
بسم الله الرحمن الرحيم

Niosome and Liposome Preparation Techniques and Structure

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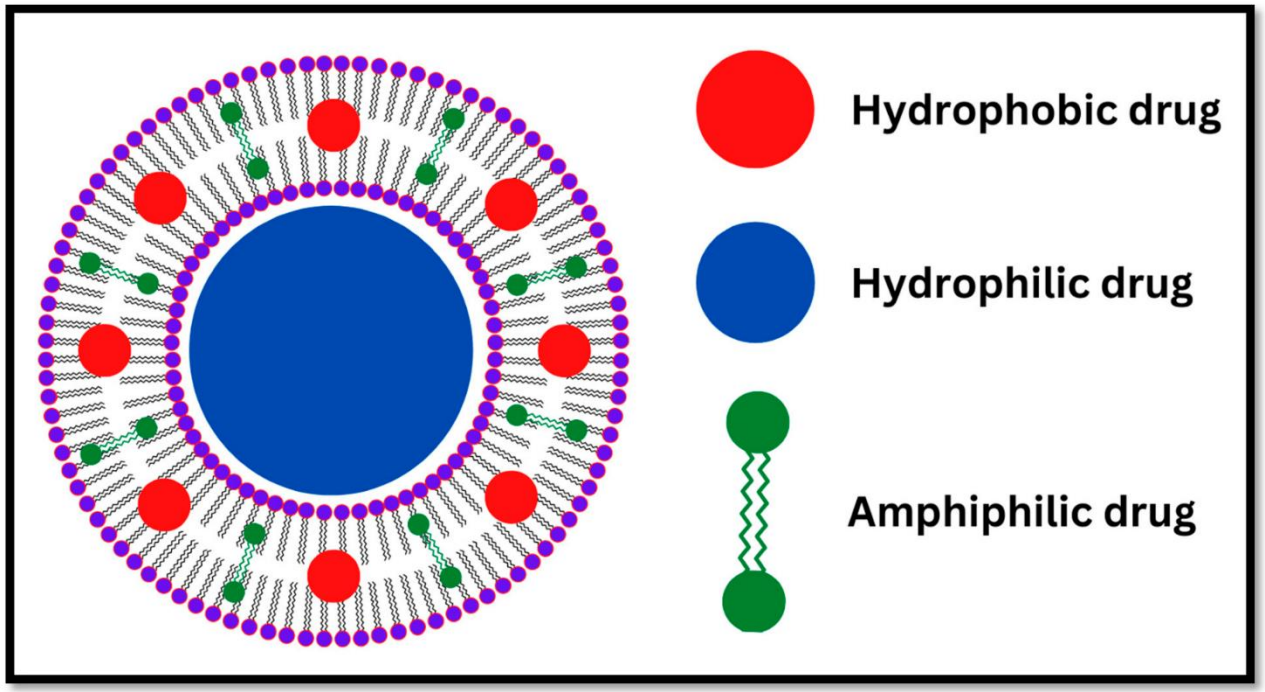
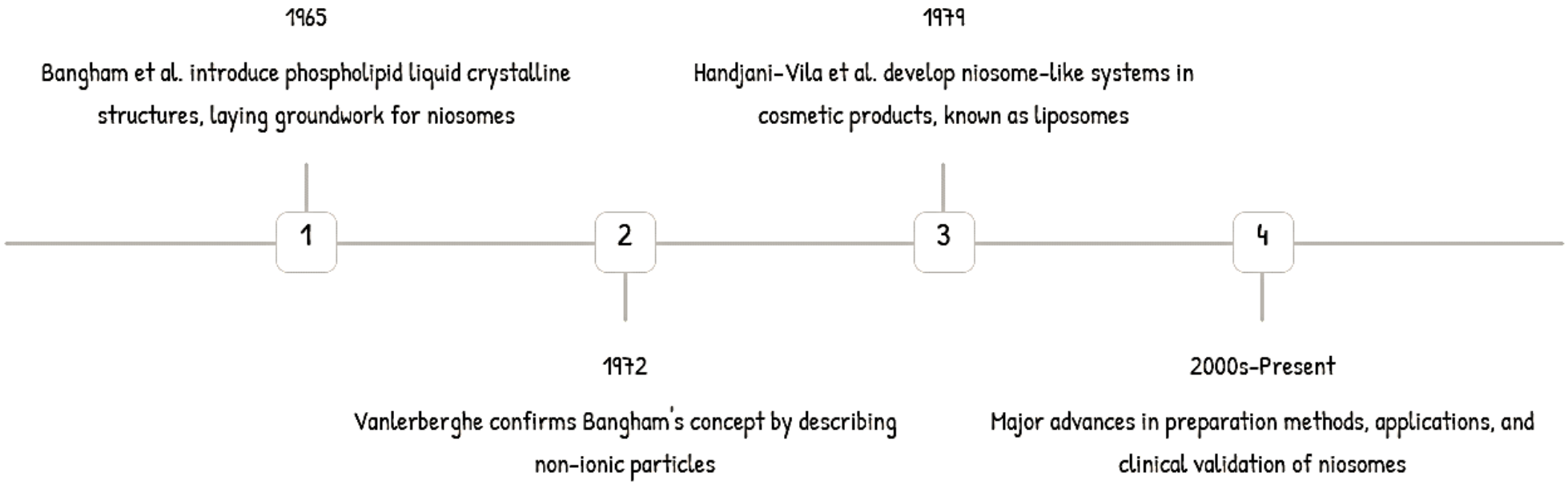
Niosomes Structure



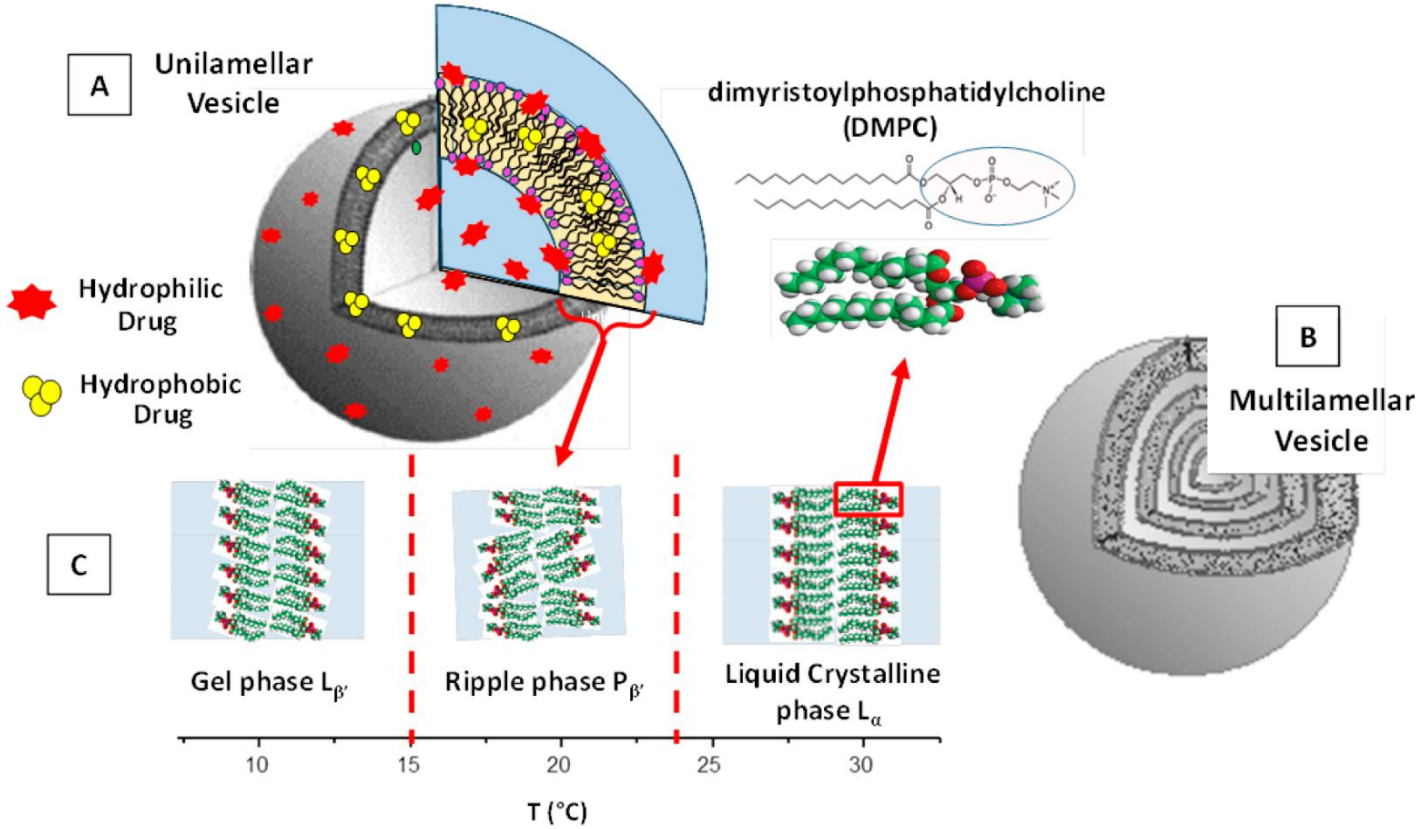
Historical Development of Niosomes



The evolution of niosomes spans over five decades, beginning with fundamental research in the 1960s. Initially explored for cosmetic applications in the 1970s, these versatile structures have since gained significant attention in pharmaceutical sciences for their drug delivery potential.

Recent decades have seen substantial progress in understanding niosome properties, preparation techniques, and therapeutic applications, establishing them as important tools in modern pharmaceutical nanotechnology.

Liposome Structure



Advantages of Niosomes Over Liposomes

Enhanced Stability

Niosomes demonstrate superior chemical and physical stability compared to liposomes, resulting in longer shelf life and better drug protection

Cost-Effectiveness

Non-ionic surfactants are less expensive than phospholipids used in liposomes, making niosomes more economical for large-scale production

Easier Handling and Storage

Less susceptible to oxidative degradation, requiring less stringent storage conditions than liposomes

Versatile Drug Encapsulation

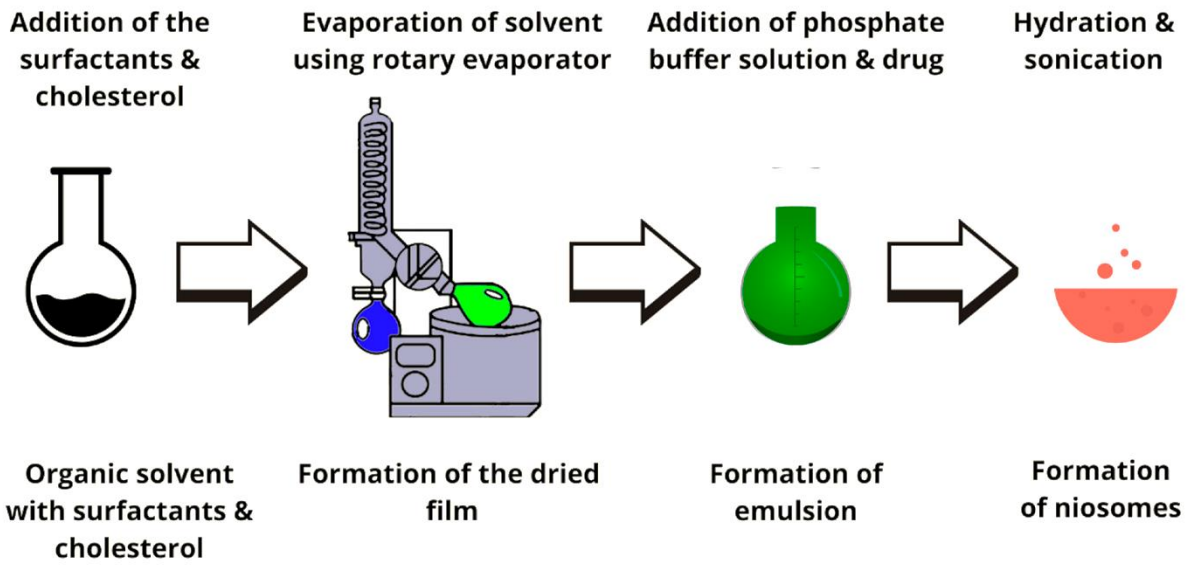
Capable of encapsulating a wider range of drug molecules with different solubility profiles due to their unique hydrophilic-hydrophobic structure

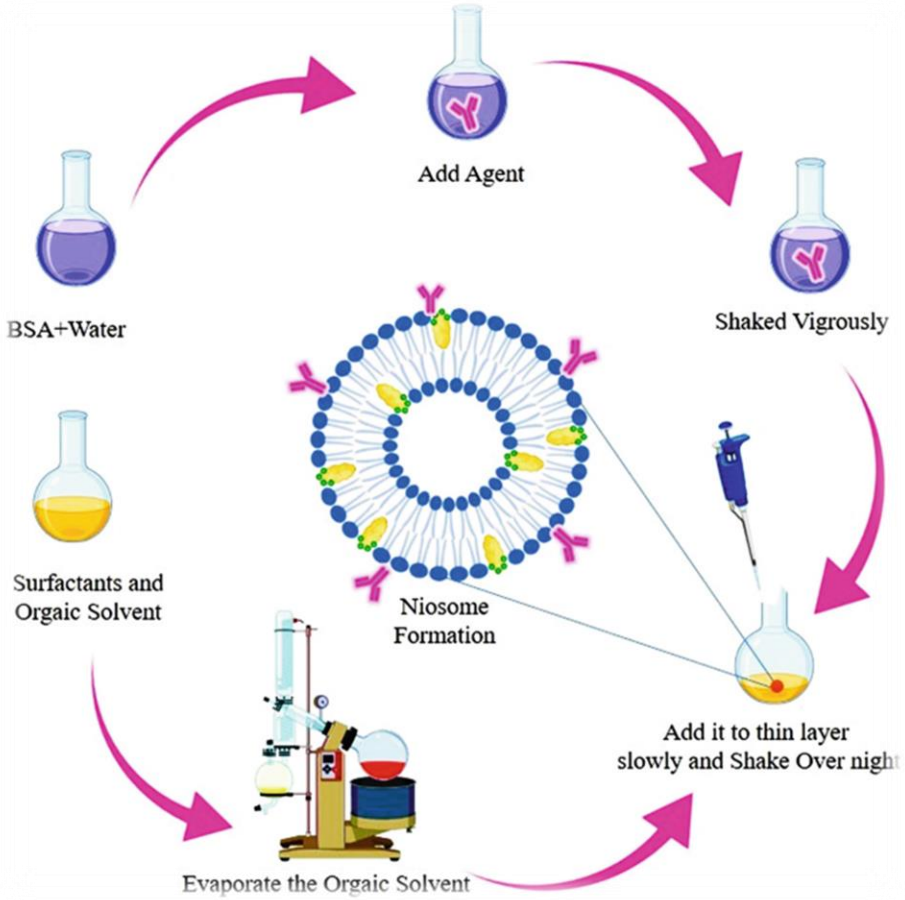
While structurally similar to liposomes, niosomes offer significant advantages that make them increasingly preferred for drug delivery applications. Their non-ionic surfactant composition provides greater stability against oxidative degradation and temperature fluctuations, addressing key limitations of phospholipid-based liposomes.

The water-based formulation process of niosomes also enhances patient compliance compared to oil-based formulations. Additionally, niosomes can be more easily modified to achieve targeted drug delivery to specific tissues or organs, improving therapeutic efficacy while reducing side effects.

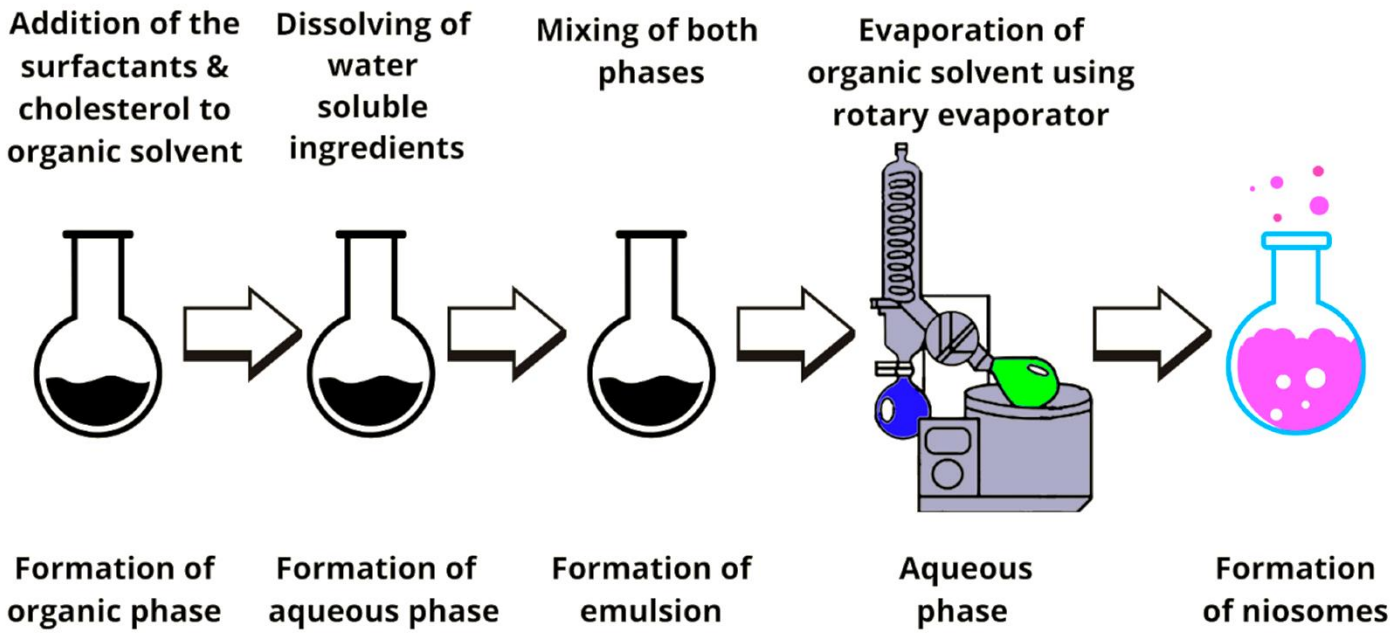
Preparation Techniques

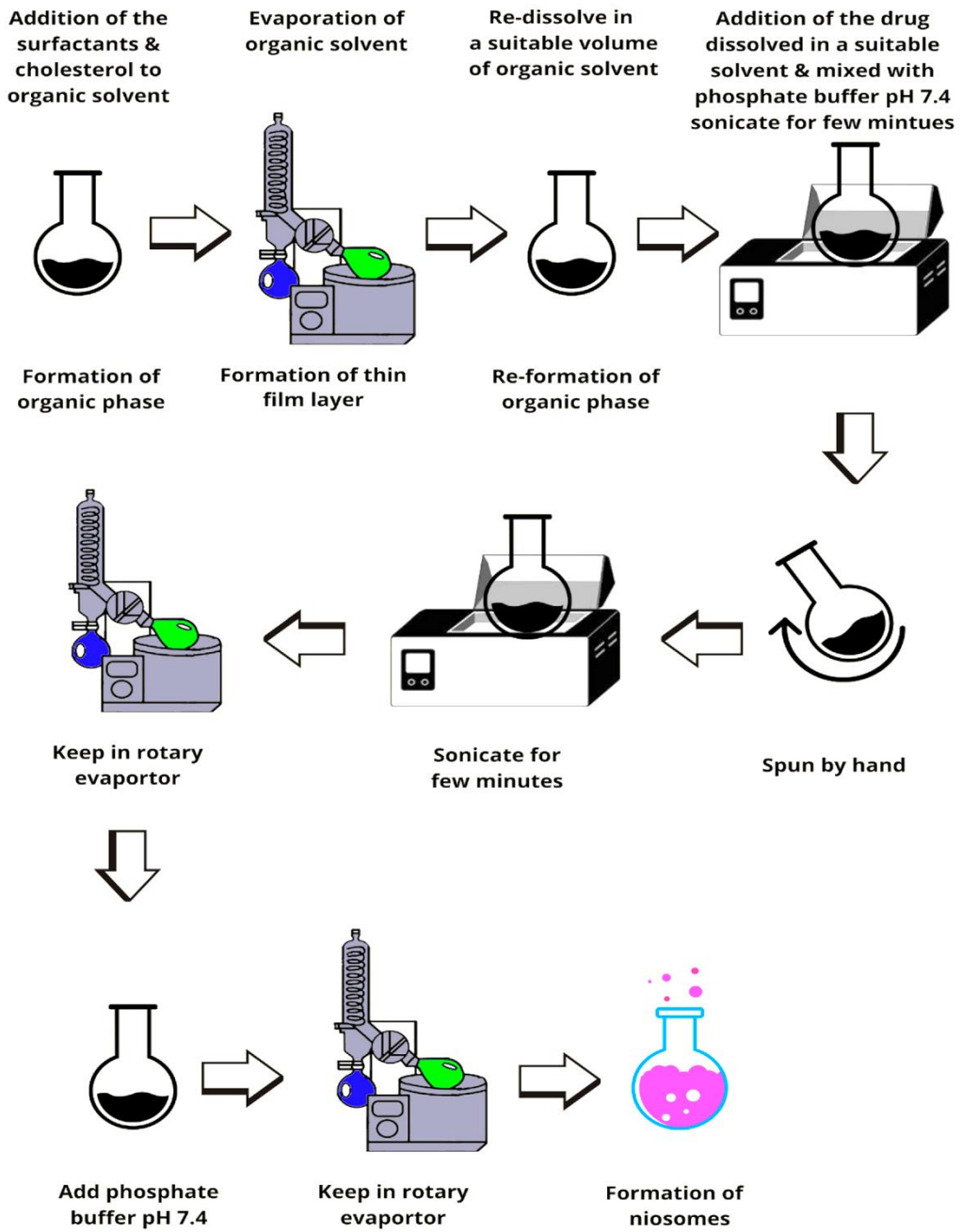
Thin Film Hydration



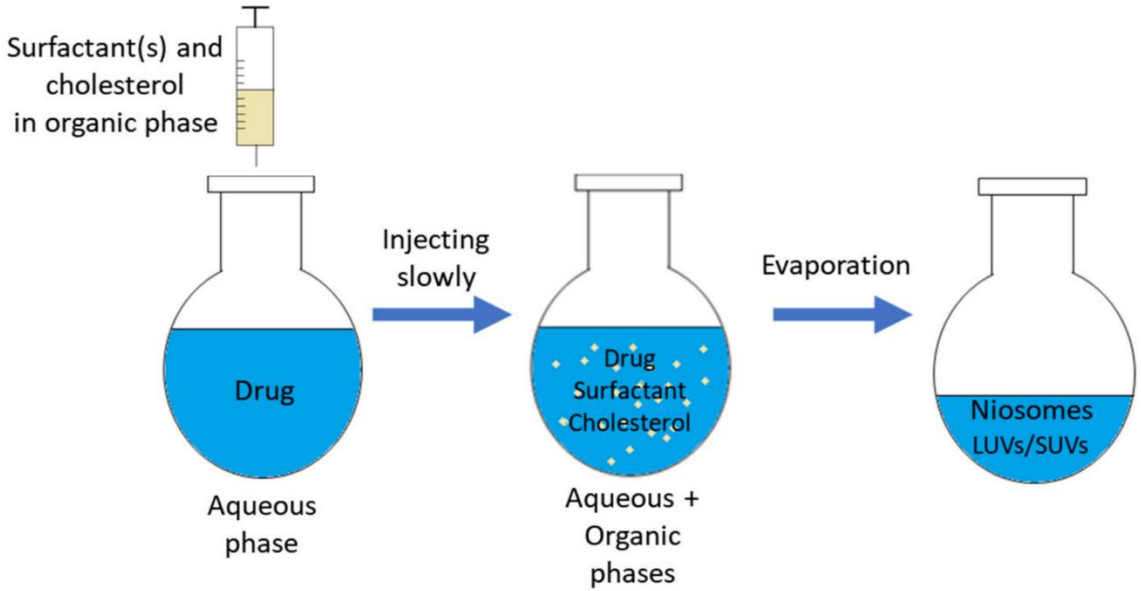


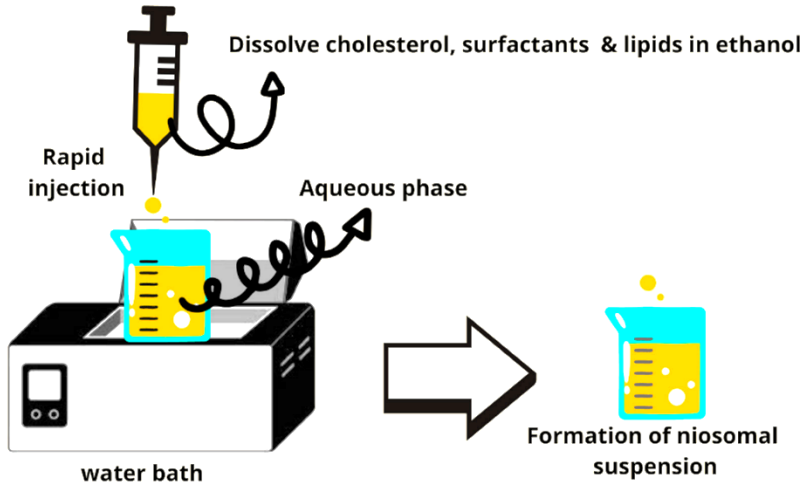
Reverse Phase Evaporation

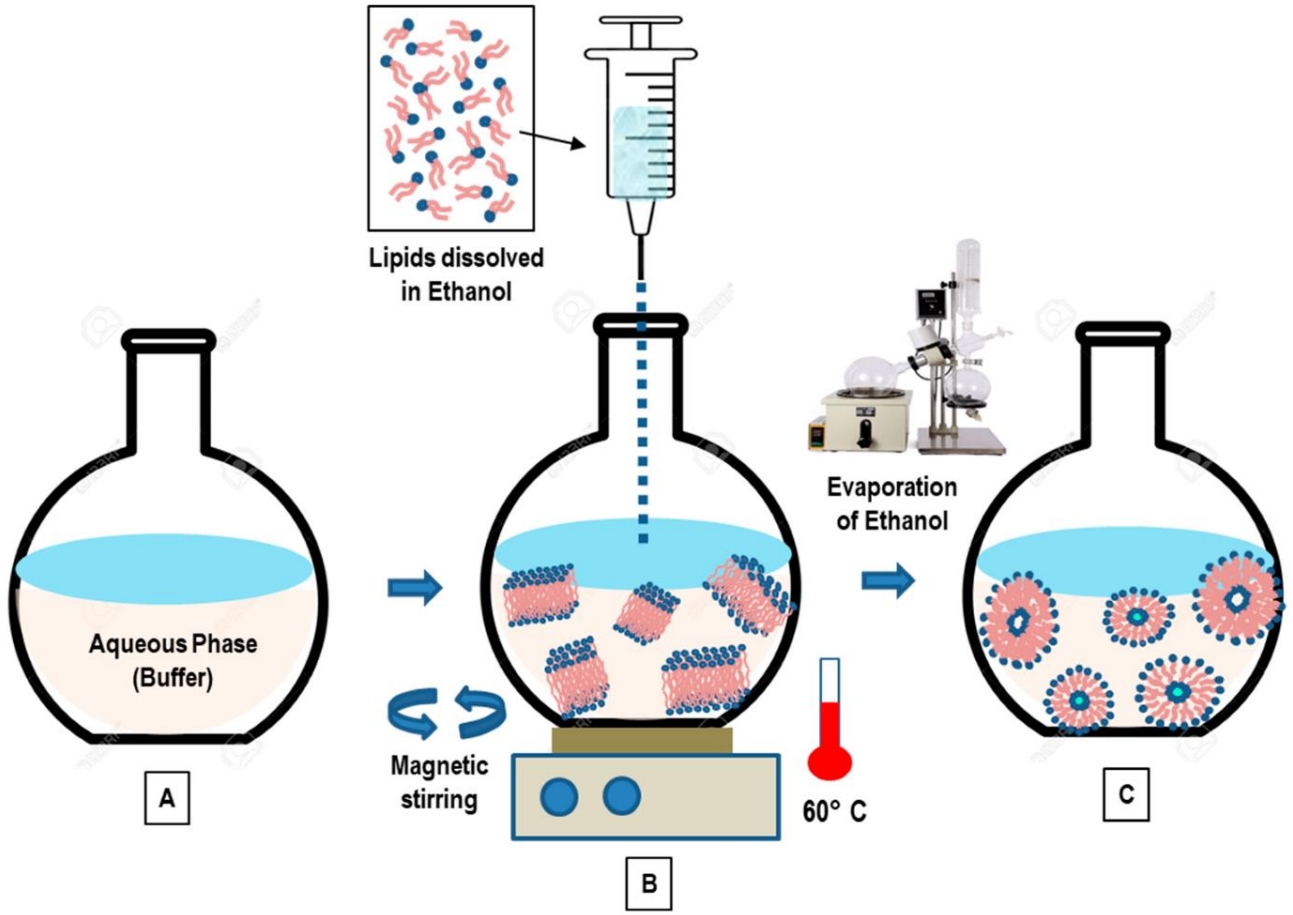


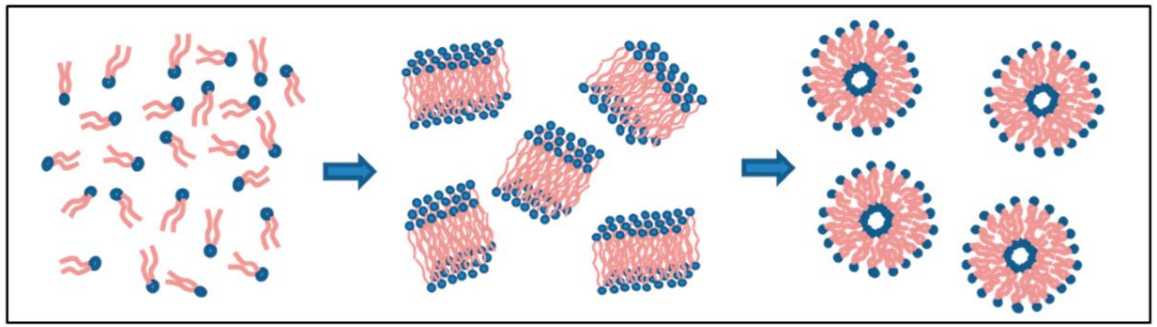

Addition of the surfactants & cholesterol to organic solvent
Evaporation of organic solvent
Re-dissolve in a suitable volume of organic solvent
Addition of the drug dissolved in a suitable solvent & mixed with phosphate buffer pH 7.4 sonicate for few mintues
Formation of organic phase
Formation of thin film layer
Re-formation of organic phase
Spun by hand
Sonicate for few minutes
Keep in rotary evaportor
Add phosphate buffer pH 7.4
Keep in rotary evaportor
Formation of niosomes

Ethanol Injection Method

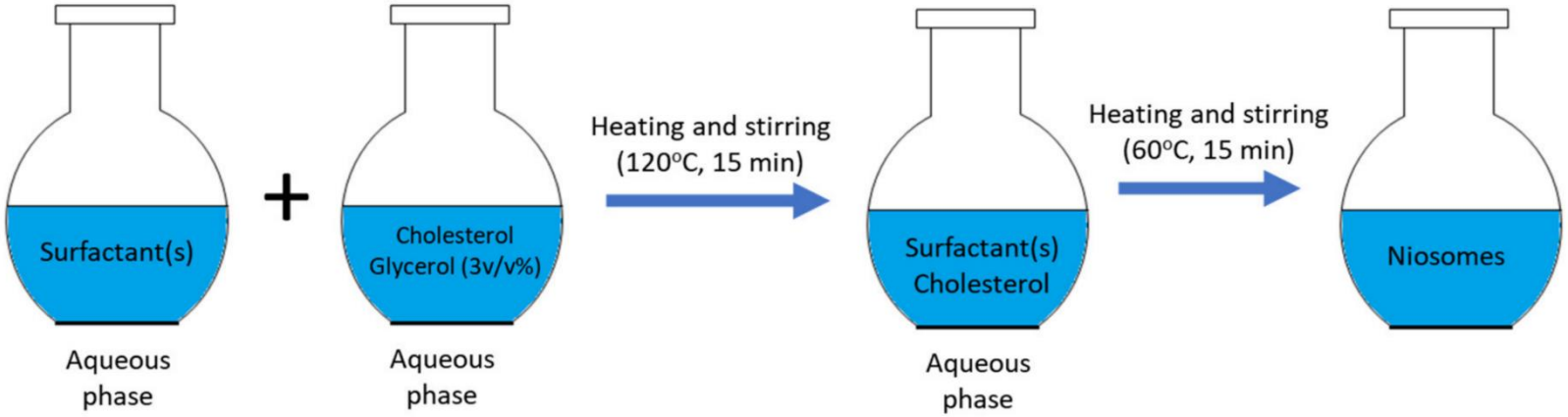





Lipids dissolved
in Ethanol
Aqueous Phase
(Buffer)
A
Magnetic
stirring
B
60° C
Evaporation
of Ethanol
C



Heating Method

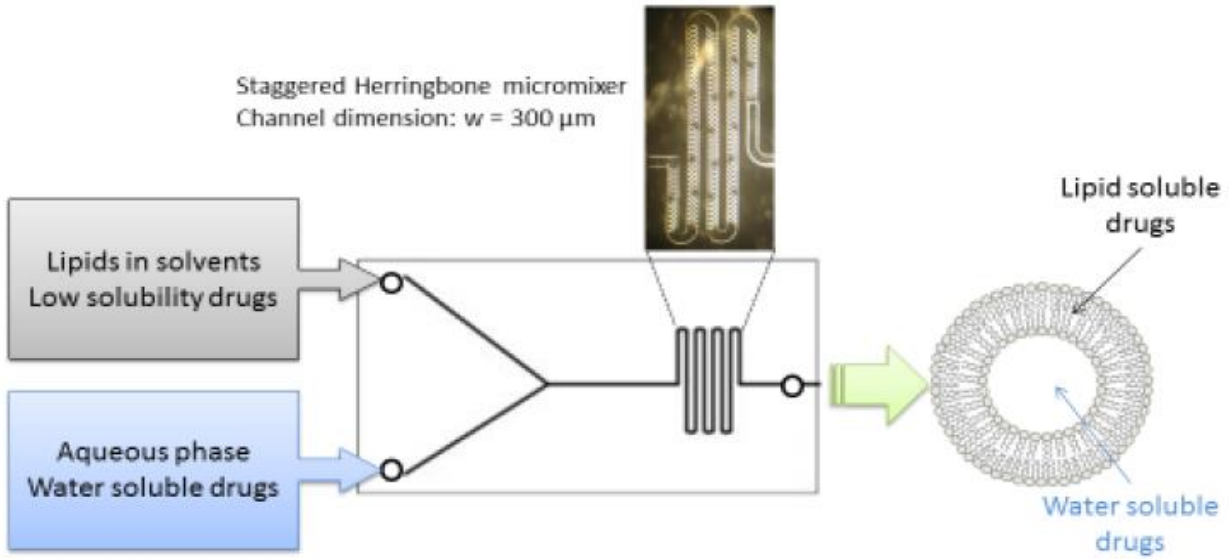


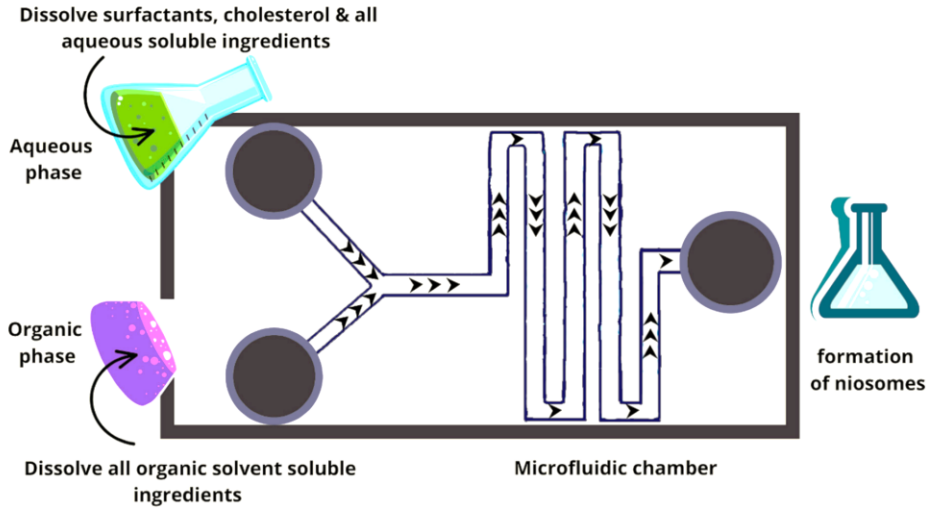
Hydrate surfactants in phosphate buffer pH=7.4 for 1 hour at room temperature

Dissolve cholesterol in phosphate buffer of pH=7.4 with stirring using hotplate stirrer at 120 °C for 15-30 mniutes

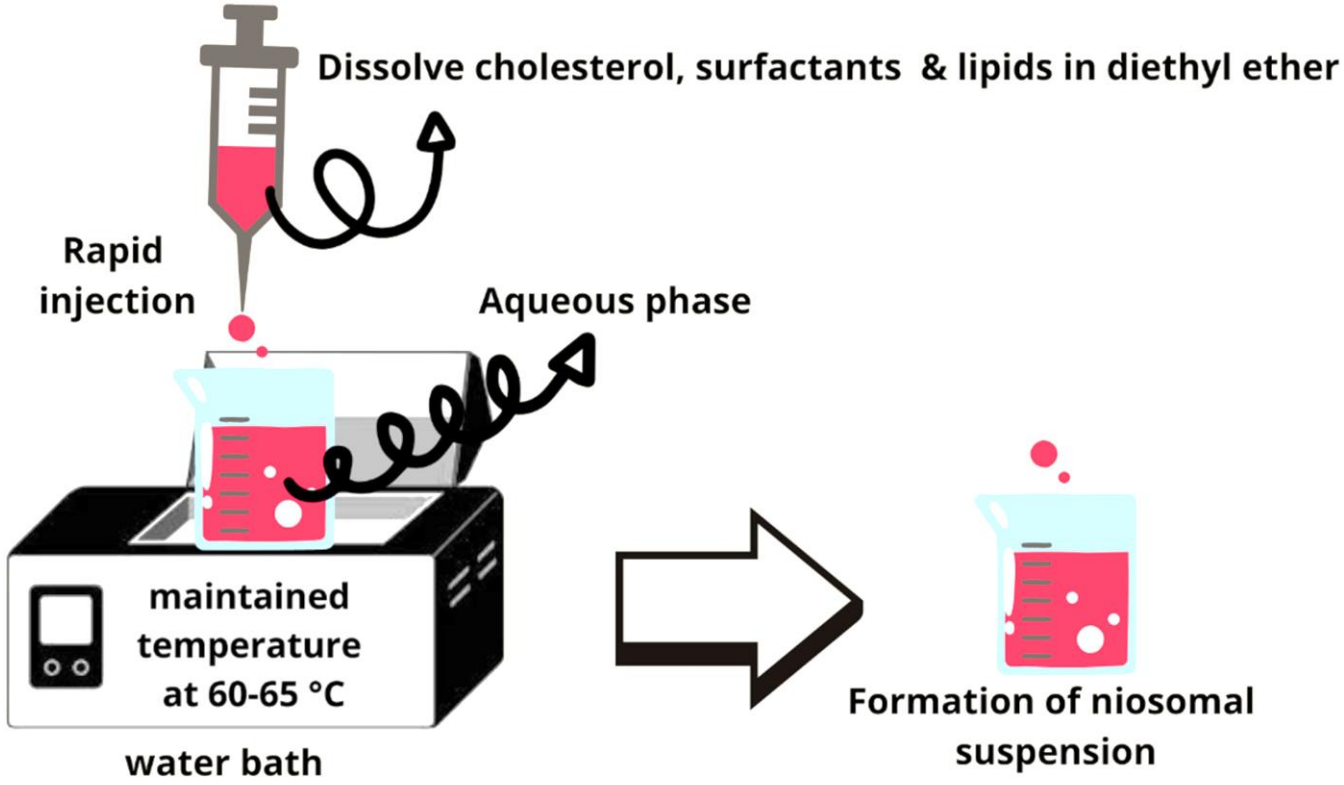
Mix both mixtuers with stirring (800-1000 rpm) for 30 minutes under nitrogen atmosphere

Microfluidics

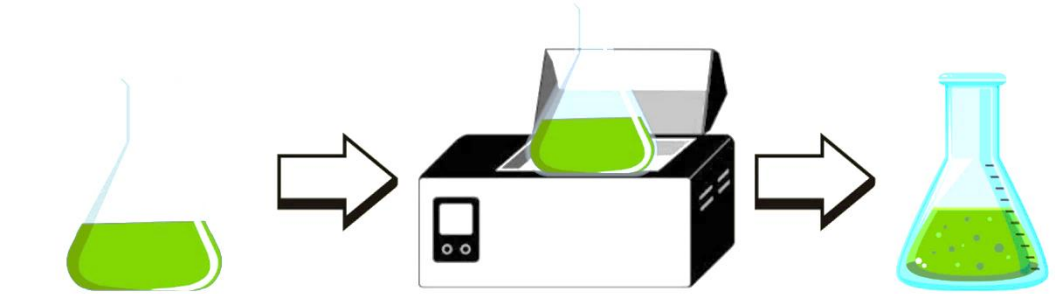




Ether Injection



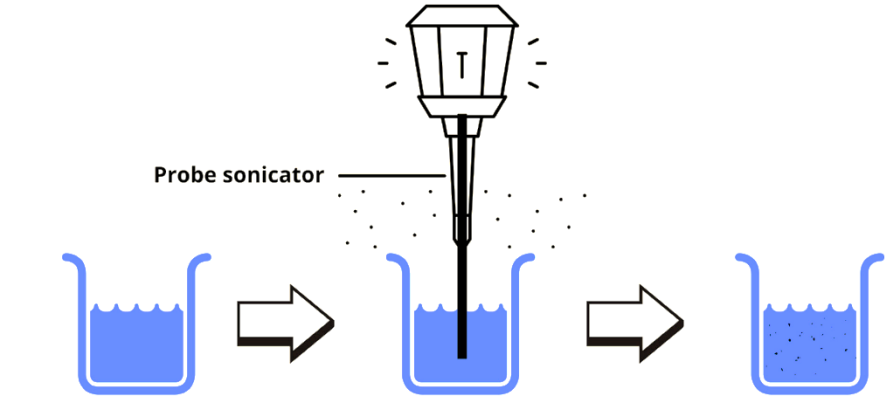
Sonication Method



Mix all; cholesterol, surfactants & active ingredient in aqueous phase

Sonication

Formation of niosomal suspension



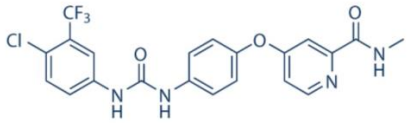
Mix all; cholesterol, surfactants & active ingredient in aqueous phase

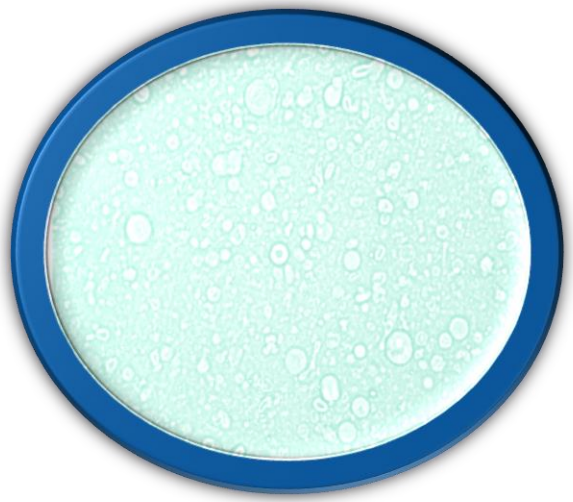
Sonication

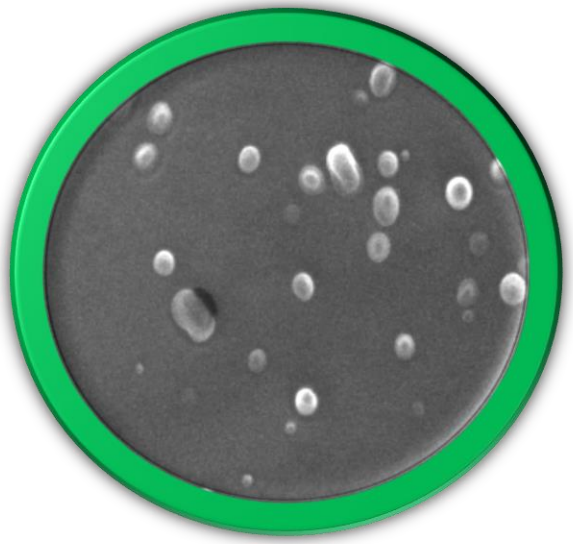
Formation of niosomal suspension

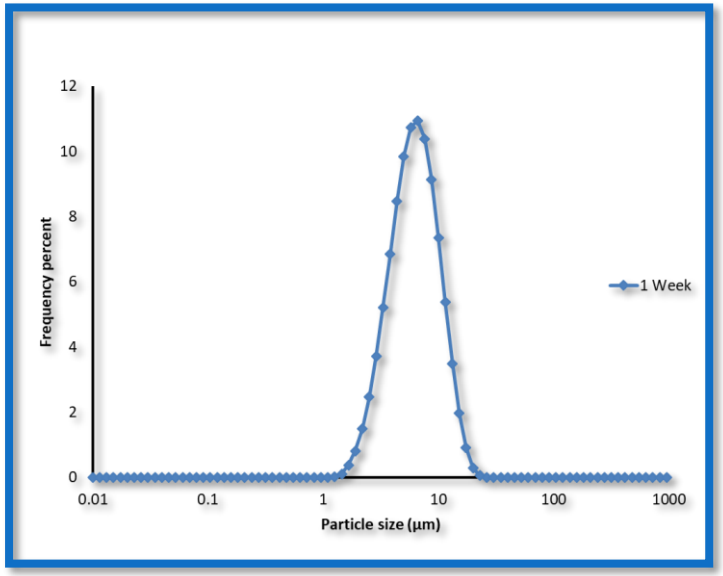
Preparation Technique	Particle Size Range (nm)	Encapsulation Efficiency	Advantages	Limitations	Applications	Possibility of Scale-Up
Thin Film Hydration	18–29 and can go up to 450 nm	77–92%	High reproducibility; cost-effective; easy to prepare with optimized parameters such as hydration temperature and polymer ratio	Limited stability in solution form; requires freeze-drying for long-term storage	Delivery of hydrophobic drugs, e.g., luteolin for anticancer applications	High potential for scaling up due to the simplicity of the method and reproducibility
Reverse Phase Evaporation	55–120	Up to 85.5%	High encapsulation efficiency, stability during freeze-drying, and good inhalation properties.	Toxicity potential of cationic surfactants, limited scalability.	Curcumin delivery for non-small cell lung cancer via the inhalation route.	Moderate: Requires optimization of solvent evaporation and vesicle stabilization for large-scale production.
Microfluidics Method	237.97–281.73	>90%	- Precise control over size and polydispersity. - High reproducibility. - Reduced preparation time and steps.	- Requires specialized equipment. - High setup cost.	- Effective for hydrophobic compounds like lycopene. - Potential for anti-aging, UVB protection, and skin applications.	- High potential due to continuous processing capabilities and scalability of microfluidic systems scaling up due to its ability to offer controlled vesicle size, high encapsulation efficiency, and applicability in both pharmaceutical and cosmetic formulations. However, the reliance on specialized equipment might limit accessibility for smaller labs or preliminary studies.

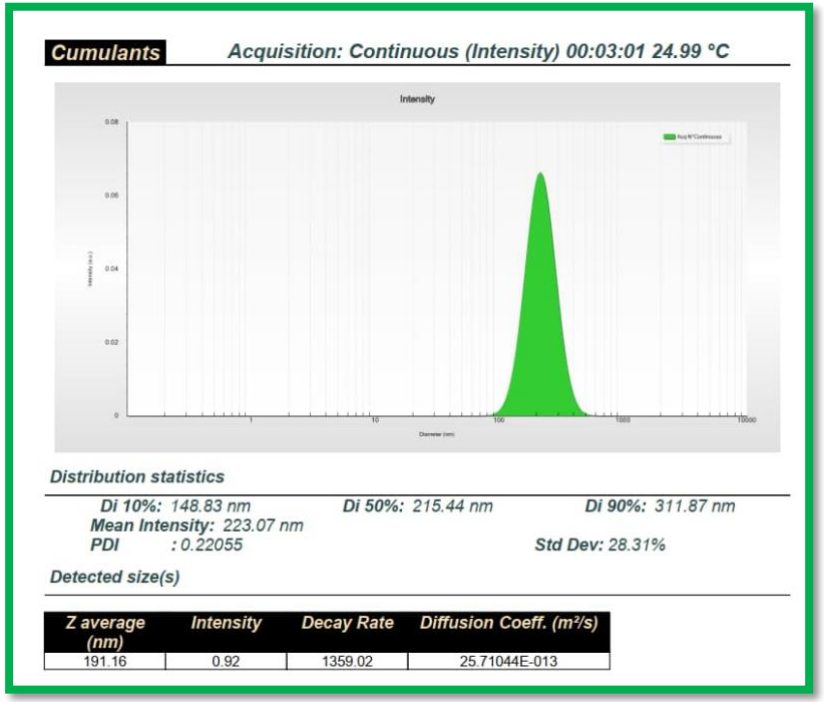
Ethanol Injection	186–256	87.6–98.2%	- Simple setup with high reproducibility. - Ability to produce unilamellar vesicles. - High encapsulation efficiency for hydrophobic molecules like Vitamin D3. - Versatile for different surfactants and cholesterol compositions.	- Size is highly sensitive to operating conditions, requiring precise optimization. - Limited stability without stabilizing agents like cholesterol. - Requires multiple steps (injection, evaporation, sonication).	- Drug delivery for hydrophobic vitamins (e.g., Vitamin D3). - Potential use in food supplements and pharmaceuticals.	High potential due to simple injection setup and ability to adapt operating conditions for larger batches.
Ether Injection	129–319	72–96%	- High encapsulation efficiency. - Suitable for both hydrophilic and lipophilic drugs. - Effective for tramadol delivery with sustained release. - Suitable for the dosage design of complex systems such as niosomes in a hydrogel complex.	- Requires precise temperature control to prevent degradation. - Solvent toxicity concerns during production.	- Delivery of tramadol for vesicular carrier for site-specific delivery. - Potential use in anti-inflammatory, antioxidant, and anticancer therapies.	Moderate: The method is scalable with proper control over solvent evaporation and injection rate.
Sonication Method	165–893 nm	95–99%	- Enhanced drug delivery (improved release profiles and sustained release for 12 h). - High stability under refrigerated conditions (4 weeks). - Eco-friendly, solvent-free process. - Facilitates dual drug delivery for antimicrobial	- Requires precise surfactant and charge agent balance for optimal performance. - Slight release profile variances based on Pluronic L121 concentration. - Potential challenges in large-scale production.	- Antimicrobial therapy for tuberculosis and biofilm-resistant infections. - Potential use for controlled delivery of hydrophilic and hydrophobic drugs.	- Feasible with optimization for consistency in particle size, stability, and encapsulation efficiency. - Requires adaptation to ensure eco-friendliness and efficiency at large scales.

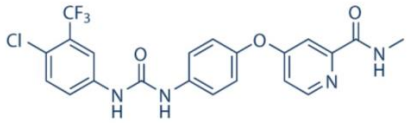


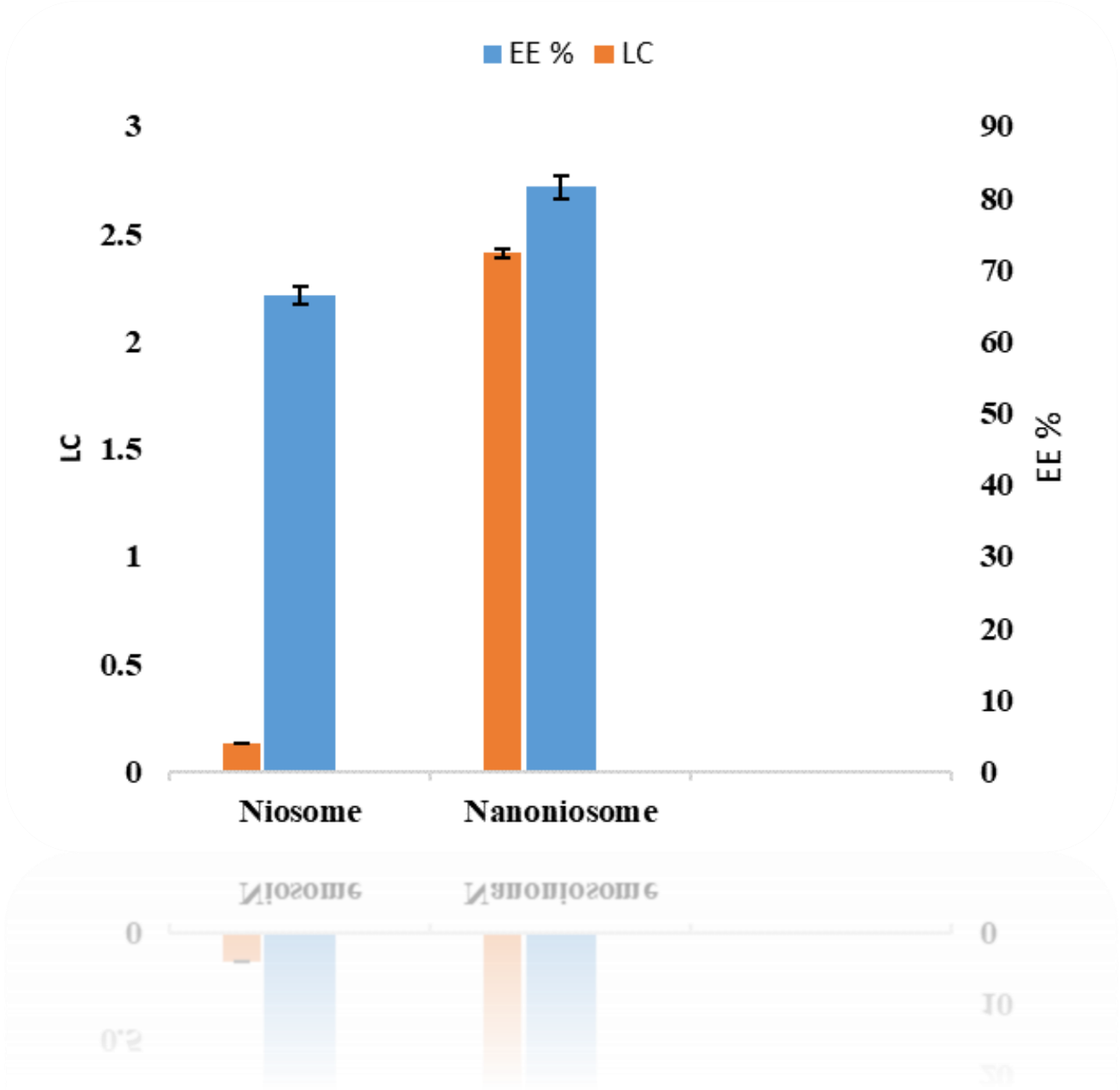





12
10
8
6
4
2
0
Frequency percent
0.01
0.1
1
10
100
1000
Particle size (µm)
1 Week


Cumulants
Acquisition: Continuous (Intensity) 00:03:01 24.99 °C
Intensity
Distribution statistics
Di 10%: 148.83 nm
Di 50%: 215.44 nm
Di 90%: 311.87 nm
Mean Intensity: 223.07 nm
PDI : 0.22055
Std Dev: 28.31%
Detected size(s)
Z average (nm)
Intensity
Decay Rate
Diffusion Coeff. (m²/s)
191.16
0.92
1359.02
25.71044E-013




EE %
LC
3
2.5
2
1.5
1
0.5
0
LC
90
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70
60
50
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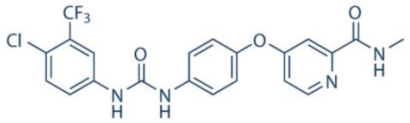
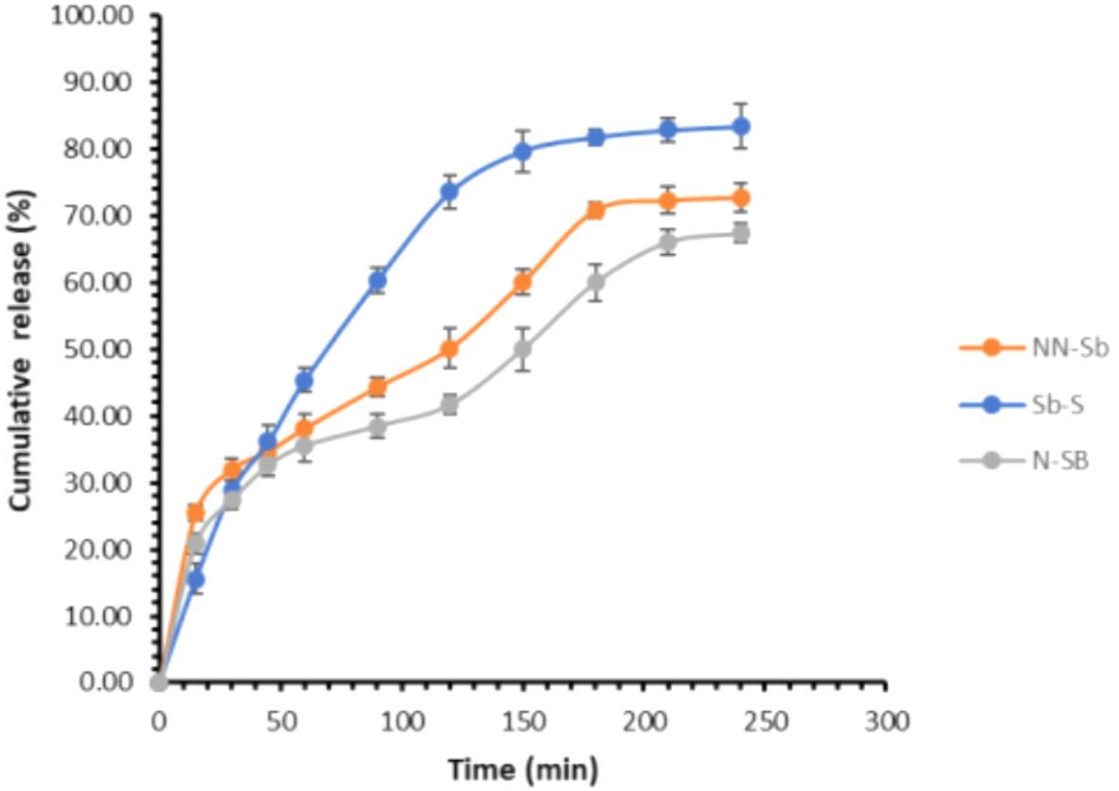
30
20
10
0
EE %
Niosome
Nanoniosome

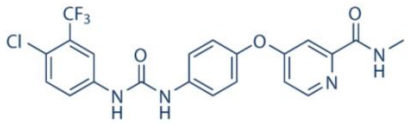




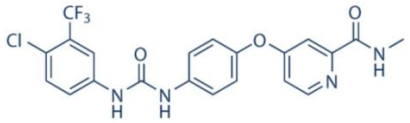
شکل ۶۰-۴ نمودار آزادسازی تجمعی نانونیوزم، نیوزوم و محلول سورافنیب (Mean±SD n=3)

S-SB: محلول سورافنیب، N-SB: نیوزوم سورافنیب (90:10) ST60 NN-SB: نانو نیوزوم بهینه

سورافنیب (HLB:9.9, FRR: 5, %S:90)



نام فرمولاسیون	میانگین IC_{50} (میکروگرم در میلی لیتر)	محدوده اطمینان ۹۵ درصد
محلول سورافنیب	۱۵/۹۶	۱۳/۸۷-۱۸/۵۳
نیوزوم سورافنیب	۷/۵۳	۵/۶۷-۹/۸۴
نانونیوزوم سورافنیب	۱/۳۲	۱/۱۰-۱/۵۴


CF3
Cl
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H
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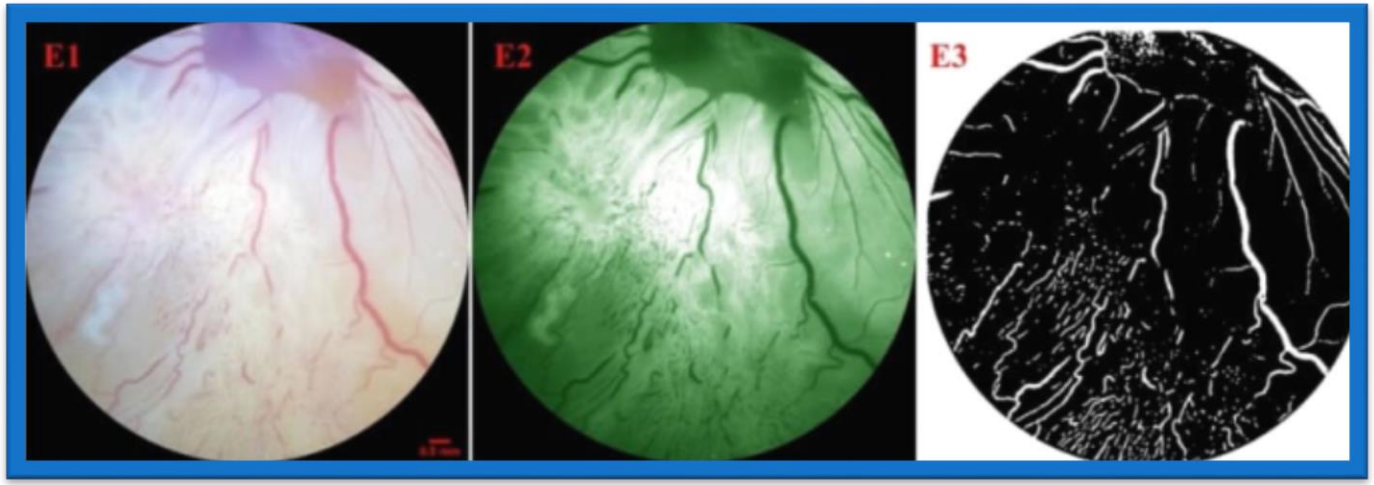
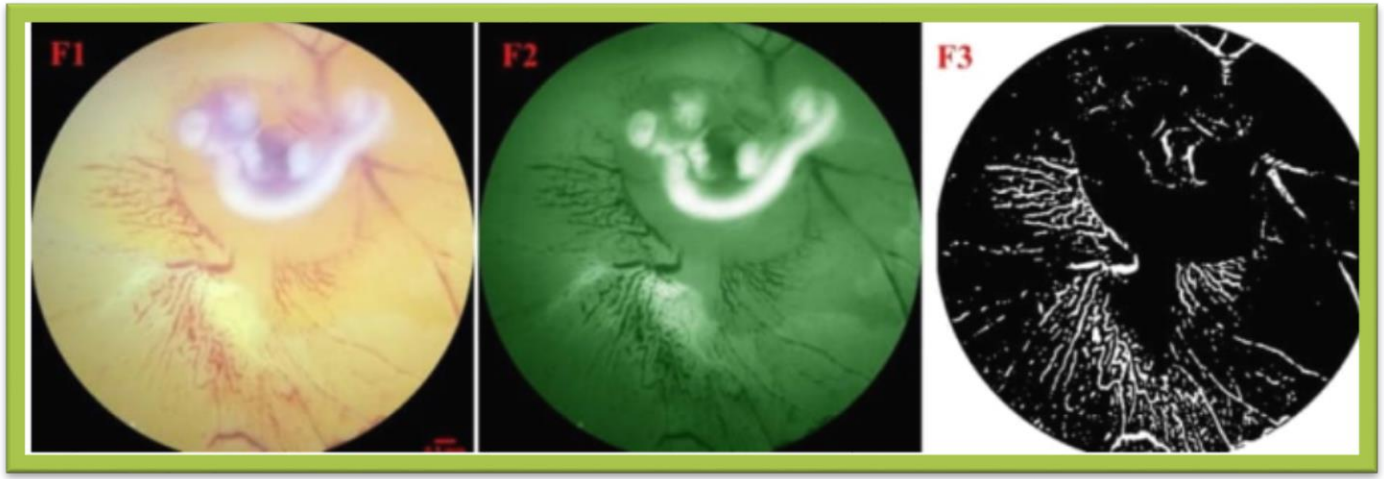
N
H


E1
E2
E3


F1
F2
F3

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