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Review on Niosomal Formulation and Evaluation of Herbal Drugs

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ABSTRACT:

Herbal remedies have been used to cure diseases since ancient times due to their potential and minimal side effects. The extraction, processing, standardisation, and identifying of herbal medications are difficult.

Rarely does it inspire scientists to develop delivery systems for herbal medicines. Herbal medicines diminished efficacy is a result of the outdated and traditional way that patients are given them. To solve this issue, plant medications are now delivered through noval techniques like niosomes. Boom in a new delivery strategy, herbal medicines will become more efficient and secure, as well as more stable.

This review article discusses different niosomal formulations loaded with herbal drugs, herbal extracts to increase bioavailability and improve patient compliance, efficacy of phytomedicines, type of active ingredients, biological activity and Evaluation, application of Niosomal formulation of herbal drugs to achieve better therapeutic response.

Keywords: Niosomes, herbal drugs, herbal extract, gel, *Psidum gujava, curcurbita pepo L, Propolis, Echinacea angustifolia, Justicia adhatoda* (JA), *Hypericum perforatum, G. sylvestre, Taraxacum officinale, Lycopene.*

INTRODUCTION:

The foundation of traditional medical methods that are still used today is made up of natural substances extracted from plants known as "herbal drugs". With the progress of science and technology in the field of formulation technology of drug products, now a day's herbal dosage forms have evolved from simple mixtures and pills to highly sophisticated technology-based drug delivery systems.[1]

In order to reduce the side effects associated with allopathic medicine, there is a need to develop herbal formulations of novel drug delivery system i.e niosomal formulation.

The materials and preparations used in herbal medicines are drawn from plants and have therapeutic or other uses for people. Natural products, particularly plants, have been used for thousands of years to cure a variety of diseases, and many contemporary drugs have been created from them.[2]

These plants can be sold either raw or as extracts, in which the plant is macerated with water, alcohol, or other solvents to separate some of the chemicals, such as fatty acids, sterols, alkaloids, flavonoids, glycosides, saponins, and so forth.

SALIENT FEATURES OF NIOSOMES:[3 -4]

- Niosomes can entangle the solute and make the entangled drug more solid because they are osmotically stable.
- Niosomes are safe, non-immunogenic, and biodegradable non-ionic surfactants.
- Niosomes have a structure that is mainly hydrophobic and deliquescent, which enables the drug molecules to have a wide range of solubilities
- Labile and sensitive medication can be easily delivered by niosomes.[3]
- Simply by protecting the drug from the biological surroundings, the drug's accessibility at the specific location is improved.[4]

ADVANTAGES:[5-6]

- Minimized adverse effects and exhibits the longest possible action.
- The preparation's active ingredient or constitutent is shielded by a bilayer from various external and internal variables.
- The vesicles can act as a depot to release the drug slowly and offer a controlled release.

- Niosomes can be administered parenterally, topically, or orally.[5]
- Non-ionic surfactants in niosomes can act as penetration enhancers various niosome preparation techniques have been due to their ability to fluidize the stratum corneum lipid reported and it has been found that niosomal properties bilayers and diffuse through them.[6]

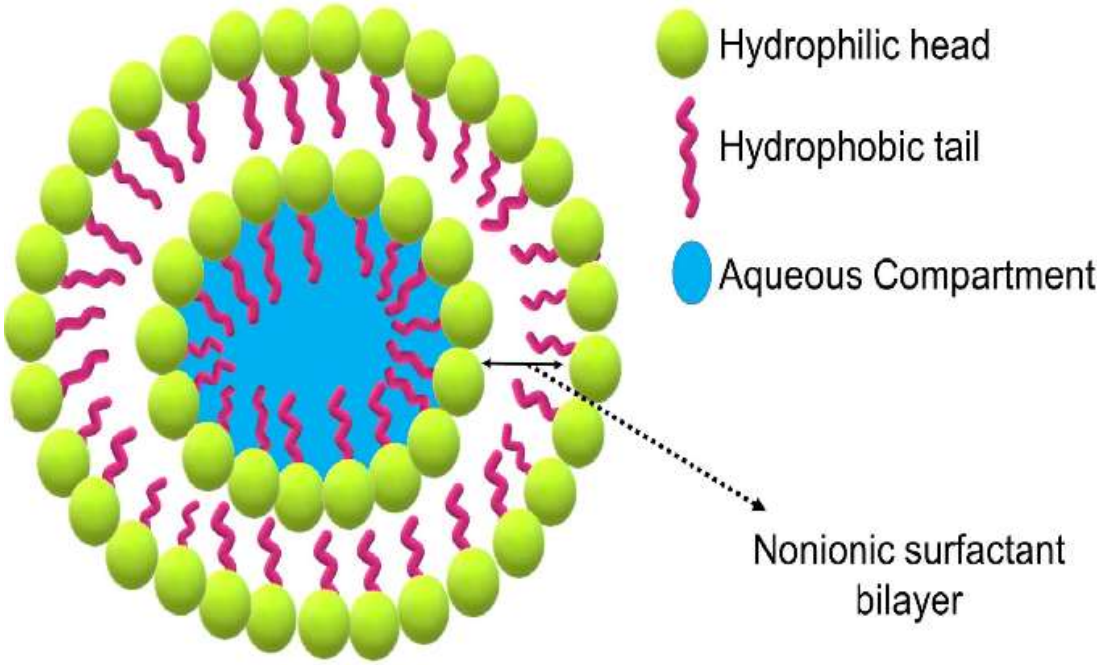

Figure 1:. A typical structure of niosome

COMPOSITION OF NIOSOMES:[7-8]

The vital components used in the Niosomal formulation are:

♣ Non-ionic surfactants

♣ Cholesterol

♣ Charge inducer

♣ Hydration medium

1) Non-ionic surfactants:

The surface-active substance is the main ingredient used to create the noisome. They are amphiphilic in character and have a non-polar tail and polar head. These substances lack an electrical charge, making them more durable, compatible, and non-toxic than other surfactants like anionic, cationic, and amphoteric surfactants. These substances lessen hemolysis and cellular surface inflammation.[7]

2) Cholesterol:

The production of niosomes primarily uses cholesterol, a waxy steroid derivative found in cell membranes. By incorporating cholesterol into the bilayer structure of niosomes, leakiness of the cell membrane is reduced, commonly increasing the entrapment efficiency of the niosomes.

In order to give the niosomal bilayer hardness and the correct direction/adjustment, cholesterol is typically added to non-ionic surfactants. It is well known that cholesterol prevents the niosomal system's shift from the gel to liquid phase, making the niosomes less leaky.[8]

3) Charge inducers:

Charge inducers are added in the preparation to increase the stability of niosomes by electrostatic repulsion to avoid coalescence.

4) Hydration medium:

Phosphate solution is the hydration medium that is most frequently used in the production of niosomes. At different pH levels, these phosphate buffers are used. The solubility of the drug being encapsulated determines the real pH of the hydration medium.

TYPES OF NIOSOMES

METHODS OF PREPARATION: [9-15]

1) Hand shaking method (Thin film hydration technique).

A volatile organic solvent (diethyl either, chloroform or methanol) is used to dissolve the mixture of vesicles-forming components like cholesterol and surfactant in a round-bottomed flask. Using a rotary evaporator, the organic solvent is removed at room temperature (20°C), leaving a thin coating of solid mixture deposited on the flask wall. Rehydrating the dried surfactant layer with aqueous phase at 0 to 60 °C while gently stirring is possible. Using this method, normal multilamellar niosomes are created.[9]

2) Micro fluidization

A more modern method for creating unilamellar vesicles with a specific size distribution is micro fluidization. This technique is based on the submerged jet principle, in which two fluidized streams engage in precisely planned microchannels inside an interaction chamber at extremely high speeds. The arrangement of the thin liquid sheet impingement along a common front ensures that the energy provided to the system stays in the region where niosomes form. The formed niosomes are more uniform, smaller, and more reproducible as a consequence.[10]

3) Sonication:

Sonication is a common technique for the niosome preparation. By dissolving the drug in the buffer, the drug solution is created using this technique. The mixture of non-ionic surfactant is then introduced at an optimized ratio to this buffer drug solution. The mixture is sonicated at a particular frequency, temperature, and time to produce the specified niosomes. It is one of the simple ways to regulate the particulate size of the niosomes. The diameters of niosomes with a narrow size range can be reduced using this technique. Although they require a lot of energy, probe sonicators can also be used. As a result, there is an abrupt rise in temperature and titanium release.[11]

4) Ether Injection Method : A technique of injecting ether

By gradually adding a surfactant solution dissolved in water, this technique offers a way to create niosomes.Diethyl ether is added to tepid water that is kept at 60°C. A 14-gauge needle is used to introduce the surfactant solution dissolved in ether into the material's aqueous solution. Ether vapourization results in the creation of single-layered vesicles.

The diameter of the vesicle can vary from 50 to 1000 nm depending on the conditions used.[12]

5) Trans-membrane pH-gradient (inside acidic)

In chloroform, surfactant and cholesterol are dispersed.

Next, a thin film is formed on the wall of the flask with a round bottom as the solvent evaporates under decreased pressure. By vertex mixing, 300mM of citric acid with a pH of 4.00 is added to the solid. The multilamellar compartments are triple-frozen, shared, and sonicated afterward. to this concentration of niosomes. Vortexes form after adding an aqueous solution containing 10 mg/ml of the substance. The sample's PH is then increased with 1M disodium phosphate to 7.0–7.2. To produce niosomes, this combination is then heated at 60 °C for 10 minutes.[13]

6) The Bubble Method:

The preparation of the niosomes using the bubble approach is novel because it does not involve organic solvents. This technique makes use of the bubbling unit. The temperature is regulated by a round-bottomed flask with three necks that is placed in a water bath. The first neck is filled with water-cooled backflow, the second neck is lined with a thermometer, and the third neck is filled with nitrogen.

At 70 °C, buffer solution with a pH of 7.4 is combined with detergent and cholesterol. After mixing the solution for 15 seconds with a high-shear homogenizer, it is instantly bubbled with nitrogen gas at 70 degrees.[14]

7) Membrane Extrusion Method:

The surfactant, cholesterol, and diacetyl phosphate are combined with chloroform in this process. Then a thin layer is created by evaporating this chloroform mixture. With the help of a liquid solution, polycarbonate membranes are hydrated.

Through this membrane, the solution and resulting suspension are ejected. (which consist of 8 passages). This technique also yields the niosomes' required size.[15]

EVALUATION OF HERBAL NIOSOMES [16-20]

1) Drug content:

By dissolving 1 ml of the niosomal formulation, the amount of drug present in the niosomes is quantified. The pH 6.8 phosphate solution in 10 ml.[16]

2) Entrapment Efficiency:

The quantity of drug encapsulated in the prepared formulation is indicated by entrapment efficiency. To separate the unentrapped drug, 1ml of the niosomal formulation was taken and dissolved in 10ml of 6.8 pH buffer. This solution was then moved to Ephendroff tubes and centrifuged at 15000 rpm, 4 °C for 15 min in two cycles. The clear percentage is used to calculate the amount of free drug.[17]

The following equation is used to determine the portion's free drug content. To determine the entrapment efficiency, the UV spectrophotometer's absorbance at 271 nm was recorded.

Entrapement Efficiency =Total drug + free drug / total drug 100 equals entrapment efficiency percent.

3) In *vitro* drug release:

Niosomal preparation is put in the Franz diffusion cell, which has a cell phase membrane, in the donor chamber for in-vitro drug release.

The niosomes are then examined at room temperature against a buffer with a pH of 6.8. The samples are then taken out of the medium at appropriate times, and aliquots are replaced before being tested with a UV spectrophotometer for drug release.[18]

4) Particle Size:

A nanoparticle analyser measured the formulation's niosomes' average diameter (HORIBA SZ 100. Series). From each formulation, one drop of the sample was removed and diluted in 10 cc of the dispersion medium (distilled water). The submicron band of particle sizes is measured using dynamic light scattering (DLS).[19]

5) Zeta potential measurement:

Each molecule in the preparation has a unique zeta potential, which can be measured. It is a crucial element that must be taken into account in order to comprehend the electric double layer repulsion, and phase analysis can be used to quantify it. Charged particles in the preparation are drawn to the electrode with the opposite charge when an electric field is introduced, while viscous forces operating on the particle tend to oppose the movement. When balance is attained, the particles exhibit electrophoretic mobility—constant velocity motion—and the zeta potential can be measured.[20]

REVIEW ON VARIOUS NIOSOMAL FORMULATION AND EVALUATION FOR HERBAL DRUGS

1) DEVELOPMENT OF HERBAL NIOSOMES FOR WOUND HEALING

Psidum gujava (guava) has traditionally been used to address a variety of disorders. Quercetin, a flavonoid found in guava leaves, is accountable for the plant's ability to promote wound healing. To enhance the transport and efficacy of many materials through stratum corneum one of various methods expanded nowadays is the usage of new drug delivery system such as Niosomal formulations.[21] Niosomes are self-assembling non-ionic surfactants that can be used for both hydrophilic and hydrophobic compounds. They can contain cholesterol or not.

Using a Soxhlet device, *Psidum guajava* is extracted, and the extract is then tested for phytochemicals, antimicrobial activity, and TLC. Span 60, cholesterol, diethyl ether, chloroform, buffer, and extract are ingredients in the composition. The reverse phase evaporation technique is used to make the herbal drug-loaded niosomes. There are a total of twelve formulations, of which F1, F2, F3, F4, F5, F6 were made by changing the drug to surfactant ratio, and F7, F8, F9, F10, F11, and F12 were made by varying the cholesterol ratio. The drug concentration, entrapment effectiveness, particle size, zeta

potential, and in-*vitro* drug testing of the evolved herbal niosomes were assessed. The final, improved batch F7 had a decent drug content of 83.4%, a particle size of 919.5 nm, and a 2:2 cholesterol ratio.with an in *vitro* drug release of 85.32%, an entrapment rate of 90.4%, and a potential of -84.1 mV. The formulation for wound healing has been effectively developed. (V.Swetha et al,2021).

2) NIOSOMAL DELIVERY OF PUMPKIN SEED OIL: DEVELOPMENT, CHARACTERZATION AND PHYSICAL STABLITY

Pumpkin seed oil *(curcurbita pepo L) (*PSO) provides many health benefits including antioxidant, cardiovascular health boost, treatment of benign prostatic hyperplasia, and reduction of hair loss.[22]

It includes a variety of bioactive substances, including phospholipids, squalene, phytosterols, vitamins, and fatty acids. These elements have several beneficial effects on human health. Designing a suitable niosomes-encapsulated Pumpkin seed oil formulation for topical delivery was the primary goal of this research. The PSO-loaded niosomes that were produced had a spherical form and ranged in size from 138 to 366 nm. The smallest particle size was supplied by the niosomes made with Tween 20. Niosome particle size was decreased as the ratio of PSO:surfactant:cholesterol increased from 2:2:1 to 2:4:1. With a percent entrapment effectiveness of 75.9914.65%, the PSO-loaded niosomes formulation F1 (PSO: Tween 20:cholesterol = 2:2:1) had the best results. The in *vitro* release study indicated that the release mechanism was followed Korsmeyer-Peppas. The three-month storage at 30°C physical stability study showed excellent stability. (Boontida Morakul et al,2019)

3) PREPARATION OF ETHANOL EXTRACT OF *PROPOLIS* LOADED NIOSOMAL FORMULATION AND EVALUATION OF EFFECTS ON DIFFERENT CANCER CELL LINES

Propolis (bee glue) is a candidate for cancer treatment with its activity against different tumor cells and, has a wide spectrum of biological and pharmacological activities due to the diversity of its components.[23]This research used 2D and 3D cell culture to compare the antitumorigenic properties of ethanol extract of propolis (EEP) and ethanol extract of *propolis* loaded niosome (PLN). Using the thin film hydration method, niosome formulations were created. Niosomes are significant pharmaceutical delivery systems used in the therapy of cancer. Due to the impact of increased permeability and retention, nanoparticular systems accumulate more in cancer cells (EPR). In cancer cells like MCF-7, MDA-MB-231, A549, SK-MEL, SK-BR-3, and DU145, propolis extract demonstrated greater activity than propolis extract. While the percentage viability rates in cancer cells treated with PLN decreased more quickly than those treated with EEP, the slow decline in cell viability was noted in those treatments. After PLN incubation, cell viability declined in 3D culture the same way it did in 2D culture as the dose concentration rose. PLN can also be used as an antitumor medication similar to doxorubicin, but this is not the case.(Emel Oyku Cetin et al,2022).

4) FORMULATION, CHARCTERIZATION, EVALUATION OF MORUSIN LOADED NIOSOMES FOR POTENTIATION OF ANTICANCER THERAPY

Morusin (white mulberry) a water-insoluble flavonoid with numerous medicinal properties, it suppresses the genes involved in the tumor progression. Due to its poor solubility of the drug, it results in low bioavailability and rapid degradation, so it has less clinical applications, to overcome this, they synthesized a niosomal formulation to improve the aqueous solubility. *Morusin* a prenylated flavonoid derived from the root bark of *morus alba* which has anti-inflammatory, anti-oxidant, antibacterial activities.[24] (Srishti Agarwal et al ,2018).The thin layer evaporation technique was modified slightly to create the *morusin*-loaded niosomes. 20 ml of chloroform was used to dissolve 100 milligrammes of span 60, 20 mg of cholesterol, and 10 mg of the medication (*morusin)*. The solution was allowed to stir for 60 minutes, and then it was allowed to evaporate in a rotary evaporator for 1 hour, producing a thin layer. The film was then moistened with 20ml of distilled water to wash away any remaining solution. The particle was washed with distilled water after the supernatant had been discarded. The *morusin*-loaded niosomes product was freeze, desiccated and kept at 20°C until use. *Morusin* showed a steady and sustained drug release from niosomes, along with increased release in acidic pH, suggesting that it would be released effectively in the acidic environment of cancer cells, as well as reducing spontaneous drug release in the acidic environment of cancer cells and spontaneous drug release under physiological pH of normal cells. Four cancer cell lines representing various cell linages were used to evaluate the toxicity of *morusin* niosomes. These studies show that the sensitivity of cancer cells to niosomes loaded with musin is HT-29, MA-MB-453, PANC-1, and then SKOV3. They assert that all cells under study are extremely susceptible to nano formulation in a concentration-dependent manner, predicting the use of this *morusin* niosomal formulation for numerous purposes. The results of evaluation tests are size is 479nm, Encapsulation Efficiency is 97%. Controlled & sustained release of *morusin* results in enhancing therapeutic efficacy was observed in cancer cell lines of four different lineages. They anticipate that morusin loaded niosomes will open new scenarios for precise delivery of morusin to cancer sites as well as lay foundation for the development of novel targeted therapies in future.[25]

5) ENCHANCED ANTIBACTERIAL ACTIVITY OF *ECHINACEAE ANGUSTIFOLIA* EXTRACT AGAINST MULTI-DRUG RESISTENT *KLEBSIELLA PNEUMONIAE* THROUGH NIOSOME ENCAPSULATION

Alternatives to traditional antibiotics are desperately required for the treatment of many infectious diseases due to the rise in antibiotic-resistant bacteria[26]. Due to their bioactive components, medicinal plant extracts are among the promising options.The preparation of niosome-encapsulated *Echinacea angustifolia* (coneflower) extract and examination of its effectiveness against types of Klebsiella pneumoniae that are multidrug resistant. Design of Experiments was used to optimise encapsulation before an empirical research.With the aid of dynamic light scattering (DLS), transmission electron microscopy (TEM), and scanning electron microscopy, the obtained niosomes were further examined for size and shape (SEM). DLS determined the width of spherical niosomes to be 142.3 5.1 nm. With the aid of dynamic light scattering (DLS), transmission electron microscopy (TEM), and scanning electron microscopy, the obtained niosomes were further examined for size and shape (SEM). DLS analysis revealed that spherical niosomes had a diameter of 142.3 5.1 nm. The extract of *E. angustifolia* had an entrapment effectiveness (EE%) of up to 77.1% 0.3%. The made niosome demonstrated

controlled drug release in the evaluated 72 hours and storage stability of at least 2 months at both 4 and 25 C. Compared to the free extract, the encapsulated *E. angustifolia* showed up to 16 times more antibacterial action against multidrug-resistant K. pneumoniae strains. (Maryam Moghtaderi et al(2021).

6) DEVELOPMENT AND CHARACTERIZATION OF PHYTONIOSOME NANO VESICLE LOADED WITH AQUAOUS LEAF EXTRACT OF *JUSTICA ADHATODA* AND *PSIDIUM JUAJOVA* AGAINST DENGU VIRUS (DEN -2)

The leaves of *Psidium guajava* (guava) and *Justicia adhatoda* (Malabar nut) are traditionally used in the Indian herbal medicine for the treatment of dengue.[27]

the objective of the present study was to assess the antiviral activity of phyto- niosomes (PN) loaded with PG and JA aqueous extracts (AGN) against the dengue virus-2 strain (DEN-2). By using tween 80, poloxamer 407, polyethylene glycol 6000, and cholesterol, the AGN were made. The PN's particle size was determined to be between 105.1 3.6-279.4 5.2 nm. Niosomes that had been PEGylated had smaller particle sizes than those that hadn't. AGN demonstrated in *vitro* antiviral action against DEN-2 virus-infected vero cells. When kept at room temperature, capsules containing AGN powder were discovered to be steady for three months. The results of the aqueous preparations from the leaves of JA and PG showed

lyophilized aqueous leaf preparations of JA and PG at a concentration of and PN containing quercetin.The DEN-2 viral strain-infected vero cells' growth was suppressed at a concentration of 60 lg/mL. After determining its safety, effectiveness, and mechanism of action in clinical trials, it can therefore be used for the treatment of dengue. Other herbal extracts can also be encapsulated using PN, and lyophilized powders can be readily added to capsules.(Govindarajan Shyamala et al, 2021).

7) AN IN-*VIVO* STUDY OF *HYPERICUM PERFORATUM* IN A NIOSOMAL TOPICAL DRUG DELIVERY SYSTEM

They created a niosomal topical gel from *Hypericum perforatum* (St.john wort) that contained known amounts of phloroglucinols, naphthodianthrones, and polyphenolic compounds. (Wolfle U,et al,2014).They used a successful transdermal drug delivery system that could entrap both lipophilic and hydrophilic constituents in the form of niosomal gels for the treatment of wounds and scars using the reverse phase evaporation method. *Hypericum perforatum* commonly known as st. jhons wort, A herb which has been used as an anti-depressant and traditionally known as an external remedy for wounds, scars, sun burns, ulcers and hemorrhoids[28]. The *Hypericum Perforatum* traditional preparations contains variable components, have strong dermatological effects which favor the synergistic activity of hyperforin, hypericins and other hydrophilic components such as flavanoids and phenolic compounds[29]. Reverse phase vaporisation is used to create *Hypericum perforatum* niosomal gel. First, after gathering the *Hypericum perforatum* flowering tips, let them dry at 400°C in a vacuum oven. The most effective extraction technique was found by using methanol and ethanol as extraction liquids at room temperature and 700 C. The herb was cut into pieces, ground with a mixer, and then dispensed into the extraction chamber. A rotating evaporator was used to evaporate the extracts at a maximum temperature of 400 C. In the reverse phase evaporation technique, niosomes are made in a variety of ratios ranging from 20, 60, and 80. There were six niosomal formulations made. After that, a sonicator was used to mix the extract with purified water.An 800rpm stirrer was used to disperse the cholesterol and span in a solution of methanol and chloroform. The produced extract solution was mixed with the solvent for three minutes, then homogenised. In order to evaporate organic liquids, the suspension was then heated for 10 minutes at 600C in a water bath. By dissolving the gelling substance polymer in distilled water and stirring at 270 rpm with a mechanical stirrer, niosomal gel was created. 38 cc of distilled water and two grammes of niosomal formula were combined to make gel. Mongrel dogs serve as the subjects for the *in-vivo* research. Due to the extent of the drug release (78.1% after 180 minutes) and the fact that it lowers the polymer content, the niosomal formulation F1Span20: cholesterol 1:1 was tested in *in-vivo* studies on dogs. This formulation showed the highest content of active constituents and had 80% of the drug entrapped. Complete reepithelialization, a substantial shrinkage of the wound, the restoration of skin appendages, and the appearance of hair follicles—markers of the end of the healing process—are the outcomes. Both 3% hydroxyethylcellulose and 1.5% sodium carboxymethylcellulose were used as fibres *in -vitro* test. In *vitro* drug release studies using both niosomal gels revealed comparable rates and levels of drug release after 180 minutes (85.0 %, 78.8 %, and 1.5% sodium carboxymethylcellulose, respectively). Assuming the synergistic action of hyperforins, hypericins, flavonoids, and phenolic compounds, the niosomal gel 1.5% sodium carboxymethylcellulose exhibits strong effects in wound treatment of 16 adult mongrel dogs when compared to panthenol.

8) DEVELOPMENT OF *GYMNEMA SYLVESTRA* EXTRACT LOADED NONIONIC SURFACTANT BASED NIOSOME

Nonionic surfactant-based *G. sylvestre* (gymnema) extract-loaded niosomes were prepared using the thin film hydration method.[30]The optimized formulation was screened for entrapment efficiency of the constituents, as well as other parameters such as release kinetics, vesicle size, zeta-potential and stability studies. The parent extract and optimized niosomal formulation were evaluated for their antihyperglycemic potential in an alloxan-induced diabetic animal model. This research highlights the benefits of niosomes that have been loaded with *G. sylvestre* extract and supports their potential to boost the anti-diabetic effects of the plant. (Kamble B, et al , 2013).

9) STABLITY AND BIODISTRIBUTION OF *TARAXAUM OFFICINALE* NIOSOMES

The plant is weed and generally found road side, wildely grown in crops and the botanical name is *Taraxacum officinale* with asteraceae family.[31]The roots and leaf extract have many potential activities like hepatoprotective, antioxidant, blood sugar decreasing activity, and triglyceride and cholesterol decreasing activity. The plant was traditionally used as diuretics from many years. It has high level of potassium supplement and rich in multivitamins. Dandelion is used to manage hypertension and lower blood pressure as well. Beta carotene and polyphenols, which can be developed as phytosomes and improve the bioavailability of dandelion plant extract and its solubility but are not present in plant extract preparation, are the primary chief pharmaceutically bioactive constituents. (Sanghadeep, G, et al , 2022).

10) ANTI -DIABETIC ACTIVITY OF *LYCOPENE* NIOSOMES

*Lycopene i*s a principal carotenoid present in ripe tomatoes (Lycopersicum esculentum). It has characteristic red color and has gained focus for its potential health benefits.[32] Liposomes are associated with problems related to stability such as aggregation, fusion, leakage, and sedimentation on storage. Niosomes are non-ionic spheres that contain cholesterol and surfactant as excipients. These problems may be overcome by niosomes, which can speed up and increase the amount of solubilization into aqueous intestinal secretions. Nonionic surfactants, like phospholipids, give off the capacity to form vesicular systems (niosomes) when dispersed in aqueous solutions. (Sharma P.K, et al 2017).

CONCLUSION:

Numerous efforts to create a drug delivery system based on herbs and their phytoconstituents with niosomes have been made in an effort to improve therapeutic effects and bioavailability. Herbal niosomes were created and improved using a variety of niosomal processing techniques. Niosomes, which are thought of as innovative drug delivery methods, can increase the solubility and drug compounds found in nature that are stable. They were created to offer natural pharmaceutical substances that can be targeted and released under controlled conditions.

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