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A COMPREHENSIVE REVIEW ON NIOSOME FOR NOVEL DRUG DELIVERY SYSTEM

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ABSTRACT

The concept of targeted delivery of drugs is designed to try to concentrate the drug in the tissues of interest while reducing the relative concentration of the drug in the remaining tissues. As a result, on the targeted location, drug is placed. Hence, the medication does not affect underlying tissues. In fact, product failure does not occur due to drug localization, contributing to optimum drug efficacy. Different drug targeting carriers have been used, such as immunoglobulin, serum proteins, synthetic polymers, liposomes, microspheres, erythrocytes, and niosomes. Niosomes are non-ionic surfactant vesicles obtained by a hydrating cholesterol and non-ionic surfactant mixture. It can be used as amphithelial and lipophilic drug carriers. The medicine is encapsulated in a vesicle in a drug delivery network of niosomes. Niosomes are biodegradable, non-immunogenic biocompatible, and demonstrate versatility in their structural characterisation. The main aim of this analysis is to use niosome technology to treat a variety of diseases, niosomes have good research opportunities and support the science and pharmaceutical industries.

KEYWORDS: Niosomes, Method of preparation, Evaluation study, Application of Niosomes

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INTRODUCTION

Paul Ehrlich, in 1909, began the era of targeted delivery production when he envisaged a method for drug delivery that would specifically target diseased cell. Drug targeting can be described as capable of directing a therapeutic agent directly to the desired place of action with little to no interference with non-target tissue [1]. Niosomes are amongst these carriers' brightest. Niosomes are microscopic lamellar structures ranging from 10 to 1000 nm and contain biodegradable, non-immunogenic and biocompatible surfactants [2].

Niosomes are a novel drug delivery system that has imprisoned hydrophilic drugs in the core cavity and hydrophobic drugs in the non-polar region found in the bilayer and can therefore be integrated into niosomes [3]. The niosomes are amphiphilic in nature, in which the medication is encapsulated in a vesicle made of non-ionic surfactant, and therefore the name niosomes. The size of the niosomes is very small and microscopic [4]. L'Oreal developed and patented the first formulations of the niosomes in 1975. With proper surfactant mixtures and charge-inducing agents from thermodynamically stable vesicles present. Niosomes are often studied as an alternative to liposomes as they mitigate the liposomal drawbacks [5].

Niosomes between these carriers are one of the strongest. Niosomes are structurally similar to liposomes and are equiative in the capacity of drug delivery, but high chemical stability and economy make niosomes superior to liposomes. All consist of bilayer, which in the case of liposomes is composed of non-ionic surfactant,

and phospholipids [2]. The niosomes are amphiphilic in nature, which allows the trapping of hydrophilic drugs in the core cavity and hydrophobic drugs in the non-polar region present in the bilayer hence the integration of both hydrophilic and hydrophobic drugs into niosomes. The structure of niosomes is given below in **Figure 1** [6].

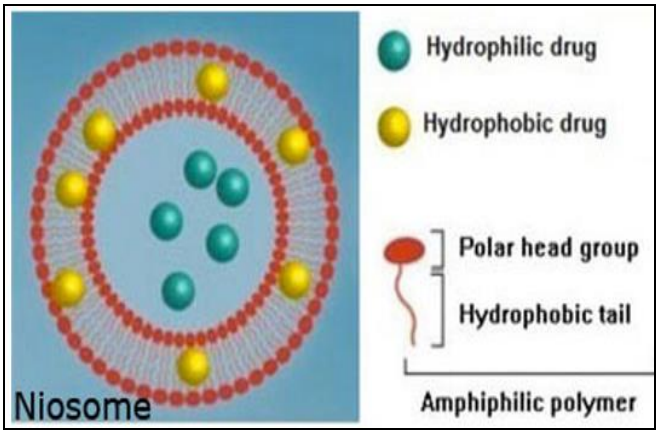

Figure 1: Structure of Niosomes

Advantages [7, 8]

- Bioavailability Improvement: The term bioavailability alludes to the part of a dosage that is accessible at the site of activity in the body. Niosomes have unmistakable advantages over normal plans, because the vesicles can serve as drug stores and protects sedate from acidic and enzymatic degradation in the gastrointestinal tract, leading to an increase in bioavailability and further increasing the ability to cross the gastrointestinal tract 's anatomical barrier.

- They enhance the restorative execution of the particles of the medication by postponing the leeway from dissemination, shielding the medication from natural condition and restricting the cell-targeting effect.

- In the aqueous phase niosomal dispersion may be emulsified in a non-aqueous phase to regulate delivery.

- Rate of drug and administer normal vesicle in external nonaqueous phase.

- They are osmotically active and stable, as well as they improve the stability of entrapped substance.

- No special conditions are required for the handling and storage of surfactants.

- Increase oral bioavailability of poorly absorbed drugs and increase the penetration of drugs in the skin.

- They can be made via oral, parenteral as well as topical routes to the site of action.

Disadvantages

The niosomes suffer certain demerits, which include the following [9]:

- Aqueous suspensions of niosomes may have limited shelf life due to fusion, aggregation, leakage of trapped drugs and hydrolysis of encapsulated drugs

- Methods of preparation of multilamellar vesicles, such as extrusion, sonication, are time-consuming and may require specialized processing equipment.

Types of Niosomes [4, 10]

Bola Surfactant Containing Niosomes

The use of surfactant in niosome-containing Bola surfactant is made of omega hexadecylbis-(1-aza-18 crown-6) (bola surfactant): span- 80 / cholesterol in 2:3:1 molar ratio.

Proniosomes

Proniosomes are made from a combination of the carrier and the surfactant. Niosomes are produced after the proniosomes have hydrated.

Aspasomes

Aspasomes are generated using the mixture of acorbylpalmitate, cholesterol and extremely charged lipid diacetyl phosphate that prompts vesicle arrangements. Aspasomes are first hydrated with the arrangement of water / fluid and then the niosomes are subjected to sonication. Aspasomes can be used to develop the medication's transdermal saturation. Aspasomes have also been used to decrease scattering caused by receptive oxygen species, as it has innate properties for cell reinforcement.

Niosomes in Carbopolgel

Niosomes is prepared from medications, spans and cholesterol, and are then integrated into carbopol-934 gel (1 % w/w) base containing propylene glycol (10% w/w) and glycerol (30% w/w). Vesicles in water and oil

method (v/w/o) In this technique, the aqueous niosomes vesicle in oil emulsion (v/w/o) into an oil stage frame in water. This can be formed by expanding the suspension of niosomes from a mixture of sorbitol monostearate, cholesterol and solulan C24 (Poly-24-Oxyethylene cholesteryl ether) to an oil stage at 60 °C. This results in the formation of vesicles in water in oil (v/w/o) emulsion which shape vesicles in water in oil gel (v/w/o gel) by cooling to room temperature. The v/w/o gel thus obtained can catch proteins / protein drugs and also protect them against enzyme degradation after oral administration and controlled release.

Niosomes of Hydroxyl Propyl Methyl Cellulose

In this case a base containing 10% glycerine of hydroxyl propyl methyl cellulose was first prepared and then incorporated into it niosomes.

Deformable Niosomes

The deformable niosomes contain the combination of non-ionic surfactants, ethanol, and water. These are smaller vesicles, which easily move through stratum corneum pores, leading to improved efficiency of penetration. This can be used to topical preparations [11, 12]. The niosomes are also classified according to the number and size of bilayer, which is as follows,

i) Multi Lamellar Vesicles (MLV)

Multilamellar vesicles are the niosomes that are used the most. It is composed of multiple bilayers. The estimated diameter of the vesicles is 0.5-10 μm. It is easy to produce and is mechanically stable after long periods of storage.

ii) Large Unilamellar Vesicles (LUV)

These are the large unilamellar vesicles with a high aqueous / lipid compartment ratio, so that greater amounts of bio-active materials can be clogged.

iii) Small Unilamellar Vesicles (SUV)

These small unilamellar vesicles are prepared mainly from multilamellar vesicles by method of sonication, French pressing and extrusion [13].

Components of Niosomes

Cholesterol and non-ionic surfactants are the two major components used for niosome readiness. Cholesterol is used to give unbending nature and suitable form, fitting to the niosomes. The surfactants part assumes a notable part in niosome development. For the most part, the corresponding non-ionic surfactants are used to organize the spans of niosomes (span 60,40,20,85,80), tweens (between 20,40,60,80), and (brij 30,35,52,58,72,76) (13).

Cholesterol

Cholesterol is an amphiphilic molecule; it orients its OH group towards the hydrocarbon chain of the aqueous process and aliphatic chain of the surfactants. Cholesterol is typically applied to the non-ionic surfactants by a waxy steroid metabolite in order to provide rigidity Cholesterol is often considered to avoid leakage by abolishing the liquid phase transfer gel [14].

Non-ionic Surfactants

Niosomes are unilamellar non-ionic surfactant or multilamellar vesicles formed from non-ionic surfactants of synthetic origin. Non-ionic surfactant has group head hydrophilic and tail hydrophobic. Consequently, as HLB value increases the alkyl chain, the size of the niosome decreases.

Therefore, HLB value 14-17 is not appropriate for formulating a niosome. HLB values 8 have the highest performance in interception [14, 15]. Non-ionic surfactants are as follows:

Ether Linked Surfactant

These are surfactants contain hydrophilic and hydrophobic molecules which are related to the general formula (CnEOm) by ether, polyoxyethylene alkyl ethers where n; i.e. the number of carbon atoms varies between 12 and 18 m; i.e. the number of oxyethylene units varies between 3 and 7.

Di-alkyl Chain Surfactant

Surfactant was used as a main component of stibogluconate niosomal preparation and its potential was explored in the delivery of sodium stibogluconate in experimental marine visceral leishmaniasis.

Ester Linked

These surfactants have an ester association between hydrophilic and hydrophobic groups; thus, they are also called surfactants linked to Ester. This surfactant has also been studied for its use in the preparation of niosomes containing stibogluconate and in the delivery of sodium stibogluconate to marine visceral leishmaniasis.

Sorbitan Esters

These are the surfactants which are related to ester. Commercial sorbitan esters are mixtures of the partial esters of sorbitals and their mono- and oleic acid di-anhydrides.

Charge Inducers

There are two types of charged inductors, such as inducers of positive and negative charge. It increases vesicle stability by inducing charge on the surface of the prepared vesicles. It works by preventing vesicles from fusing due to repulsive forces of the same charge and by providing higher zeta potential values. Sterylamine and cetylpyridinium chloride are the widely used positive charge inducers, and the negative charge inducers are dicetyl phosphate, dihexadecyl phosphate and lipoamine acid [15].

Factors Governing Niosome Formation
Niosome Composition

Ideally the presence of a specific class of amphiphilic and aqueous solvent is necessary for the formation of niosomes, but in some cases cholesterol is necessary in the formulation in order to provide the niosomes with rigidity, proper shape and conformation. Cholesterol also stabilizes the system by preventing aggregates from forming through repulsive steric or electrostatic effects. An example of steric stabilisation is the use of Solulan C24 (a poly-24-oxyethylene ether cholesteryl) in the niosome formulations of doxorubicin (DOX) sorbitan monostearate (Span 60). An example of electrostatic stabilization is the inclusion of dicetyl phosphate in 5(6)- carboxyfluorescein (CF) loaded Span 60 based niosomes [16].

Surfactant and Lipid Level

The surfactant / lipid level is typically maintained at 10-30 mM (1- 2.5 per cent w / w) to allow niosomal dispersions. If the surfactant is altered during the hydration step, water ratio may affect the system's microstructure and its properties. If we increase the surfactant / lipid ratio the total amount of drug encapsulated increases as well, but the system's viscosity ratio also increases [17].

Nature of the Encapsulated Drug

The nature of encapsulated drug influences the niosomal formation, generally the physico-chemical properties of encapsulated drug influence charge and rigidity of the niosome bilayer. The encapsulated drug interacts with surfactant head groups and produces the charge that induces mutual repulsion between surfactant bilayers and thus increases vesicle size, and also causes vesicle aggregation, which is prevented by the use of electrostatic stabilizers such as dicetyl phosphate in 5(6)-carboxyfluorescein (CF) [18].

Structure of Surfactants

The geometry of the vesicle to form from surfactants is affected by the structure of the surfactant which can be defined by critical parameters of the packaging. The structure of the vesicle to be formed can be determined by the critical packaging parameters of the surfactants. Critical packing parameters can be defined using following equation,

$$\text{CPP (Critical Packing Parameters)} = V/ l_c \times a_0$$

Where, v = hydrophobic group volume, l_c = the critical hydrophobic group length, a_0= the area of hydrophilic head group. From the critical packing parameter value type of miceller structure formed can be ascertained as given below, If CPP < ½ formation of spherical micelles, If ½ < CPP < 1 formation of bilayer micelles, If CPP > 1 formation inverted micelles [17, 19].

Temperature of Hydration

Hydration temperature influences the shape and size of the niosome, the change in temperature of the niosomal system affects the assembly of surfactants into vesicles which induces the transformation of the vesicle form. Ideally, the niosome hydration temperature should be above the system's liquid phase transition temperature gel [20, 21].

Method of Preparation
Ether Injection

Slow injection of surfactant by this method: cholesterol (150micro.mol.) in 20ml ether by means of a 14-gauze needle (25ml / min.) in preheated 4ml aqueous phase maintained at 600c. The ether solution was evaporated using a rotary evaporator, forming single layered vesicles after evaporation of the organic solvent [11].

Hand Shaking Method (Thin Film Hydration Technique)

The surfactant and other vesicles that form ingredients such as cholesterol are blended and mixture dissolved in a round bottom flask in a volatile organic solvent such as diethyl ether,

chloroform or methanol. The organic solvent is extracted at room temperature (20 °C) using a rotary evaporator, thus depositing a thin layer of solid mixture on the flask surface. The dried surfactant film can be rehydrated with aqueous phase at 60°C with gentle agitation results in formation of multilamellar niosomes [22].

Sonication

Baillie *et al.,* prepared niosomes using sonication method in 1986. In this method, the surfactant: mixture of cholesterol (150micro.mol.) was dispersed in vial at 2ml aqueous phase. At 600c, the dispersion is subjected to a 3-minute sonication test. This method involved the formation of ultrasonic vibration MLVs. Sonicator is two type Probe and Bath sonicator. Probe sonicator is use when sample volume is small and Bath sonicator is use when sample volume is large[23].

Trans-membrane pH Gradient (Inside Acidic) Drug Uptake Process (Remote Loading)

Surfactant and cholesterol are dissolved in chloroform in a round-bottom flask blend, and the chloroform is then evaporated under reduced pressure to obtain a thin film on the flask wall. The film is hydrated by mixing the vortex with a 300 mM citric acid (pH 4.0). Multilamellar vesicles are three times frozen and thawed, and then sonicated. To this niosomal suspension is applied and vortexed aqueous solution containing 10 mg / ml of drug. The pH of the sample is increased to 7.0- 7.2 with 1 M disodium phosphate and the mixture is then heated to 60 ° C for 10 minutes to achieve the desired multilamellar vesicles [24, 25].

Extrusion Method

In this process, niosomes were prepared by extrusion through a polycarbonate membrane using C16G2, a chemically determined non-ionic surfactant. These studies demonstrate not only the effect of the amount of extrusions on the size of the vesicles but also the effect of size on the encapsulation of the drug [23].

Reverse Phase Evaporation Technique (REV)

In this method, a mixture of ether and chloroform is added to cholesterol and surfactant (1:1). To this is added an aqueous phase containing medication, and the resulting two phases are sonicated at 4-5 °C. The transparent gel shaped above is then added to a small amount of phosphate buffer saline and is further sonicated. The organic phase is extracted under low pressure, and at 40 ° C. Phosphate buffer saline is applied to dilute the resulting viscous niosome suspension and heated to produce niosomes in a water bath at 60 ° C for 10 min [26].

The "Bubble" Method

It is one step technique which prepares liposomes and niosomes without the use of organic solvents. Round bottomed flask is used to monitor the temperature as a bubbling unit with its three necks placed in water bath. Water-cooled reflux and thermometer are placed via the third neck through the first and second neck and nitrogen supply. At 70°C, cholesterol and surfactant are spread together in the buffer (pH 7.4) and blended for 15 seconds with a high shear homogenizer and then instantly 'bubbled' at 70°C using nitrogen gas [16].

Micro Fluidization Method

Micro fluidization is a current strategy for the planning of unilamellar vesicles with characterized circulation estimates. Through this technique, two fluidized streams link at ultra-high speeds, through properly defined smaller channels inside the interaction chamber, based on the submerged jet theory.

The impingement on a common front of thin liquid sheet is structured in such a way that the energy supplied to the device remains within the niosome formation region. The effect is a more prominent quality of formed niosomes, smaller size and greater reproducibility [27].

Formation of Niosomes from Proniosomes

A water-soluble carrier such as sorbitol is coated with surfactant in this process of manufacturing niosomes resulting in dry formulation formulation in which each water-soluble particle is covered with a thin film of dry surfactant. This preparation is called "Proniosomes." Then proniosome powder is filled in a screwed vial and mixed by vortexing with water or saline at 80 °C, followed by agitation for 2 min [28].

Lipid Injection Method

In this step, either the lipid and surfactant mixture is first melted and then injected into a highly agitated heated aqueous phase containing dissolved drug, or the drug may be

dissolved into molten lipid and the mixture injected into agitated, heated aqueous phase containing surfactant. This method does not take a costly organic phase [25].

Niosome Preparation using Micelle

Niosomes may also be formed in a mixed micellar solution by using enzymes. When incubated with esterases, a mixed micellar solution of C16 G2, dicalcium hydrogen phosphate (DCP), polyoxyethylene cholesteryl sebacetate di ester (PCSD) converts to a noisome dispersion. PCSD is cleaved by the action of esterases to yield polyoxyethylene, sebacic acid and cholesterol and then cholesterol in combination with C16 G2 and DCP [25].

Emulsion Method

Oil in water (o/w) emulsion is prepared from an organic solution of the surfactant, cholesterol, and aqueous drug solution. The organic solvent is then evaporated, leaving niosomes in the aqueous phase dispersed [29, 20].

Characterisation of Niosomes

Size

The shape of the niosomal vesicles is believed to be spherical, and various techniques can be used to determine their mean diameter, such as laser light scattering, electron microscopy, molecular sieve chromatography, ultra-centrifugation, photon correlation microscopy and optical microscopy, and freeze electron fracture microscopy [19, 30, 31].

Bilayer Formation, Membrane Rigidity and Number of Lamellae

Bilayer vesicle formation by assembly of non-ionic surfactants is characterized by X-cross formation under light polarization microscopy and membrane rigidity can be measured as a function of temperature by means of the fluorescent probe mobility. NMR spectroscopy, small angle X-ray scattering and electron microscopy are used to determine the no of lamellae [32, 33].

Entrapment Efficiency

As described above after the preparation of niosomal dispersion, the untrapped drug is separated by dialysis, centrifugation or gel filtration and/or complete vesicle destruction using 50 percent n-propanol or 0.1 percent Triton X-100 is used to estimate the drug that remained stuck in niosomes and then analyze the resulting solution using the drug's proper test process. Entrapment efficiency (EF) can be defined by [17]:

Entrapment efficiency (EF) = (Amount Entrapped/ Total Amount) x100.

Numbers of Lamellae

This is determined by the use of Nuclear Magnetic Resonance (NMR) spectroscopy, X-ray scattering at small angles and electron microscopy.

Membrane Rigidity

Membrane rigidity can be measured as a function of temperature by means of the fluorescence probe mobility.

Microscopic Evaluation

Transmission electron microscopy was used to test niosomal dispersions in a microscopic way. TEM used for scale calculation and used to determine whether or not it is spherical [34, 35, 36].

***In-vitro* Methods for Niosomes**

In-vitro drug release can be done by

- ✓ Dialysis tubing
- ✓ Reverse dialysis
- ✓ Franz diffusion cell

Dialysis Tubing

The release of drugs *in-vitro* may be accomplished by the use of dialysis tubing. The niosomes are put in prewashed, hermetically sealable dialysis tubing. The dialysis sac is then dialyzed at room temperature against an acceptable dissolution medium; the samples are extracted from the medium at suitable intervals, centrifuged and analyzed for drug content using the correct method (U.V. spectroscopy, HPLC etc). The maintenance of sink condition is essential [37].

Reverse Dialysis

For this technique, a number of small dialysis are put for proniosomes as containing 1ml of the dissolution medium. The proniosomes are then displaced into the medium of dissolution. This approach allows for direct dilution of the proniosomes; however, the rapid release cannot be quantified using this approach [38, 32].

Franz Diffusion Cell

Franz diffusion cell can be used to conduct the *in-vitro* diffusion studies. Proniosomes are placed

in a Franz diffusion cell donor chamber, fitted with a cellophane membrane. The proniosomes are then dialyzed at room temperature to an appropriate dissolution medium; the samples are extracted from the medium at appropriate intervals and tested for drug content using the correct method (U.V spectroscopy, HPLC, etc). The maintenance of sink condition is essential [39, 40].

Application

Niosomes have been used for studying the nature of the immune response provoked by antigens.

Immunological Application of Niosomes

Niosomes have been used to study the nature of the antigen-caused immune response. Niosomes may also be used to target drugs against organs other than the Reticulo-Endothelial System. Niosomes can be attached to a carrier system (such as an antibodies) (as the immunoglobulin binds readily to the lipid surface of the niosome) to target them to specific organs[41].

Targeting of Bioactive Agents

1. To reticulo-endothelial system (RES) Preferentially the vesicles occupy RES cells. It is known as opsonins due to circulating serum factors, which mark them for clearance. However, such localized accumulation of drugs has been used in the treatment of animal tumors proven to metastasize the liver and spleen and in parasitic hepatic infestation [42].

2. To organs other than reticulo-endothelial system (RES) Antibodies can be used to guide the carrier system to different locations in the body. Immunoglobulins appear to have lipid surface affection, thus providing a convenient means for drug carrier targeting. Most cells have the intrinsic ability to recognize and bind common carbohydrate determinants and this property can be used to direct carrier systems to specific cells[43, 40].

Neoplasia

The anthracyclic antibiotic such as doxorubicin, which shows broad anti-tumor activity in the spectrum, has a dose-dependent cardio-toxic effect. This drug increased the lifespan of mice with S-180 tumor and decreased the rate of sarcoma proliferation when administered by niosomal delivery [36].

Leishmaniasis Therapy

Antimony derivatives are most widely used drugs for the treatment of leishmaniasis. Higher doses of these medications – can cause harm to the liver , heart and kidney. The use of niosomes as a drug carrier has shown that the side effects can also be resolved at higher concentrations and therefore has demonstrated greater effectiveness in care [44].

Niosome as a Carrier for Haemoglobin

Niosomal suspension shows a super-imposable visible spectrum over that of free haemoglobin so it can be used as a haemoglobin carrier. Vesicles are therefore oxygen-permeable, and the curve of haemoglobin dissociation can be changed similarly to non-encapsulated haemoglobin [45].

Delivery of Peptide Drugs

In an *in-vitro* intestinal loop model, niosomal trapped oral delivery of 9-desglycinamide, 8- arginine vasopressin was examined, and the peptide stability increased significantly [46].

Transdermal Delivery of Drugs by Niosomes

Transdermal drug delivery integrated in niosomes has achieved an increase in penetration rate, as slow drug penetration through skin is the major downside of transdermal delivery route for other dosage types. The topical delivery of erythromycin from different formulations including niosomes has been studied on hairless mouse and studies, and confocal microscopy has shown that non-ionic vesicles can be developed to target pilosebaceous glands [47].

Ophthalmic Drug Delivery

Due to tear production, impermeability of the corneal epithelium, non-productive absorption and transient residence time, excellent bioavailability of the drug from ocular dosage form such as ophthalmic solution, suspension and ointment is difficult to achieve.

Yet it has been suggested to achieve strong bioavailability of niosomal vesicular systems for drugs [48]. Carter et al. reported that multiple doses of niosomes loaded with sodium stibogluconate were found to be effective against parasites in the liver, spleen and bone marrow compared to a simple sodium stibogluconate solution [48, 49].

Diagnostic Imaging with Niosomes

The diagnostic agents can be used with the niosomal system. Conjugated niosomal formulation of gadobenate dimeglcemine with [N-palmitoylglucosamine (NPG)], PEG 4400 and both PEG and NPG demonstrate significantly enhanced tumor targeting for an encapsulated paramagnetic agent tested with MR imaging [50].

Table 1: List of Drugs formulated as Niosomes

S. No.	Routes of drug administration	Examples of Drugs
1	Intravenous route	Doxorubicin, Methotrexate, Sodium Stibogluconate, Iopromide, Vincristine, Diclofenac Sodium, Flurbiprofen, Centchroman, Indomethacin, Colchicine,Rifampicin, Tretinoin, Transferrin and Glucose ligands, Zidovudine, Insulin, Cisplatin, Amarogentin, Daunorubicin, Amphotericin B, 5-Fluorouracil, Camptothecin, Adriamycin, Cytarabine Hydrochloride
2	Peroral route	DNA vaccines, Proteins, Peptides, Ergot, Alkaloids, Ciprofloxacin, Norfloxacin, Insulin
3	Transdermal route	Flurbiprofen, Piroxicam, Estradiol Levonorgestrol, Nimesulide, Dithranol, Ketoconazole, Enoxacin, Ketorolac
4	Ocular route	Timolol Maleate, Cyclopentolate
5	Nasal route	Sumatriptan, Influenza Viral Vaccine
6	Inhalation	All-trans retinoic acids

CONCLUSION

The niosomal drug delivery system is one of the best examples of great development of nanotechnology and drug delivery technologies. Niosomes are superior structures in terms of reliability, toxicity and cost-effectiveness as compared to other carriers. They represent alternative vesicular systems in relation to liposomes which also have different advantages over liposomes such as cost, stability etc. Niosomes are a promising technology for the delivery of drugs, and much research must be inspired in this to satiate all the potential in this novel drug delivery system.

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CONFLICT OF INTEREST

None

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