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REVIEW ARTICLE

Novel Drug Delivery System (NDDS): Niosomes.

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ABSTRACT

Different carriers like liposomes, niosomes, microspheres, resealed erythrocytes, dendrimers, aquasomes, trasfersomes, ethosomes, phytosomes, nanoparticles etc. are used in novel drug delivery system. Vesicular systems are a novel means of drug delivery that can enhance bioavailability of encapsulated drug and provide therapeutic activity in a controlled manner for a prolonged period of time. Liposomes were the first such system but they suffer from a number of drawbacks including high cost and lack of stability at various pHs. Niosomes are non-ionic surfactant vesicles obtained on hydration of synthetic nonionic surfactants, with or without incorporation of cholesterol or other lipids. Niosomes are one of the best carriers for drug targeting. The basic method of preparation is the same as liposomes i.e. hydration of the lipid phase by aqueous phase which may be either a pure surfactant or a mixture of surfactant with cholesterol. Niosomes are promising vehicle for drug delivery and being non-ionic; it is less toxic and improves the therapeutic index of drug by restricting its action to target cells. Niosomal drug delivery is potentially applicable to many pharmacological agents for their action against various diseases. This review article deals with advantages, preparation, separation of unentrapped drug, factors affecting vesicles size, entrapment efficiency and release characteristics of niosomes, evaluation, applications and Marketed formulations of niosomes.

KEYWORDS: Niosomes, NDDS, Surfactant, Ether injection, Entrapment, Dialysis.

INTRODUCTION:

The main aim of novel drug delivery systems (NDDS) is to provide some control of drug release in the body, which is either of temporal or spatial nature, or both. It attempts to either sustain drug action at a predetermined rate, or maintains a relatively constant, effective drug level in the body with concomitant minimization of undesirable side effects. It also localizes drug action by spatial placement of control release systems adjacent to, or in the diseased tissue or organ; or target drug action by using carriers or chemical derivatization to deliver drug to particular target cell type. Different carriers like liposomes, niosomes, microspheres, resealed erythrocytes, dendrimers, aquasomes, trasfersomes, ethosomes, phytosomes, nanoparticles etc. are used in novel drug delivery system (1). Niosomes were first reported in the seventies as a feature of the cosmetic industry by Vanlerberghe et al., Handjani-vila et al., Van Abbe explained that the non – inonic surfactants are preferred because the irritation power of surfactants decreases in the following order: cationic > anionic > ampholytic > non-ionic (2). Niosomes are self-assembled vesicles composed primarily of synthetic surfactants and cholesterol (3). Niosomes can be modified by the incorporation of other excipients like cholesterol, into the membrane and they can possess one or more lipid bilayers encapsulating an aqueous core. A diverse range of materials have been used to form niosomes such as

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sucrose ester surfactants and polyoxyethylene alkyl ether surfactants. Niosomes can be Small Unilamellar Vesicles (SUV), Multilamellr Vesicles (MLV) or Large Unilamellar Vesicles (LUV) (4). Niosomes are vesicular systems similar to liposomes that can be used as carriers of amphiphilic and lipophilic drugs. Niosomes possess many advantages over liposomes. In comparison with classical formulations such as emulsions, these systems exhibit lower toxicity and permit closer control of the availability of active substances at the stratum corneum. Niosomes may act as a depot, releasing the drug in a controlled manner. The therapeutic performance of the drug molecules can also be improved by delayed clearance from the circulation, protecting the drug from biological environment and restricting effects to target cells. It enhances the bioavailability by crossing the anatomical barrier of gastrointestinal tract It can also be used as vehicle for poorly absorbable drugs to design the novel drug delivery system (5). Many drugs are administered through niosomes via transdermal route to improve the therapeutic efficacy. Encapsulation of various anti-neoplastic agents in this carrier vesicle has minimized drug-induced toxic side effects while maintaining, or in some instances, increasing the anti-tumor efficacy. Niosomes are taken up by reticulo-endothelial system (RES). This type of localized drug accumulation is used in treatment of diseases, such as leishmaniasis, in which parasites invade cells of liver and spleen. Some non-reticulo-endothelial systems like immunoglobulins also recognize lipid surface of this delivery system (6). Drug encapsulated in niosomes includes glucose, insulin, salbutamol, clotrimazole and bovine serum albumin (1).

ADVANTAGES OF NIOSOMES (1, 4-6):

1. They improve oral bioavailability of poorly absorbed drugs and enhance skin penetration of drugs.

2. The vesicle suspension is water-based vehicle. This offers high patient compliance in comparison with oily dosage forms.

3. The vesicles may act as a depot, releasing the drug in a controlled manner.

4. They are osmotically active and stable, as well as they increase the stability of entrapped drug.

5. They improve the therapeutic performance of the drug molecules by delayed clearance from the circulation, protecting the drug from biological environment and restricting effects to target cells.

6. Handling and storage of surfactants requires no special conditions.

7. Niosomes exhibits flexibility in their structural characteristics (composition, fluidity and size) and can be designed according to the desired situation.

8. Niosomes can enhance the skin penetration of drugs.

9. Altering vesicle composition, size, lamellarity, tapped volume, surface charge and concentration can control the vesicle characteristics.

10. Niosomes possess an infrastructure consisting of hydrophilic, amphiphilic and lipophilic moieties together and as a result can accommodate drug molecules with a wide range of solubilities.

11. Niosomes can be made to reach the site of action by oral, parenteral as well as topical routes.

12. They improve the therapeutic performance of the drug by protecting it from the biological environment and restricting effects to target cells, thereby reducing the clearance of the drug.

LIMITATION OF NIOSOMES (1):

1. Practical yield with any process for commercial production is very low.

2. Production, isolation and purification is a time consuming and expensive.

COMPARISON OF NIOSOMES VS LIPOSOMES:

1. Niosomes are now widely studied as an alternative to liposomes, which exhibit certain disadvantages such as liposomes are expensive, their ingredients like phospholipids are chemically unstable because of their predisposition to oxidative degradation, they require special storage and handling and purity of natural phospholipids is variable (1, 3).

2. Differences in characteristics exist between liposomes and niosomes, especially since niosomes are prepared from uncharged single-chain surfactant and cholesterol whereas liposomes are prepared from double-chain phospholipids (neutral or charged) (7). Niosomes behave *in-vivo* like liposomes, prolonging the circulation of entrapped drug and altering its organ distribution and metabolic stability (8). Encapsulation of various anti neoplastic agents in these carrier vesicles has been shown to decrease drug induced toxic side effects, while maintaining, or in some instances, increasing the anti-tumor efficacy (9). Such vesicular drug carrier systems alter the plasma clearance kinetics, tissue distribution, metabolism and cellular interaction of the drug (8, 10). They can be expected to target the drug to its desired site of action and/or to control its release (11).

3. The entrapment efficiency increases with increase in the concentration and lipophilicity of surfactant (12). Chandraprakash et al (12) made Methotrexate loaded non-ionic surfactant vesicles using lipophilic surfactants like Span 40, Span 60 and Span 80 and found that Span 60 (HLB = 4.7) gave highest percent entrapment while Span 85 (HLB = 9.8) gave least entrapment. They also observed that as

HLB value of surfactant decreased, the mean size was reduced.

4. As with liposomes, the properties of niosomes depends both on the composition of the bilayer and on method of their production (13). It was observed by Baillie et al (11) that the intercalation of cholesterol in the bilayers decreases the entrapment volume during formulation and thus entrapment efficiency. As the concentration of cholesterol increases, entrapment efficiency decreases.

PREPARATION OF NIOSOMES:

The preparation methods should be chosen according to the use of the niosomes, since the preparation methods influence the number of bilayers, size distribution, and entrapment efficiency of the aqueous phase and the membrane permeability of the vesicles.

1. ETHER INJECTION:

This method provides a means of making niosomes by slowly introducing a solution of surfactant dissolved in diethyl ether into warm water maintained at 60°C. The surfactant mixture in ether is injected through 14-gauge needle into an aqueous solution of material. Vaporization of ether leads to formation of single layered vesicles. Depending upon the conditions used the diameter of the vesicle range from 50 to 1000 nm. The disadvantage of this method is that a small amount of ether is often still present in the vesicle suspension and is often difficult to remove (4, 5).

2. SONICATION:

In this method an aliquot of drug solution in buffer is added to the surfactant-cholesterol mixture in a 10 ml glass vial. The mixture is probe sonicated at 60°C for 3 minutes using a sonicator with a titanium probe to yield niosomes (4, 6).

3. HAND SHAKING METHOD:

The mixture of vesicles forming ingredients like surfactant and cholesterol are dissolved in a volatile organic solvent (diethyl ether, methanol or chloroform) in a round bottom flask. The organic solvent is removed at room temperature using rotary evaporator leaving a thin layer of solid mixture deposited on the wall of the flask. The dried surfactant film can be rehydrated with aqueous phase at 0-60°C with gentle agitation. This process forms typical multilamellar niosomes. The aqueous phase containing drug was added slowly with intermittent shaking of flask at room temperature followed by sonication. Large multilamellar vesicles are prepared (4-6).

4. MICRO FLUIDIZATION:

Micro fluidization is a technique used to prepare unilamellar vesicles of defined size distribution. This method is based on submerged jet principle in which two fluidized streams interact at ultra high velocities, in precisely defined micro channels within the interaction chamber. The impingement of thin liquid sheet along a common front is arranged such that the energy supplied to the system remains within the area of niosomes formation. The result is a greater uniformity, smaller size and better reproducibility of niosomes formed (14).

5. REVERSE PHASE EVAPORATION TECHNIQUE (REV):

Cholesterol and surfactant (1:1) are dissolved in a mixture of ether and chloroform. An aqueous phase containing drug is added to this and the resulting two phases are sonicated at 4-5°C. The clear gel formed is further sonicated after the addition of a small amount of phosphate buffered saline (PBS). The organic phase is removed at 40°C under low pressure. The resulting viscous niosome suspension is diluted with PBS and heated on a water bath at 60°C for 10 min to yield niosomes (15).

6. TRANS MEMBRANE PH GRADIENT DRUG UPTAKE PROCESS (REMOTE LOADING):

Surfactant and cholesterol are dissolved in chloroform. The solvent is then evaporated under reduced pressure to get a thin film on the wall of the round bottom flask. The film is hydrated with 300 mM citric acid (pH 4.0) by vortex mixing. The multilamellar vesicles are frozen and thawed 3 times and later sonicated. To this niosomal suspension, aqueous solution containing 10 mg/ml of drug is added and vortexed. The pH of the sample is then raised to 7.0-7.2 with 1M disodium phosphate. This mixture is later heated at 60°C for 10 minutes to give niosomes (4-6).

7. MULTIPLE MEMBRANE EXTRUSION METHOD:

Mixture of surfactant, cholesterol and dicetyl phosphate in chloroform is made into thin film by evaporation. The film is hydrated with aqueous drug solution and the resultant suspension extruded through polycarbonate membranes, which are placed in series for upto 8 passages. It is a good method for controlling niosome size (4-6).

8. THE "BUBBLE" METHOD:

It is novel technique for the one step preparation niosomes without the use of organic solvents. The bubbling unit consists of round-bottomed flask with three necks positioned in water bath to control the temperature. Water-cooled reflux and thermometer is positioned in the

first and second neck and nitrogen supply through the third neck. Cholesterol and surfactant are dispersed together in this buffer (pH 7.4) at 70°C, the dispersion mixed for 15 seconds with high shear homogenizer and immediately afterwards "bubbled" at 70°C using nitrogen gas (16).

9. FORMATION OF NIOSOMES FROM PRONIOSOMES:

Another method of producing niosomes is to coat a water-soluble carrier such as sorbitol with surfactant. The result of the coating process is a dry formulation. In which each water-soluble particle is covered with a thin film of dry surfactant. This preparation is termed 'Proniosomes'. The niosomes are recognized by the addition of aqueous phase at T > Tm and brief agitation.

T = Temperature, and Tm = mean phase transition temperature (4-6).

SEPARATION OF UNENTRAPPED DRUG:

Separation of unentrapped drug from the vesicles can be accomplished by various techniques, which include:

A. DIALYSIS:

The aqueous niosomal dispersion is dialyzed in dialysis tubing against phosphate buffer or normal saline or glucose solution (16).

B. CENTRIFUGATION:

The niosomal suspension is centrifuged and the supernatant is separated. The pellet is washed and then resuspended to obtain a niosomal suspension free from unentrapped drug (17).

C. GEL FILTRATION:

The unentrapped drug is removed by gel filtration of niosomal dispersion through a Sephadex-G-50 column and elution with phosphate buffered saline or normal saline (18).

FACTORS AFFECTING VESICLES SIZE, ENTRAPMENT EFFICIENCY AND RELEASE CHARACTERISTICS OF NIOSOMES:

1. METHODS OF PREPARATION:

Methods of preparation of niosomes such as hand shaking, ether injection and sonication have been reviewed by Khandare et al. Hand shaking method forms vesicles with greater diameter (0.35-13nm) compared to the ether injection method (50-1000nm). Microfluidization method gives greater uniformity and small size vesicles. Small sized niosomes can be produced by Reverse Phase Evaporation (REV) method. Parthasarthi et al. prepared niosomes by trans membrane pH gradient (inside acidic) drug uptake process. Niosomes obtained by this method showed greater entrapment efficiency and better retention of drug (4-6, 19).

2. AMOUNT AND TYPE OF SURFACTANT:

Size of niosomes increases proportionally with increase in the HLB of surfactants like Span 85 (HLB 1.8) to Span 20 (HLB 8.6) because the surface free energy decreases with an increase in hydrophobicity of surfactant. The bilayers of the vesicles are either in the so-called liquid state or in gel state, depending on the temperature, the type of lipid or surfactant and the presence of other components such as cholesterol. In the gel state, alkyl chains are present in a well-ordered structure, and in the liquid state, the structure of the bilayers is more disordered. The surfactants and lipids are characterized by the gel-liquid phase transition temperature (TC). Phase transition temperature (TC) of surfactant also effects entrapment efficiency i.e. Span 60 having higher TC, provides better entrapment (4, 20).

3. DRUG:

Entrapment of drug in niosomes increases vesicle size, probably by interaction of solute (drug) with surfactant head groups, increasing the charge and mutual repulsion of the surfactant bilayers, thereby increasing vesicle size. In polyoxyethylene glycol (PEG) coated vesicles; some drug is entrapped in the long PEG chains, thus reducing the tendency to increase the size. The hydrophilic lipophilic balance of the drug affects degree of entrapment (4, 21).

4. CHOLESTEROL CONTENT AND CHARGE:

Inclusion of cholesterol in niosomes increases its hydrodynamic diameter and entrapment efficiency. In general, the action of cholesterol is two folds; on one hand, cholesterol increases the chain order of liquid-state bilayers and on the other, cholesterol decreases the chain order of gel state bilayers. At a high cholesterol concentration, the gel state is transformed to a liquid-ordered phase. An increase in cholesterol content of the bilayers resulted in a decrease in the release rate of encapsulated material and therefore an increase of the rigidity of the bilayers obtained. Presence of charge tends to increase the interlamellar distance between successive bilayers in multilamellar vesicle structure and leads to greater overall entrapped volume (18, 22).

5. MEMBRANE COMPOSITION:

The stable niosomes can be prepared with addition

of different additives along with surfactants and drugs. Niosomes formed have a number of morphologies and their permeability and stability properties can be altered by manipulating membrane characteristics by different additives. In case of polyhedral niosomes formed from C16G2, the shape of these polyhedral niosome remains unaffected by adding low amount of solulan C24 (cholesteryl poly-24-oxyethylene ether), which prevents aggregation due to development of steric hindrance**.** In contrast spherical Niosomes are formed by C16G2: cholesterol: solulan (49:49:2)**.** The mean size of niosomes is influenced by membrane composition such as Polyhedral niosomes formed by C16G2: solulan C24 in ratio (91:9) having bigger size (8.0 ± 0.03mm) than spherical/tubular niosomes formed by C16G2: cholesterol: solulan C24 in ratio (49:49:2) (6.6±0.2mm). Addition of cholesterol molecule to niosomal system provides rigidity to the membrane and reduces the leakage of drug from noisome (23).

6. TEMPERATURE OF HYDRATION:

Hydration temperature influences the shape and size of the noisome. For ideal condition it should be above the gel to liquid phase transition temperature of system. Temperature change of niosomal system affects assembly of surfactants into vesicles and also induces vesicle shape transformation. Arunothayanun et al. reported that a polyhedral vesicle formed by C16G2: solulan C24 (91:9) at 25°C which on heating transformed into spherical vesicle at 48°C, but on cooling from 55°C, the vesicle produced a cluster of smaller spherical niosomes at 49°C before changing to the polyhedral structures at 35°C**.** In contrast vesicle formed by C16G2: cholesterol: solulanC24 (49:49:2) shows no shape transformation on heating or cooling. Along with the above mentioned factors, volume of hydration medium and time of hydration of niosomes are also critical factors. Improper selection of these factors may result in formation of fragile niosomes or creation of drug leakage problems (6).

7. RESISTANCE TO OSMOTIC STRESS:

Addition of a hypertonic salt solution to a suspension of niosomes brings about reduction in diameter. In hypotonic salt solution, there is initial slow release with slight swelling of vesicles probably due to inhibition of eluting fluid from vesicles, followed by faster release, which may be due to mechanical loosening of vesicles structure under osmotic stress (2, 4, 6).

EVALUATION:

1. ENTRAPMENT EFFICIENCY:

After preparing niosomal dispersion, unentrapped drug is separated by dialysis, centrifugation or gel filtration as described above and the drug remained entrapped in niosomes is determined by complete vesicle disruption using 0.1% Triton X-100 and analyzing the resultant solution by appropriate assay method for the drug (2,4,6).
Where, Entrapment efficiency = Amount entrapped / Total amount used in preparation × 100

2. VESICLE DIAMETER:

Niosomes, similar to liposomes, assume spherical shape and so their diameter can be determined using light microscopy, photon correlation microscopy and freeze fracture electron microscopy (4, 6).

3. NUMBER OF LAMELLAE:

This is determined by using nuclear magnetic resonance (NMR) spectroscopy, small angle X-ray scattering and electron microscopy (6).

4. BILAYER FORMATION:

Assembly of non-ionic surfactants to form a bilayer vesicle is characterized by an X-cross formation under light polarization microscopy (4, 6).

5. MEMBRANE RIGIDITY:

Membrane rigidity can be measured by means of mobility of fluorescence probe as a function of temperature (5, 6).

***6. IN-VIVO* RELEASE STUDY:**

Albino rats were used for this study. These rats were subdivided with groups. Niosomal suspension used for in vivo study was injected intravenously (through tail vein) using appropriate disposal syringe (4-6).

***7. IN-VITRO* RELEASE:**

A method of *in-vitro* release rate study includes the use of dialysis tubing. A dialysis sac is washed and soaked in distilled water. The vesicle suspension is pipette into a bag made up of the tubing and sealed. The bag containing the vesicles is placed in 200 ml of buffer solution in a 250 ml beaker with constant shaking at 25°C or 37°C. At various time intervals, the buffer is analyzed for the drug content by an appropriate assay method (5, 6).

VARIOUS APPLICATIONS OF NIOSOMES:

Niosomal drug delivery is potentially applicable to many pharmacological agents for their action against

various diseases. Some of their therapeutic applications are discussed below.

1. TARGETING OF BIOACTIVE AGENTS:

A. TO RETICULO-ENDOTHELIAL SYSTEM (RES):

The cells of RES preferentially take up the vesicles. The uptake of niosomes by the cells is also by circulating serum factors known as opsonins, which mark them for clearance. Such localized drug accumulation has, however, been exploited in treatment of animal tumors known to metastasize to the liver and spleen and in parasitic infestation of liver (3, 6).

B. TO ORGANS OTHER THAN RES:

It has been suggested that carrier system can be directed to specific sites in the body by use of antibodies. Immunoglobulins seem to bind quite readily to the lipid surface, thus offering a convenient means for targeting of drug carrier. Many cells possess the intrinsic ability to recognize and bind particular carbohydrate determinants and this can be exploited to direct carriers system to particular cells (24, 25).

2. NEOPLASIA:

Doxorubicin, the anthracyclic antibiotic with broad spectrum anti tumor activity, shows a dose dependant irreversible cardio toxic effect. Niosomal delivery of this drug to mice bearing S-180 tumor increased their life span and decreased the rate of proliferation of sarcoma Niosomal entrapment increased the half-life of the drug, prolonged its circulation and altered its metabolism. Intravenous administration of methotrexate entrapped in niosomes to S-180 tumor bearing mice resulted in total regression of tumor and also higher plasma level and slower elimination (26, 27).

3. LEISHMANIASIS:

Niosomes can be used for targeting of drug in the treatment of diseases in which the infecting organism resides in the organ of reticulo-endothelial system. Leishmaniasis is such a disease in which parasite invades cells of liver and spleen. The commonly prescribed drugs are antimonials, which are related to arsenic, and at high concentration they damage the heart, liver and kidney (28).

4. NIOSOMES AS CARRIERS FOR HEMOGLOBIN:

Niosomes can be used as a carrier for hemoglobin. Niosomal suspension shows a visible spectrum super imposable onto that of free hemoglobin. Vesicles are permeable to oxygen and hemoglobin dissociation curve can be modified similarly to non-encapsulated hemoglobin (29).

5. TRANSDERMAL DELIVERY OF DRUGS BY NIOSOMES:

Slow penetration of drug through skin is the major drawback of transdermal route of delivery. An increase in the penetration rate has been achieved by transdermal delivery of drug incorporated in niosomes. Jayraman et al. has studied the topical delivery of erythromycin from various formulations including niosomes or hairless mouse. From the studies, and confocal microscopy, it was seen that non-ionic vesicles could be formulated to target pilosebaceous glands (30).

6. DELIVERY OF PEPTIDE DRUGS:

Yoshida et al. investigated oral delivery of 9-desglycinamide, 8-arginine vasopressin entrapped in niosomes in an in-vitro intestinal loop model and reported that stability of peptide increased significantly (18, 22).

7. IMMUNOLOGICAL APPLICATION OF NIOSOMES:

Niosomes have been used for studying the nature of the immune response provoked by antigens. Brewer and Alexander have reported niosomes as potent adjuvant in terms of immunological selectivity, low toxicity and stability (31).

8. OTHER APPLICATIONS:

A. LOCALIZED DRUG ACTION:

Drug delivery through niosomes is one of the approaches to achieve localized drug action, since their size and low penetrability through epithelium and connective tissue keeps the drug localized at the site of administration. Localized drug action results in enhancement of efficacy of potency of the drug and at the same time reduces its systemic toxic effects e.g. Antimonials encapsulated within niosomes are taken up by mononuclear cells resulting in localization of drug, increase in potency and hence decrease both in dose and toxicity. The evolution of niosomal drug delivery technology is still at an infancy stage, but this type of drug delivery system has shown promise in cancer chemotherapy and anti-leishmanial therapy (28).

B. SUSTAINED RELEASE:

Azmin et al. suggested the role of liver as a depot for methotrexate after niosomes are taken up by the liver cells. Sustained release action of niosomes can be applied to drugs with low therapeutic index and low water solubility since those could be maintained in the circulation via niosomal encapsulation (32).

Sr. No.	Brand	Name
1	Estee Lauder - Beyond Paradise	Beyond Paradise After Shave Lotion 100ml
2	Orlane - Lipcolor & Lipstick	Lip Gloss
3	Liz Claiborne - Realities	Realities Shower Gel 200ml
4	White Shoulders	White Shoulders Eau De Cologne Spray 130ml
5	Jean Paul Gaultier - Le Classique	Le Classique Eau De Toilette Spray 100ml
6	Hugo Boss - Boss Soul	Boss Soul After Shave 90ml
7	Lancaster - Suractif - Night Care	Suractif Non Stop Lifting Advanced Night Cream 50ml
8	Givenchy - Blanc Parfait - Day Care	Blanc Parfait W4-L Universal Brightening Spots Corrector SPF 45 1.6ml
9	Nina Ricci - Love In Paris	Love In Paris Deodorant Spray 100ml
10	Lancome - Foundation & Complexion	Flash Retouch Brush On Concealer
11	Gatineau - Moderactive - Cleanser	Moderactive Almond Make-Up Remover 250ml
12	Britney Spears - Curious	Curious Coffret: Edp Spray 100ml+ Dual-ended Parfum & Pink Lipgloss+ Body Souffle 100ml
13	Loris Azzaro - Chrome	Chrome Eau De Toilette Spray 200ml
14	Guinot - Night Care	Deep Action Whitening Serum 30ml
15	Helena Rubinstein - HR - Golden Beauty - Body Care	Golden Beauty After Sun Soothing Moisturizer 150ml
16	Givenchy - Amarige	Amarige Eau De Toilette Spray 100ml

Table No. 1: Marketed formulation of Niosome

CONCLUSION:

Niosomes are novel drug delivery system which offers a large number of advantages over other conventional and vesicular delivery systems. Niosomes present a structure similar to liposome and hence they can represent alternative vesicular systems with respect to liposomes, due to the niosome ability to encapsulate different type of drugs within their multi environmental structure. Niosomes are considered to be better candidates for drug delivery as compared to liposomes due to various factors like cost and stability. These advantages over the liposomes make it a better targeting agent. Ophthalmic, topical, parentral and various other routes are used for targeting the drug to the site of action for better efficacy. Niosomes have evolved for treatment of many dreadful diseases efficiently with reduced side effects and better patient compliance. Overall, niosomes are a very effective tool for drug delivery and targeting of numerous therapeutically active moieties.

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