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Review Article

A Review on Formulation and Evaluation of Ondansetron Hydrochloride Niosomes in Transdermal Drug Delivery

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Abstract

The niosomal gel of the chosen formula (F2) was formulated by incorporating the niosomal dispersion in a mixture of Carbopol 974 gel base and Na-CMC. Briefly, a sufficient amount of Carbopol 974 was gradually added to water and kept for 24 h for complete hydration of polymer chains. Niosomes and liposomes have similar physical properties but differ in the chemical nature. Niosomal vesicle is formed by non-ionic surfactants whereas liposomal vesicles of lipids. Niosomes are superior to liposomes because of higher chemical stability of surfactants than lipids. This review article focuses on the concept of niosomes, advantages and disadvantages, composition, method of preparation, factors influencing the niosomal formulation and characterization, application of niosomes. Niosomes can be utilized in the treatment of several diseases like Psoriasis, leishmaniasis, cancer, migraine, Parkinson etc.

Keywords: Niosomal, liposomes, chemical. Polymer, lipids

Introduction

A drug delivery system is a process for delivering a therapeutic agent by any of the usual routes of administration for a therapeutic effect in humans or animals. The most fundamental goals in this area are to improve drug viability and well-being. There are several routes by which drugs can be delivered to the human body. The choice of route depends on three factors, namely

(a) Effect desired,

(b) Type of disease,

(e) Type of product

The most common routes of drug administration are as follows

- Oral
- Parenteral
- Inhalation route
- Transdermal route (Abdul & Hassan, 2012)

Today recent advances in the kind of pharmacokinetic and pharmacodynamic nature of drugs offer a more rational approach to the development of an ideal delivery system. The novel drug delivery systems are carriers it maintains the drug concentration in the therapeutic range for a longer period. The novel drug delivery system is developed and it aims to minimize drug degradation, reduce side effects, and improve the bioavailability of medication. New drug carriers are being developed that are useful for the controlled and targeted delivery of drugs.

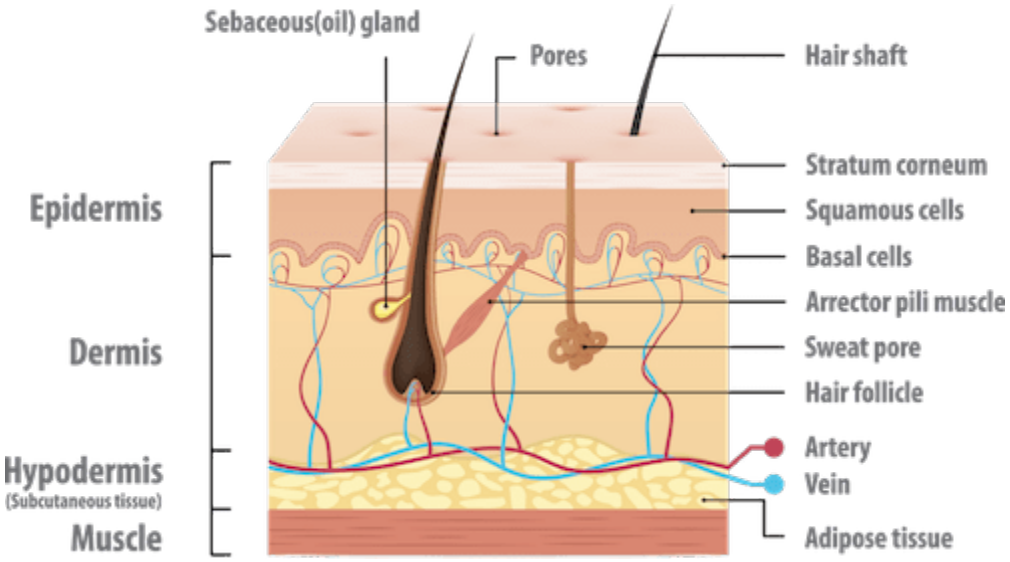

Figure 1.1: Structure of Skin

In general, controlled drug delivery attempts to

- Controlled drug action at a determined rate by maintaining a prolonged or constant release, at the therapeutically effective level in the circulation.
- Localize drug action through spatial or temporal control of drug release in the local of the target.
- The rate of pre-programmed drug action by using the release of drug molecules by system design controls the molecular diffusion of drug molecules.
- Targeted drug action by using carriers of chemical derivatives to distribute the drug to a specific cell. (Khan, 2019)

Research Survey

Peeyush Bhardwaj *et al*., (2020) in the last one-decade numbers of review and research, article have been published on niosomes. That shows the interest of researchers in niosomes because of the advantages offered by them over other vesicular carrier systems. Niosomes formation occurs when non-ionic surfactant vesicles assemble themselves. There are several factors like the type of non-ionic surfactant used , method of preparation, that temperature of hydration, etc. which affect the noisome formation . In this review article, we have made an attempt to incorporate all the basic details of niosomes like various methods of preparation, different types of niosomes, factors affecting their formation, characterization of niosome, their applications, routes of administration as well as the advancements taken place in the field of niosomal research with a literature review of research done in the last decade.

Fausto Roila *et al*., (1995) Ondansetron is a potent and highly selective serotonin S-HT3-receptor antagonist which has demonstrated important antiemetic activity and good tolerability in the prevention of chemotherapy-induced nausea and vomiting. Ondansetron is completely and rapidly absorbed from the gastrointestinal tract after oral administration, and does not accumulate with repeated oral administration. Owing to hepatic first-pass metabolism, its bioavailability is only about 60% compared with ondansetron administered by infusion over IS minutes. Bioavailability is slightly increased when administered after a standard meal, and is not influenced by co-administration of antacids; a slightly enhanced bioavailability has been observed in patients with cancer. Since the time to reach peak concentration is O.S to 2 hours after oral ingestion, the drug should be administered at least 30 minutes before chemotherapy. Possible alternative ways of administration of ondansetron include intramuscular, subcutaneous and rectal administration, and oral controlled-release formulations.

Patnaik et al.,(2021) The skin can be used as the site for drug administration for continuous

transdermal drug infusion into the systemic circulation. For the continuous diffusion penetration of the drugs through the intact skin surface membrane-moderated systems, matrix dispersion type systems, adhesive diffusion controlled systems and micro reservoir systems have been developed. Various penetration enhancers are used for the drug diffusion through skin. In matrix dispersion type systems, the drug is dispersed in the solvent along with the polymers and solvent allowed to evaporate forming a homogeneous drug-polymer matrix. Matrix type systems were developed in the present study. In the present work, an attempt has been made to develop a matrix-type transdermal therapeutic system comprising of Ondansetron HCL with different concentration of various polymers alone using solvent evaporation technique. The physicochemical compatibility of the drug and the polymers was studied by infrared spectroscopy. The results obtained showed no physical-chemical incompatibility between the drug and the polymers. F5 formulation has been selected as the best formulation among all the other formulations. The in vitro drug diffusion studies from the formulation were found to be sustained release. All the evaluation parameters obtained from the best formulation were found to be satisfactory. The data obtained from the in vitro release studies were fitted to various kinetic models like zero order, first order. Higuchi model and peppas model. From the kinetic data it was found that drug release follows peppas model release by diffusion technique from the polymer.

Rampal RAJERA *et al*.,(2011) During the past decade formulation of vesicles as a tool to improve drug delivery, has created a lot of interest amongst the scientist working in the area of drug delivery systems. Vesicular system such as liposomes, niosomes, transferosomes, pharmacosomes and ethosomes provide an alternative to improve the drug delivery. Niosomes play an important role owing to their nonionic properties, in such drug delivery system. Design and development of novel drug delivery system (NDDS) has two prerequisites. First, it should deliver the drug in accordance with a predetermined rate and second it should release therapeutically effective amount of drug at the site of action. Conventional dosage forms are unable to meet these requisites. Niosomes are essentially non-ionic surfactant based multilamellar or unilamellar vesicles in which an aqueous solution of solute is entirely enclosed by a membrane resulting from the organization of surfactant macromolecules as bilayer. Niosomes are formed on hydration of non-ionic surfactant film which eventually hydrates imbibing or encapsulating the hydrating aqueous solution. The main aim of development of niosomes is to control the release of drug in a sustained way, modification of distribution profile of drug and for targeting the drug to the specific body site. This paper deals with composition, characterization/evaluation, merits, demerits and applications of niosomes.

Mahmoud H. Teaima *et al*.,(2020) Ondansetron HCl is a (5-HT3) serotonin receptor antagonist, used as anti-emetic drug in combination with anticancer agents. Conventional dosage forms have poor bioavailability and patient compliance. These problems can be reduced by the use of nasal niosomal thermo reversible in situ gelling system; Niosomes were formulated using various surfactants (Span 60, Span 80, Tween 20 and Tween 80) in different ratios using thin film hydration technique. Niosomes were evaluated for particle size, zeta potential, Transmission Electron Microscopy (TEM) imaging, drug entrapment efficiency and in-vitro drug release. Niosomes prepared using span 60 and cholesterol in the ratio 1:1 (F5) showed higher entrapment efficiency (76.13±1.2%) and invitro drug release (91.76%) after 12 hrs. was optimized. The optimized niosomes were developed into thermo reversible in situ gel, composed of Poloxamer 407& sodium carboxymethyl cellulose, prepared by cold method. Compatibility study (FTIR, DSC) was made for drug and excipients that showed no significant interaction. The gel formulation G5 showed the most suitable gelation Temp. (31°C), Viscosity (1250 mpois), bio adhesion force (5860±28 dyne/cm2), and in-vitro drug release (70.6%) after 12 hrs. Comparative in vivo pharmacokinetic study on rabbits showed a sustained release and higher relative

bioavailability of the prepared nasal in-situ gel compared to similar dose of oral tablets (202.4%).Which make ondansetron Accepted Manuscript HCl niosomal nasal thermo-sensitive in-situ gel a more convenient dosage form for the administration of ondansetron HCl than oral tablets.

Rianne Bartelds *et al*.,(2018) Niosomes are used in studies for drug delivery or gene transfer. However, their physical properties and features relative to liposomes are not well documented. To characterize and more rationally optimize niosome formulations, the properties of these vesicle systems are compared to those of liposomes composed of phosphatidylcholine and phosphatidylethanolamine lipids plus cholesterol. Niosomes are highly stable and only slightly more leaky than liposomes as assayed by calcein leakage; the permeability for ions (KCl) is higher than that of liposomes. Contrary to liposomes, the size of niosomes decreases substantially upon freezing in liquid nitrogen and subsequent thawing, as shown by cryo-EM and dynamic light scattering. The packing of niosomal membranes was determined by laurdan fluorescence and is slightly lower than that of liposomes. We did not succeed in the functional reconstitution of the L-arginine/L-ornithine antiporter Arc D2 in niosomes, which we attribute to the non-ionic nature of the surfactants. The antimicrobial peptides alamethicin and melittin act similarly on niosomes and liposomes composed of unsaturated components, whereas both niosomes and liposomes are unaffected when saturated amphiphiles are used. In conclusion, in terms of stability and permeability for drug-size molecules niosomes are comparable to liposomes and they may offer an excellent, inexpensive alternative for delivery purposes.

Ahasanuzzaman et al.,(2022) Niosomes are the non-ionic surfactant-based vesicular drug delivery system used to improve the permeability of a hydrophilic drug. This vesicular approach enhances the bioavailability by preventing the enzymatic degradation and acidic degradation of the drug. Niosomes are ampiphilic in nature and can entrap both the hydrophilic and lipophilic drug. It can provide sustained and controlled drug release inside the body. This review article explains briefly about different formulations of niosomes available to enhance the drug bioavailability. To enhance the topical bioavailability niosomes can be formulated as niosomal creams, niosomal gels andniosomal patches. Fororal bioavailability enhancement niosomal tablets and suspensions are available and also niosomal formulations to enhance the bioavailability of the drug given via nasal, pulmonary and parenteral route. The niosomal formulation provides better stability, enhanced bioavailability, reduced toxicity and adverse effects by preventing the degradation and presystemic metabolism and also by maintaining a constant plasma drug concentration when compared to the conventional dosage form available in the market. The niosomal formulations are better than the liposomal formulations because niosomes are more stable and costeffective and do not undergo leakage due to the absence of lipid content. They are used for the treatment of diseases locally and systemically. They are used widely in cosmetic industry too. Still researchers are focusing on commercializing these niosomal drug delivery.

Akhtar et al., (2014) study the liposomal formulation is a stable and efficient vesicular carrier for enhanced transdermal delivery of buflomedil hydrochloride. These are higher entrapment efficiency and stability then liposomal vesicle. Niosomal loaded transdermal patch was higher than the reference liposomal patch. These are in vitro permeation studies and found the enhanced skin permeation of the drug. Thus, the liposomal system is good carrier for effective and safe transdermal drug delivery.

Rita Muzzalupo et al.,(2015) Niosomes are vesicular nanocarriers and are receiving much attention as potential transdermal drug delivery systems due to properties such as enhanced drug penetration, local depot for sustained drug release, and a rate-limiting membrane for modulation of systemic absorption of drugs via the skin. Several mechanisms have been proposed to explain the ability of niosomes to increase drug transfer through the skin. Niosomal carriers are suitable for the transdermal delivery of numerous pharmacological agents, including antioxidant,

anticancer, anti-inflammatory, antimicrobial, and antibacterial molecules, and this review attempts to provide an exhaustive collection of recent investigations in this interesting field, with special emphasis on the strategies used to enhance the Niosomes are non-ionic surfactant-based multilamellar or unilamellar vesicles in which an aqueous solute solution is completely encapsulated by a membrane formed by surfactant macromolecules organized as a bilayer. Because vesicles are made up of a bilayer of non-ionic surface-active substances, the term "Niosomes" was coined (non-ionic surfactants). Niosomes are a unique drug delivery technology that encapsulates the medication in a vesicle. Ionic drug carriers are hazardous and inappropriate, whereas niosomal drug carriers are less dangerous. Niosomes do not require any specific handling or storage conditions. Niosomes have shown to be a promising drug carrier, with the potential to minimize medication side effects and improve therapeutic efficacy in a variety of disorders. Drug insolubility, instability, limited bioavailability, and fast degradation are all issues that niosomes address. The benefits, preparations, assessment, and medicinal uses of niosomes are discussed in this review article. potential of niosomes.

Patil Abhishek et al.,(2021) Niosomes are non-ionic surfactant-based multilamellar or unilamellar vesicles in which an aqueous solute solution is completely encapsulated by a membrane formed by surfactant macromolecules organized as a bilayer. Because vesicles are made up of a bilayer of non-ionic surface-active substances, the term "Niosomes" was coined (non-ionic surfactants). Niosomes are a unique drug delivery technology that encapsulates the medication in a vesicle. Ionic drug carriers are hazardous and inappropriate, whereas niosomal drug carriers are less dangerous. Niosomes do not require any specific handling or storage conditions. Niosomes have shown to be a promising drug carrier, with the potential to minimize medication side effects and improve therapeutic efficacy in a variety of disorders. Drug insolubility, instability, limited bioavailability, and fast degradation are all issues that niosomes address. The benefits, preparations, assessment, and medicinal uses of niosomes are discussed in this review article.

Kaur Dhanvir et al.,(2018) Drug targeting is a kind of phenomenon in which drug gets distributed in the body in such a manner that the drug interacts with the target tissue at a cellular or subcellular level to achieve a desired therapeutic response at a desire site without undesirable interactions at other sites. This can be achieved by modern methods of targeting the drug delivery system such as niosomes. Niosomes are the type of non-ionic surfactant vesicles, which are biodegradable, non-toxic, more stable and inexpensive, a new approach to liposomes. Their structure similar to liposome and hence they can represent alternative vesicular systems with respect to liposomes. The niosomes have the tendency to load different type of drugs. This review article represents the structure of niosome, advantages, disadvantages, the methods for niosome preparation and characterization of pharmaceutical NSVs.

Sanklecha VM.,(2018) Vesicular medication delivery system, for example, Niosome is a novel medication delivery system, in which the solution is enclosed in vesicle which is made by Non-ionic surfactant. The niosomes provides several important advantages over conventional drug therapy. Structurally, niosomes are similar to liposomes, in that they are also made up of a bilayer. However, the bilayer in the case of niosomes is made up of non-ionic surface active agents rather than phospholipids as seen in case of liposomes. Niosomes tackled the issue of insolubility, instability, low bioavailability and fast debasement of medications. This paper overviews the method of preparation of Niosomes along with applications in pharmaceutical areas.

Lohumi Ashutosh et al.,(2012) Treatment of infectious diseases and immunisation has undergone a revolutionary shift in recent years. Not only a large number of disease-specific biological have been developed, but also emphasis has been made to effectively deliver these biological. Niosomes represent an emerging class of novel vesicular systems. Niosomes are self assembled vesicles composed

primarily of synthetic surfactants and cholesterol. A comprehensive research carried over niosome as a drug carrier. Various drugs are enlisted and tried in niosome surfactant vesicles. Niosomes proved to be a promising drug carrier and has potential to reduce the side effects of drugs and increased therapeutic effectiveness in various diseases. This article presents an overview of the techniques of preparation of niosome, types of niosomes, characterisation and their applications.

DidemAg Seleci *et al*., (2016) Drug delivery systems are defined as formulations aiming for transportation of a drug to the desired area of action within the body. The basic component of drug delivery systems is an appropriate carrier that protects the drug from rapid degradation orclearance and thereby enhances drug concentration in target tissues. Based on their biodegradable, biocompatible, and non immunogenic structure, niosomes are promising drug carriers that are formed by self-association of nonionic surfactants and cholesterol in an aqueous phase. In recent years, numerous research articles have been published in scientific journals reporting the potential of niosomes to serve as a carrier for the delivery of different types of drugs.The present review describes preparation methods, characterization techniques, and recent studies on niosomal drug delivery systems and also gives up to date information regarding recent applications of niosomes in drug delivery.

Satyanand Tyagi et al.,(2012) 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.

V.Shakya et al.,(2014) Niosomes are a novel drug delivery system, in which the medication is encapsulated in a vesicle. Niosomes are formations of vesicles by hydrating mixture of cholesterol and nonionic surfactants. Different novel approaches used for delivering these drugs include liposomes, microspheres, nanotechnology, micro emulsions, antibody loaded drug delivery, magnetic microcapsules, implantable pumps and niosomes. Niosomes and liposomes are equiactive in drug delivery potential and both increase drug efficacy as compared with that of free drug. Niosomes are now widely studied as an alternative to liposomes . 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. The application of niosomal technology is widely used to treat a number of diseases. Keywords: niosomes , vesicles , target cells , biological environment.

Applications of Niosomes

Niosomal cosmetics are already in market. Examples of niosomal cosmetic preparations include Estee Lauder- Beyond Paradise After Shave Lotion, White Shoulders Eau De Cologne Spray, Orlane Lip Gloss, LeClassique Eau De Toilette Spray, Love In Paris- Deodorant Spray, Liz Claiborne - Realities Shower Gel,Givenchy - Blanc Parfait - Day Care, Lancome- Foundation & Complexion, Britney Spears-

Curious Coffret,Elene - Eye Care, Guinot - Night Care, Gatineau - Moderactive – Cleanser, Shiseido - Bio Performance - NightCare, Boss Soul After Shave, Amarige Eau De Toilette Spray, Chrome Eau De Toilette Spray, Golden BeautyAfter Sun Soothing Moisturiser, Guinot – Cleanser Gentle Face Exfoliating Cream. Apart from these otherapplication of niosomes.

Conclusion

From the past few decades, there is a great revolution in development of novel drug delivery system.The technology of utilizing niosomes as promising drug delivery system is still in its infancy. Niosomes haveshown a profound influence in targeting the particular organ and tissue. Niosomes can serve as better diagnosticagents, vaccine delivery system, tumour targeting agents, ophthalmic, nasal and transdermal delivery systems.Research has to be carried out extensively to have commercially available niosomal formulation

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