Phytosome: Recent Investigation for a New Drug Delivery System

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ABSTRACT
A revolutionary strategy for plant extracts and active ingredients is the development of innovative drug delivery systems (NDDS). Plant and bioactive extracts have been found to be the accessible methods for creating novel herbal formulations such as cubosomes, transferosomes, ethosomes, liposomes, phytosomes, nanoemulsions, microspheres, niosomes, planterosomes, cubosomes, and polymeric nanoparticles. Nutraceuticals and a well-known producer of herbal medications created the patented technique known as Phytosome. To create a lipid-compatible molecular complex in phytosomes, standardized extracts of plant or water-soluble phytoconstituents were enhanced and added to phospholipids. The drug's bioavailability and absorption are enhanced by these phytosomes. This innovative formulation offers a number of noteworthy benefits over traditional plant actives and extract formulations, such as improved solubility, bioavailability, and capacity to cross cell membranes, defense against toxicity, improved stability, prolonged delivery, and defense against physical and breakdown by chemical means. This review aims to provide an overview of water soluble phytoconstituents (such as tannins, terpenoids, flavonoids, etc.) that are poorly absorbed because of their large molecular size or poor lipid solubility, which leads to poor bioavailability, preparation techniques, particle size and shape, entrapment efficiency, administration route, biological activity, and applications of novel formulations.

Keywords: Novel drug delivery systems; Phytosomes; Herbal drugs; Phospholipid, Phytoconstituents.

INTRODUCTION
Important steps have been taken in the past century to create innovative drug delivery systems (NDDS) for herbal medicines. Using plant extracts and active ingredients in the development of innovative drug delivery systems (NDDS) is a novel strategy.[1] The goal of a novel drug delivery system is to route the active ingredient to the site of action and supply the medication at a rate determined by the body's demands during the course of treatment. To accomplish regulated and targeted drug delivery, a number of innovative drug delivery systems with multiple routes of administration have been developed. One such technique is the encapsulation of the medication in vesicular structures, which, if selective absorption is successful, should extend the drug's half-life in systemic circulation and lower its toxicity.[2] Plants are referred to as "phyto" and cell-like structures as "some".[3-4] It is a proprietary technology that nutraceuticals, a well-known producer of herbal medications, developed and introduced. The low oral bioavailability of many plants, particularly those with polyphenolic rings in their structures like flavonoids and other water-soluble constituents like terpenoids and tannins, has raised concerns among researchers and scholars regarding the bioavailability of plant active principles. Several fundamental factors contributing to the limited bioavailability of these compounds include their high molecular weight/size, poor plasma membrane permeability, and low solubility in water or lipids.[5-8] In an effort to address these issues and improve the efficacy of herbal medicine, these medications have recently been integrated into a number of cutting-edge delivery methods. Several methods for improving bioavailability include creating nanoparticles at the nanoscale, complexing with cyclodextrins, delivering the drug as a prodrug, modifying chemical structures, and
binding with lipids as liposomes, herbosomes, or phytosomes.[5,9-10] Using phospholipids to compound plant medications or extracts has become one of the most effective and difficult ways to increase the bioavailability and therapeutic efficacy of several poorly absorbed plant elements in recent years. This method uses phospholipid molecules with phosphatidylcholine in their structure to create complexes with standardized herbal extracts and/or a particular plant bioactive ingredient. These compounds improve the water-oil partition coefficient, membrane permeability, systemic bioavailability, solubility, and ability to cross cell membranes, as well as provide protection against toxicity, stability, sustained delivery, and resistance to the physical and chemical degradation of medications, a phenomenon known as phytosomes.[11–12]

While poorly water soluble drugs' phospholipid complexation improved their solubility in gastric fluids, water soluble drugs' incorporation into their complexes has significantly increased their bioavailability by increasing penetration through the lipid plasma membrane.[13–14] In recent times, the phyto-phospholipid complexation method has facilitated the administration of highly effective plant actives with enhanced biological profiles. Since the phospholipid molecules' unique structural components are similar to the lipid content of mammalian cell membranes, making them highly compatible with the human physiological system, they have emerged as a potentially unique carrier system for enhancing the bioavailability of poorly absorbed plant extracts/actives.[15]

It can be found in brain tissue, egg yolk, and a wide range of plant and animal fats. It frequently exists in biliary fluid, where it aids in the emulsification of dietary ingredients for absorption. Amphiphatic in nature, phospholipid molecules have significant solubility in both aqueous and oily media. Their structures contain both polar and non-polar elements.[16] It is involved in the creation of a bilayer and has the highest entropy in a cylindrical shape. Its structure consists of one unsaturated and one saturated chain. Cone-shaped, phosphatidylethanolamine is not a bilayer by itself. Naturally occurring phospholipids include a saturated fatty acid (like stearic acid or palmitic acid) in position 1 and an unsaturated fatty acid (like oleic acid, linoleic acid, or arachidonic acid) in position 2.[18] The most widely utilized phospholipids (Fig. 1) are made from soy beans, which have larger quantities of phosphatidylcholine roughly 76% and polyunsaturated fatty acids, such as oleic acid, linoleic acid, and linoleic acid, which make up about 70% of the phospholipids.[19]

After oral treatment, soy phospholipids are absorbed at a rate higher than 90% in humans and reach maximal plasma concentration in around 6 hours. It was discovered that 20% of the dose given was the maximum plasma concentration that could be obtained[20]. It has been demonstrated that phospholipids, particularly those that include phosphatidylcholine, are integrated into cell membranes to replace existing phospholipids, which alters the membrane's fluidity.[21]

According to research, soy-based phospholipids, also known as essential fatty acids, have hepatoprotective properties that shield the liver from toxins, medications, and alcohol.[22]. Additionally, they have been shown to raise plasma levels of circulating HDL and help with blood cholesterol clearance.[23] Because soy phospholipids contain proportionately more polyunsaturated fatty acids, they may be helpful in lowering the risk of coronary heart disease. By preventing the rise of total lipids in dietary hypercholesterolemia at both therapeutic and preventive dosages, essential phospholipids have also been demonstrated to have antilipemic and antiatherogenic properties.[24]
Mechanism of Phytosome Formation

Plant extracts' polyphenolic components are very suitable for direct binding to phosphatidylcholine. Phospholipids, such as phosphatidylcholine, react with standardized extract or polyphenolic components, such as simple flavonoids, in an aprotic solvent to generate phytosomes.\(^{[25-26]}\) The phosphatidyl and choline moieties of phosphatidylcholine are lipophilic and hydrophilic, respectively, making it a bifunctional molecule. Phosphatidylcholine's choline head specifically attaches to these substances, and the lipid-soluble phosphatidyl portion which consists of the body and tail envelops the choline-bound material. Thus, the phytomolecules and phospholipids combine to form a lipid-soluble molecular complex known as the phytophospholipid complex. Certain spectroscopic techniques can show that phytomolecules are chemically linked to the polar choline head of phospholipids.\(^{[27]}\) Frequently According to precise chemical analysis, a flavonoid molecule connected to at least one phosphatidylcholine molecule often makes up the unit phytosome. A tiny microsphere or cell is created as a result.\(^{[28-29]}\)

The phosphatidylcholine in these drug-phospholipid complexes can be prepared as a solution, suspension, emulsion, syrup, lotion, gel, cream, aqueous micro dispersion, pill, capsule, powder, granules, and chewable tablet form. This allows for improved absorption and improved outcomes compared to traditional herbal extracts.

**Advantages**

1. Botanical extracts have a significant increase in bioavailability as a result of their complexation with phospholipid and enhanced intestinal absorption.

2. They penetrate the botanical extract that isn't lipophilic, making it feasible for improved absorption from the intestinal lumen, which wouldn't be conceivable otherwise.

3. Phytosome's composition is safe, and each of its ingredients has been given the go-ahead for usage in cosmetic and medicinal applications.

4. Because they are readily accessible through the action of phytosomes, they have been utilized to provide flavonoids that protect the liver. Furthermore, phosphatidylcholine has hepatoprotective properties as well, which work in concert to protect the liver.

5. When utilized as functional cosmetics to protect the skin from exogenous or endogenous hazards, this approach offers affordable phytoconstituent administration and synergistic effects in both normal and stressed environmental situations.

6. They can also be used to improve drug penetration through the skin for dermal and transdermal administration.

7. These serve as delivery systems for a wide range of medications (peptides, protein molecules).

8. The vesicular system can be commercialized right away and is non-invasive and passive.

9. Phosphatidylcholine serves as a transporter and skin nourishment; it is a crucial component of the cell membrane utilized in phytosome technology.

10. Drug entrapment during formulation production is not an issue.

11. The drug itself forms vesicles after conjugating with lipid, which contributes to the high and predefined entrapment efficiency.

12. Because phosphatidylcholine molecules and phytoconstituents create chemical bonds, they provide a superior stability profile.

13. Better absorption of the primary component results in a lower dose required. To get the intended effects, they can also be administered in lesser doses.

14. Low risk profile: Because the toxicological profiles of the phytosomal components are well-documented in the scientific literatures, there is no risk associated with the large-scale creation of drugs using this technology.

15. Relatively easy to produce; creating phytosomes doesn't require a significant technological investment. Negative aspect the phytosome quickly loses phytoconstituents.\(^{[30-31]}\)
Methods of Preparation of Phytosomes

Method of evaporating solvents

Typically, solvent evaporation techniques are used to produce the complex of plant extracts or particular active components with dietary phospholipids, with alcoholic or organic solvents serving as the reaction medium. The medication and the phospholipids are combined in a flask with an appropriate solvent system, like ethanol or tetrahydrofuran, in the more popular solvent evaporation method. For a predetermined amount of time, the reaction is permitted to run at a proper fixed temperature in order to achieve the highest yield and drug entrapment. Based on a prepared marsupsin-phospholipid complex and a mechanical dispersion-oriented liquid antisolvent precipitation procedure, the research was conducted.\(^{[32-34]}\)

They used sonication to dissolve soy lecithin in diethyl ether and double-distilled water to dissolve marupsin. Subsequently, the drug solution was sonicated into the phospholipid solution drop by drop. After the final formulation was chilled, an analysis of the complex revealed that 44% of marsupsin was entrapped, with 20% cumulative drug release.\(^{[35]}\)

Super critical fluids (SCF)

Super critical fluids, or SCFs, have become a useful instrument for producing particles with sizes between 5 and 2000 nm. Many supercritical fluid techniques, Such as the supercritical antisolvent method,\(^{\text{)}\}, the gas anti-solvent technique (GAS) the compressed antisolvent process (PCA) and solution enhanced dispersion by supercritical fluids (SEDS) have been used to enhance the solubility profiles of low soluble drug.

The supercritical fluid method was used in the research to create the purer in phospholipid complex. They used three distinct traditional ways to synthesize the complex: solvent evaporation, lyophilization, and micronized puerarin. They then qualitatively compared these methods to the complex made using the supercritical antisolvent precipitation technique. Two methods for SEDS, viz. GAS and SCF, were used for preparation of complexes.\(^{[36-37]}\)

Gas anti-solvent technique (GAS)

Using the GAS method, the medication and phospholipid solutions were treated separately with a supercritical antisolvent until the required pressure was reached. Following that, the reaction vessel was left undisturbed for three hours at a temperature of 38°C and a pressure of 10 mPa.

Anti-solvent precipitation technique

Many studies have also employed the conventional anti-solvent precipitation approach, wherein the drug phospholipids complex is precipitated out of the organic solvent by adding n-hexane as the antisolvent.\(^{[29]}\) Study based on a similar approach that was patented and used n-hexane as an anti-solvent during the final precipitation of the product and dichloromethane as the reaction medium to construct a Phyto-phospholipid complex of andrographolide. After that, the solution evaporates, and the residue is typically vacuum-dried.\(^{[38]}\) A rutin-phospholipid combination was created in a more recent study using an anhydrous co-solvent lyophilization technique, in which the medication and the phospholipids were dissolved in methanol but in different containers. Both solutions were combined while being mechanically stirred until all of the solvents had evaporated. In contrast to crystalline rutin, the photomicrography revealed the amorphous rutin-phospholipid combination. A medication to phospholipids ratio of 1:3 produced experimental outcomes that were noticeably better.\(^{[39]}\)

Characterization and Evaluation of Phytosomes

In both physical and biological systems, the physical size, membrane permeability, proportion of entrapped solutes, chemical composition, and quantity and purity of the starting ingredients all influence the behavior of phytosomes. Thus, form, size, distribution, percentage of drug collected, entrapped volume, percentage of drug released, and chemical composition can all be used to describe phytosomes.\(^{[29, 40]}\)

Entrapment efficiency

You can use the ultracentrifugation method to find out how well a drug is encapsulated in a phytosome.\(^{[41]}\)
Zeta potential and vesicle size
Particle size and zeta potential can be measured by dynamic light scattering (DLS) using a computerized inspection system and photon correlation spectroscopy (PCS).[42]

Visualization
Transmission electron microscopy (TEM) and scanning electron microscopy (SEM) can both be used to visualize phytosomes.[43–45]

Drug content
A suitable spectroscopic method or a modified high performance liquid chromatographic method can be used to quantify the amount of drug.[46]

Transition temperature
Differential scanning calorimetry can be used to find the vesicular lipid systems' transition temperature.[47-48]

Measurement of surface tension activity
The drug's surface tension activity in aqueous solution can be assessed using the ring method and a Du Nouy ring tensiometer.[49-51]

Vesicle stability
The size and shape of vesicles can be evaluated over time to ascertain their stability. DLS measures the mean size, while TEM keeps track of structural alterations.[50]

Spectroscopic evaluations
To confirm the formation of a complex or study the reciprocal interaction between the phytoconstituent and the phospholipids, the spectroscopic methods listed below are utilized.[27, 52]

Fourier Transform Infrared (FTIR) spectroscopy studies
Through the use of infrared spectroscopy, the synthesis of the complex can also be confirmed by comparing its spectrum to that of its component parts and their mechanical mixing. FTIR spectroscopy is also useful for controlling the stability of phytosomes when they are microdispersed in water or added to very simple cosmetic gels. Stability can be practically confirmed by comparing the spectra of the complex in its solid form (phytosomes) with the spectrum of its water-based microdispersion after lyophilization, at different times. In simple formulations, the spectrum of the cosmetic form needs to be periodically subtracted from the excipients' (blank) spectrum, and the complex's residual spectrum needs to be compared.

1H-NMR
Studies have been done on the NMR spectra of (+)-catechin and its stoichiometric combination with disearoylphosphatidylcholine.[27] Without any accumulation of the signal specific to the individual molecules, there is a noticeable shift in the 1H-NMR signal in nonpolar liquids that originates from the atoms participating in the complex formation. It is necessary to disseminate the signals from the flavonoid proton that it cannot be eased.
All of the signals in phospholipids expand, and the singlet associated with choline's N-(CH3)3 undergoes an upward shift. New, broad bands arise when the sample is heated to 60˚; these bands primarily correlate to the flavonoid moiety's resonance.

13C-NMR
The 13C-NMR spectra of (+)-catechin and its stoichiometric combination with disearoyl phosphatidylcholine clearly show all of the flavonoid carbons, particularly when recorded in C6D6 at room temperature.
Some of the signals associated with the glycerol and choline component of the lipid (between 60 and 80 ppm) are shifted, whereas most of the fatty acid chain resonances retain their original crisp line shape. When the temperature rises to 60˚, all of the signals linked to the flavonoid moieties reappear, but they are still somewhat diffuse and partially overlap.

In vitro and in vivo evaluations
The projected therapeutic action of the physiologically active phytoconstituents contained in the phytosomes is the basis for the selection of models for in-vitro and in-vivo evaluations.[53] The antioxidant and free radical scavenging properties of the phytosomes, for instance, can be used to measure the in-vitro antipapetotoxic activity. The effect of produced phytosomes on animals against hepatotoxicity generated by alcohol, paracetamol, or
thioacetamide can be investigated for evaluating antihepatotoxic activity in-vivo.\(^{[54]}\) A commercial product called Glycyrrhetinic Acid Phytosome\(^{®}\) ointment's skin sensitization and tolerance tests outline the in vivo safety evaluation approach.\(^{[55]}\)

**Difference between Phytosomes and Liposomes**

**Layer of membrane**

The primary distinction between phytosomes and liposomes is that the latter contain the active principle integrally within the membrane, as molecules anchored to the polar head of the phospholipids, while the former dissolve the active principle in the medium within the cavity or in the layers of the membrane.

**Layer of phospholipids**

Liposomes are mostly used in cosmetics to apply substances that are soluble in water to the skin. A water-soluble material is combined to create a liposome. Depending on the material, there could be hundreds or even thousands of phosphatidylcholine and the various plant components from a 1:1 or a 2:1 complex. Conversely, the active principle in a phytosome is comparable to a crucial component of the lipid membrane.\(^{[25]}\)

![Fig. 2: Difference between phytosome and liposome.](image)

**Therapeutic Application of Phytosomes**

Heart disease and liver disease are two of the many illnesses that phytosomes are used to treat. Moreover, it has vasokinetic, lipolytic, anti-oedema, anti-inflammatory cicatrizizing, trophodermic, neutraceutical immune-modulatory, cardio protective, anti-wrinkles, and UV protection properties.

Flavonoids with hepatoprotective properties are found in the fruit of the milk thistle plant. Numerous liver illnesses, such as hepatitis, cirrhosis, fatty filtration of the liver, and bile duct inflammation, have been demonstrated to respond favorably to silymarin treatment. The liver's resistance to harmful effects is significantly increased by silymarin's antioxidant capacity. The main components of silymarin are three flavonoids from the flavonol subclass silybin, which are followed by silidainin and silychristin. Silybin protects the liver by preserving glutathione in the parenchyma cells. Cell membrane replacement and repair are assisted by parenchyma cells (PC).\(^{[56-57]}\)

These ingredients probably work together to prevent liver cells from being destroyed. Conducted a pharmacokinetic study on rats after preparing the silymarin phytosome. Due to a notable enhancement in the lipophilic characteristic of the synthesized silybin-phospholipid complex and an improvement in the biological effect of silybin, the study found that oral administration of the complex significantly enhanced the bioavailability of silybin in rats. Silymarin phytosomes have been shown to exhibit a stronger antihepatotoxic effect than silymarin alone and to be able to protect broiler chick performance from aflatoxin B1.\(^{[58]}\)

Combined hesperidin with hydrogenated phosphatidylcholine to form a novel hesperidin phytosome. After that, rats that had received CCL4 were subjected to pharmacokinetic testing and an evaluation of the antioxidant activity of this complex. It was shown that the phytosome had a sustained release characteristic that lasted longer than twenty-four hours and boosted antioxidant activity. A pharmacokinetic analysis revealed that the phytosome had a higher relative bioavailability than the parent molecule at the same dose level. Reported phytosomes with silymarin that combined to generate a phospholipid-containing molecule. It shows considerably higher specific activity than the separate components in terms of the percentage decrease of edema, the inhibition of
myeloperoxidase activity, the antioxidant and free radical scavenging properties, and the total duration of action.[59]

Created the quercetin phospholipids complex using an easy-to-replicate procedure, and demonstrated that in rat liver damage caused by carbon tetrachloride, the formulation demonstrated superior therapeutic activity than the molecule. Have out a human investigation to evaluate silybin absorption when it is directly linked to phosphatidylcholine. After giving healthy participants single oral doses of silybin phytosome and a comparable quantity of silybin from milk thistle, plasma silybin levels were measured.[60]

The findings showed that compared to the absorption of silybin from ordinary milk thistle extract, the absorption of silybin from silybin phytosome is almost seven times larger. Carried out several investigations on created the quercetin phospholipids complex using an easy-to-replicate procedure, and demonstrated that in rat liver damage caused by carbon tetrachloride, the formulation demonstrated superior therapeutic activity than the molecule. Have out a human investigation to evaluate silybin absorption when it is directly linked to phosphatidylcholine.

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**Recent Advanced Research in Phytosome**

**Phospholipids Complexation**

Researchers are doing a lot of study, and the most recent studies show that phytosome technology is a revolutionary way to increase the absorption and bioavailability of plant extracts while drastically lowering the dosage level. Due to their possible pharmacological effects, some plant extracts such as andrographolide, ginkgo biloba extract, quercetin, curcumin, silymarin, and grape seed extract are receiving increased attention these days. Newer studies have been made possible by the technique's applicability and the rising need for herbal remedies for the treatment of numerous diseases in the current environment. The important works of a few different researchers are listed in brief below.

Researchers found that phospholipids had a strong affinity for particular flavonoid groups. By complexing phospholipid with extremely polar botanical derivatives—that is, between pure phospholipids and pure active principles—they created a novel class of molecules known as phytosomes. He began by determining the chemophysical characteristics of phytosomes including glycyrrhetinic acid, quercetin, escin, and catechin. He also acquired some pharmacological information.

He stated right away that phytosomes were an effective way to deliver phytocomponents through the skin.[62] The hepatoprotective properties of silymarin were investigated in nine human volunteer patients. The results showed that the phytosomal form of silybin had four times more hepatic passage.[56, 57]

Scientists synthesized phytosomes from Gingko biloba terpenes and found that they effectively relieved individual contact reactions to other ingredients in topical formulations. Researchers used silymarin phytosomes in a number of their studies, and they found that the phytosomal version had superior fetoprotectant efficacy. Additionally, researchers found that silymarin phytosomes had superior fetoprotectant action against ethanol-induced behavioral deficits than did uncomplexed silymarin.

In terms of the percentage reduction of edema, the inhibition of myeloperoxidase activity, the antioxidant activity, and the free radical scavenging activity, scientists discovered that the silymarin phytosomes exhibited substantially higher specific activity and a longer lasting action than the single ingredient.[61]

Additionally, in two distinct investigations, researchers produced phytosomes containing naringenin and curcumin, and they found that the phytosomal complex's antioxidant activity had superior therapeutic efficacy. They created basic protocols for phytosome preparation.[62, 63]

Scientists found that in sylimarin phytosomes in
experimental models, the well-known calming effect of silymarin is enhanced by a factor of more than six. Because the complex has a greater affinity for skin phospholipids, the phytosome form's activity is improved when compared to the free active principle. Researchers have found a connection between the phospholipid complex's liposomal-like characteristics and the hydration of the superficial corneous layer.

Ginselect phytosomes are able to transdermic activity that supports the phospholipid complex's ginseng saponin to make contact with the skin. In their review, researchers found that phospholipid complexation is an excellent way to prepare cosmetics for topical distribution of plant-derived compounds. Oxymatrine- phospholipid complex (OMT-PLC) was developed by scientists to increase OMT's lipid solubility and efficacy. Their study's goal was to investigate the potential of using an OMT-PLC in conjunction with a microemulsion as a topical delivery vehicle to improve OMT's absorption and effectiveness. The solubility of OMT-PLC was ascertained and a microemulsion phase diagram was created. They acquired a range of physicochemical characteristics as well as in vitro and in vitro skin permeability. They came to the conclusion that phospholipid complexes combined with microemulsions make an efficient topical administration system for OMT.

Researchers found that a higher bioavailability could not be achieved by including a large amount of curcumin into a topical formulation. They created a complex between curcumin and phosphatidylcholine and used FT-IR, TLC, DSC, and melting point analysis to describe them. They contrasted the functions of vesicular systems such as phytovesicles, liposomes, and niosomes. It may be because of the complex's amphiphilic character, which significantly increases the curcumin's water and lipid miscibility, that the phytovesicles exhibit superior antioxidant and antiaging qualities than other vesicular systems.

In a randomized, double blind cross over design human trial, scientists examined the relative absorption of a standardized curcuminoids mixture and its matching lecithin formulation (Meriva). They reported that the Meriva had better plasma curcuminoid profile and increased absorption at a dose that was much lower than that of the unformulated curcuminoid mixture. Researchers have created a curcumin-phospholipid combination with phospholipids and curcumin in a 1:2 molar ratio. They used DSC analysis and FT-IR spectroscopy to verify the complex's synthesis. When they compared the curcumin's skin penetration with that of the complexed form, they discovered that the complexed form had a 60% higher penetration rate through rat skin. They found that compared to pure curcumin, the phospholipids complex exhibits greater transdermal penetration.

Because of their lower lipophilicity, gallic acid and its derivatives exhibit limited absorption when given orally, despite being a family of naturally occurring polyphenol antioxidants with potential health effects that have recently been demonstrated. In order to get around this restriction, the scientists created a combination known as gallic acid-phospholipids in an alternative ratio to enhance gallic acid's lipophilic qualities. Differential scanning calorimetric (DSC), ultraviolet light-visible spectrometry (UV), infrared spectrometry (IR), and solubility/dissolution analyses were among the methods used to examine the complex's physicochemical characteristics. The findings showed that no new molecule was formed between the phospholipids and Gallic and phospholipids in the complex; rather, they were bound together by non-covalent bonds.

Conduct preclinical research on a novel polyherbal phyto-complex hair growth stimulating cream that contains aqueous extracts of Abrusprecatorius (A. prectorius) Linn and Trichosanthes cucumerica (T. cucumerica) Linn. In the experimental investigation, both plant extracts were extracted, tested chemically, and then the extracts were combined to form a phyto-phosphatidylcholine complex. The formulation of the cream containing the polyherbal phyto-complex was then prepared, and its efficacy was assessed. Preclinical research demonstrated the effectiveness of the 2% polyherbal phytocomplex hair growth boosting cream by showing results comparable to those of 2% minoxidil. The formulation may be utilized to treat alopecia, as evidenced by the significant
increase in the percentage of hair follicles in the anagen phase.[73-75]

CONCLUSION

Research in the field of new medication delivery systems is still in its exploratory stages because it involves lengthy studies that focus on plant actives and extracts. With reference to plant products' utility, particularly those that contain flavonoids and other polyphenolic chemicals. The phytophospholipid complexation technology has presented a huge opportunity and hope for herbal medications that have not demonstrated a comparable response in vivo despite encouraging in vitro results.

Plants that contain flavones and other polyphenolic constituents have a great deal of therapeutic potential. However, due to their inability to cross lipoidal barriers, their application in the treatment of severe illnesses such as cancer, hepatic diseases, and rheumatic conditions has remained unresolved for a considerable amount of time. Phytosomes are new formulations that provide hydrophilic flavonoids and other comparable chemicals with enhanced skin or gastrointestinal tract bioavailability. The phytosome formulation process is straightforward and easily expanded to a commercial scale.

For this kind of new formulation, the characterization procedures and analytical techniques are well-established. For creative phytosome applications, techniques, and formulations, numerous patents and commercialized formulations have already received approval. Regarding phytosome technology's potential, it appears to have a bright future in the formulation of hydrophilic plant chemicals and their uses.

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