

SUPPLEMENTARY FILE

Table I. Phytochemical content comparison of ethanolic extract vs. flavonoid-rich fraction (total phenolics, total flavonoids, yield %).

Parameter	Ethanolic Extract	Flavonoid-Rich Fraction
Extraction Yield (%)	<i>e.g.</i> , 12.4 ± 0.8	<i>e.g.</i> , 4.8 ± 0.4
Total Phenolic Content (mg GAE/g extract)	<i>e.g.</i> , 48.6 ± 1.9	<i>e.g.</i> , 112.3 ± 3.1
Total Flavonoid Content (mg QE/g extract)	<i>e.g.</i> , 23.4 ± 1.2	<i>e.g.</i> , 78.5 ± 2.4

Table II. Formulation variables with selected optimized conditions.

Formulation Variable	Tested Range / Conditions	Selected Optimized Condition
Phospholipid concentration (mg/mL)	5–25 mg/mL	<i>e.g.</i> , 20 mg/mL
Cholesterol ratio (% of total lipids)	10–40%	<i>e.g.</i> , 25%
Drug-to-lipid ratio (w/w)	1:5, 1:10, 1:15	<i>e.g.</i> , 1:10
Hydration medium (pH)	Water, PBS pH 7.4	PBS pH 7.4
Hydration temperature (°C)	40–65°C	<i>e.g.</i> , 55°C
Hydration time (min)	15–45 min	<i>e.g.</i> , 30 min
Probe sonication amplitude (%)	20–60%	<i>e.g.</i> , 40%
Sonication time (min)	2–12 min	<i>e.g.</i> , 8 min (pulsed)
Cooling during sonication	Ice bath / no cooling	Ice bath used
Final vesicle size target (nm)	120–200 nm	<150 nm
Target PDI	0.15–0.35	<0.25

Table III. Encapsulation efficiency of extract-loaded vs. flavonoid-loaded liposomes.

Formulation	Encapsulation Efficiency (EE%)
Ethanolic Extract-Loaded Liposomes	<i>e.g.</i> , 67.8 ± 2.4%
Flavonoid-Rich Fraction-Loaded Liposomes	<i>e.g.</i> , 82.5 ± 1.7%

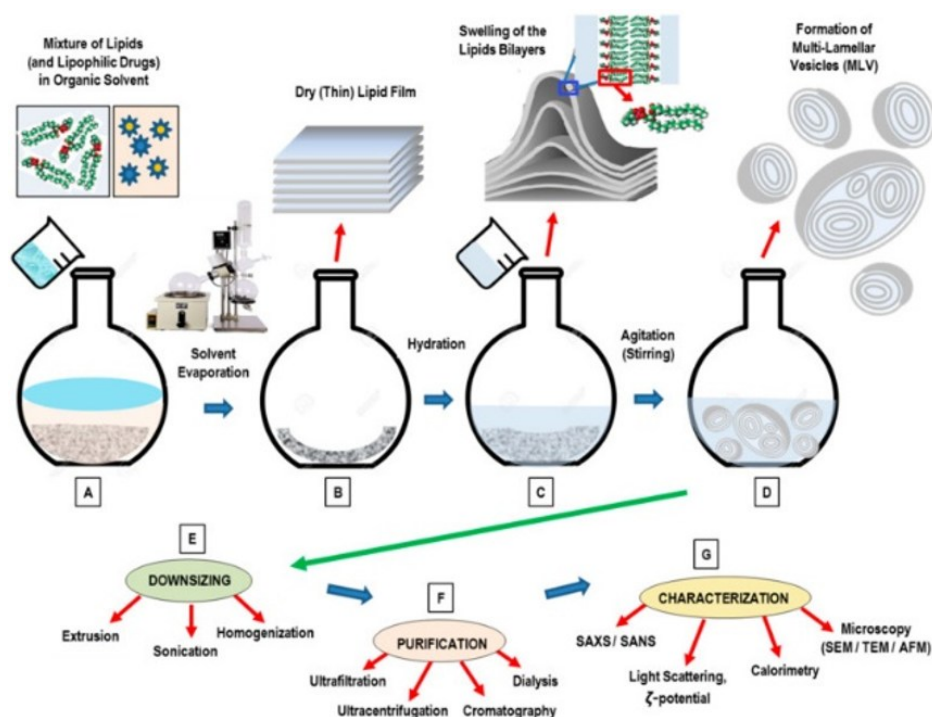


Figure 1. Schematic of thin-film hydration method. A schematic representation of the thin-film hydration technique delineating the sequential processes of lipid dissolution in an organic solvent, the creation of a dry lipid film following solvent evaporation, hydration of the film to produce multilamellar vesicles, and the subsequent size reduction to achieve uniform liposomal dispersions. [Majcher, M. et al., Methods of Liposomes Preparation: Formation and Control Factors of Versatile Nanocarriers for Biomedical and Nanomedicine Application, Pharmaceutics, 2022]

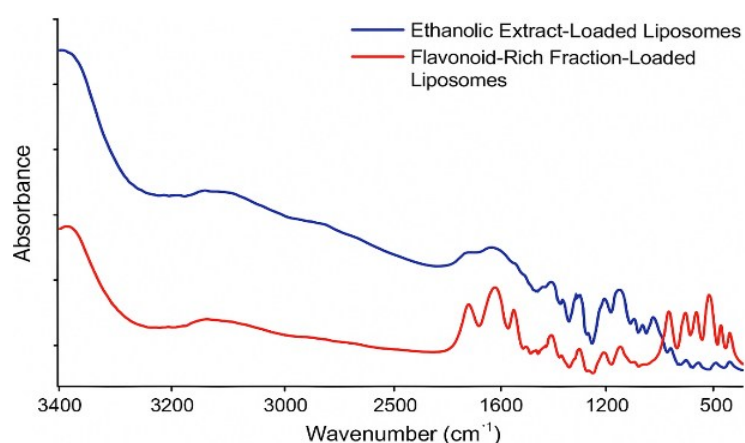


Figure 2. FTIR overlay spectra. An overlay of FTIR spectra for liposomes loaded with ethanolic extract and flavonoid-rich fractions, emphasizing distinctive functional group vibrations and validating the efficient integration of phytoconstituents inside the phospholipid bilayer. Shifts and intensity fluctuations in principal absorption bands signify molecular interactions between bioactive chemicals and lipid constituents.

