



International Journal of Science, Architecture, Technology and Environment

Niosomes: A Novel Drug Delivery System

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DOI: <https://doi.org/10.63680/ijssate102663.51>

Abstract

Niosomes are vesicular structures created from non-ionic surfactants and cholesterol. Their bilayer membrane allows encapsulation of both hydrophilic drugs in the aqueous core and hydrophobic drugs in the membrane. The carriers were subject of investigations for their ability to improve the stability of encapsulated molecules and control their release rate for various routes of administration, including oral, topical, transdermal, ocular, and parenteral. The commonly used methods of niosomes production are thin-film hydration, ether injection, sonication, and proniosome hydration. The properties which are determined for the produced vesicular structures include particle size distribution, polydispersity index, zeta potential, entrapment efficiency, drug release characteristics, and stability during storage. Niosomes appear to offer reasonable potential in drug delivery due to variety of administration routes and relatively low production costs compared to phospholipid liposomes. However, the tendency to aggregate, possible drug leakage, and inconsistent performance at higher scales require thorough evaluation of each individual drug and administration route. Keywords: Niosomes; non-ionic surfactants; cholesterol; vesicular carriers; drug delivery; controlled release.

Keywords: Niosomes; Non-ionic surfactants; Cholesterol; Drug delivery; Controlled release

INTRODUCTION

Niosomes are the vesicular drug-delivery system composed mainly of non-ionic surfactants, cholesterol and water. It is similar to liposomes in that it can encapsulate both hydrophilic and lipophilic drugs, however, niosomes employ non-ionic surfactants in their hydrophobic layer instead of phospholipids. They can also offer protection to the encapsulated drug molecules and allow for controlled release of the chemistries.^{1,2}

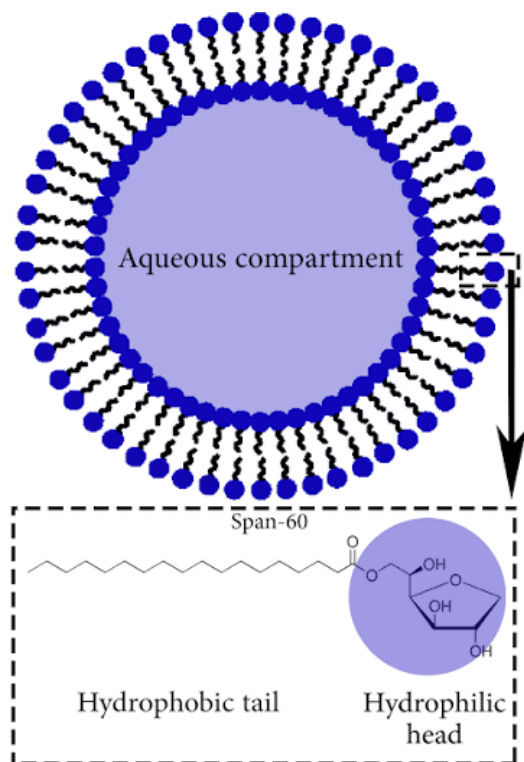


Figure 1: Structure of Niosome

Niosomes have the potential to enhance the stability, solubility, and bioavailability of a drug and improve its absorption and penetration through the skin. It can reduce the toxicity of pharmaceuticals and act as a carrier for oral, topical, ocular, parenteral, transdermal, anticancer, antimicrobial, vaccine, cosmetics routes.¹⁻⁴ and biological molecule delivery. However, niosomes can leak out the encapsulated drugs during storage, fuse together, or aggregate. There are also various challenges in producing them at a large scale and the impact of numerous variables on their formulation.¹⁻⁴ The properties of surfactants and cholesterol and the fabrication process affect the characteristics of niosomes, and further studies are necessary to evaluate their safety, efficacy, and economic viability for pharmaceutical applications.

CHARACTERIZATION AND EVALUATION

- Niosomes require extensive physicochemical and performance evaluation testing to determine the suitability of a formulation. Common approaches include:
- Particle size, and polydispersity index (PDI): typically determined by dynamic light scattering; which describe the average size and the breadth of the size distribution.
- Zeta potential: provides information on surface charge which can be useful in determining colloidal aggregation behaviour.
- Entrapment efficiency: the percentage of the total drug incorporated into or associated with the vesicles, free drug is separated before quantification.

➤ Morphology and lamellarity: assessed by microscopy techniques such as TEM or SEM. ➤ In vitro drug release: describes the amount of drug released overtime under specified experimental conditions.

MARKETED PRODUCTS AND DRUGS

Table 1: Drugs of niosomes

Drug	Therapeutic uses
Doxorubicin	Cancer treatment; drug delivery
Curcumin	Cancer treatment and anti-inflammatory therapy
Cefdinir	Oral drug delivery
Lornoxicam	Anti-inflammatory drug delivery
Temozolomide	Brain cancer treatment and drug delivery

FUTURE PROSPECTS

The future of niosomes in pharmaceutical sciences is promising, offering targeted drug delivery with surface modified niosomes to deliver more drug to a specific tissue or cell and less exposure to healthy tissue, particularly in cancer therapy.

They are also being explored for transdermal and ocular delivery, where niosomal gels, creams, and eye formulations may penetrate the skin or enhance drug retention.^{3,5} In addition, niosomes are being studied for vaccines, proteins, peptides, and genetic material, while more advanced forms, such as surface-functionalized niosomes and proniosomes, could overcome these limitations and enhance the targeting efficiency and maneuverability.^{1,3,6} However, their clinical and commercial applications will require further studies to optimize their physicochemical properties and address multiple formulation-related challenges, including stable storage, drug leakage, and uniform particle size, as well as safety, efficacy, regulatory approval, and cost-effectiveness issues. Therefore, future studies should focus on physicochemical characterization and quality control as well as clinical investigations to evaluate their safety and efficacy in large-scale trials.^{1,3,4}

CONCLUSION

The Niosomes as versatile Both hydrophilic and lipophilic drugs can be encapsulated by non-ionic surfactant-based carriers. This is achieved due to the possibility of encapsulation of drugs in the aqueous core and surfactant bilayer and the possibility to modify the properties of the vesicular drug delivery system.^{1,2} By varying the formulation parameters which was reported. The thin-film hydration method for the preparation of Niosomes is described as convenient for laboratory practice. It is proposed to characterize the physicochemical properties of the obtained preparations by determining their particle size, PDI, zeta potential, entrapment efficiency, drug release and stability profiles.^{1,6} The research team concluded that Niosomes could be promising drug delivery carriers for the tested drugs and administration routes, however additional safety and efficacy studies, as well as scaling trials, would be required before making final conclusions about their potential advantages.^{3,4}

Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship and publication of this article.

Funding

The author received no financial support for the research, authorship and publication of this article.

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