of phytosomes for herbal constituents have improved the pharmacological efficacy by decreasing the amount of dose needed as well as bioavailability of phytoconstituents. Some of the significant work on phytosome formulations is discussed in Table 1.

Because of these effects there is continuous innovation going on in this field. New methods and their increased efficacy of phytosomes are prepared. Table 2 illustrate the patents in this field.

CONCLUSION

There is a need of development of new drug delivery system from herbal source because of the effectiveness of phytoconstituent in management of various diseases. Several plant extracts and phytomolecules, despite having excellent bio-activity in vitro provide less or no in vivo actions owing 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 complexed with phospholipids like phosphatidylcholine give rise to a new drug delivery technology called phytosome (or herbosome) showing much better absorption profile following oral administration owing to improved lipid solubility which enables them to cross the biological membrane, resulting enhanced bioavailability i.e. more amount of active principle in the systemic circulation.

Hence there is a great potential in the development of novel drug delivery systems for the plant actives and extracts. The phytosome technology forms a link between the conventional delivery system of phytoconstituents and novel drug delivery systems. In nutshell, Phytosomes serves as a boon for poorly absorbed natural extracts**.**

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