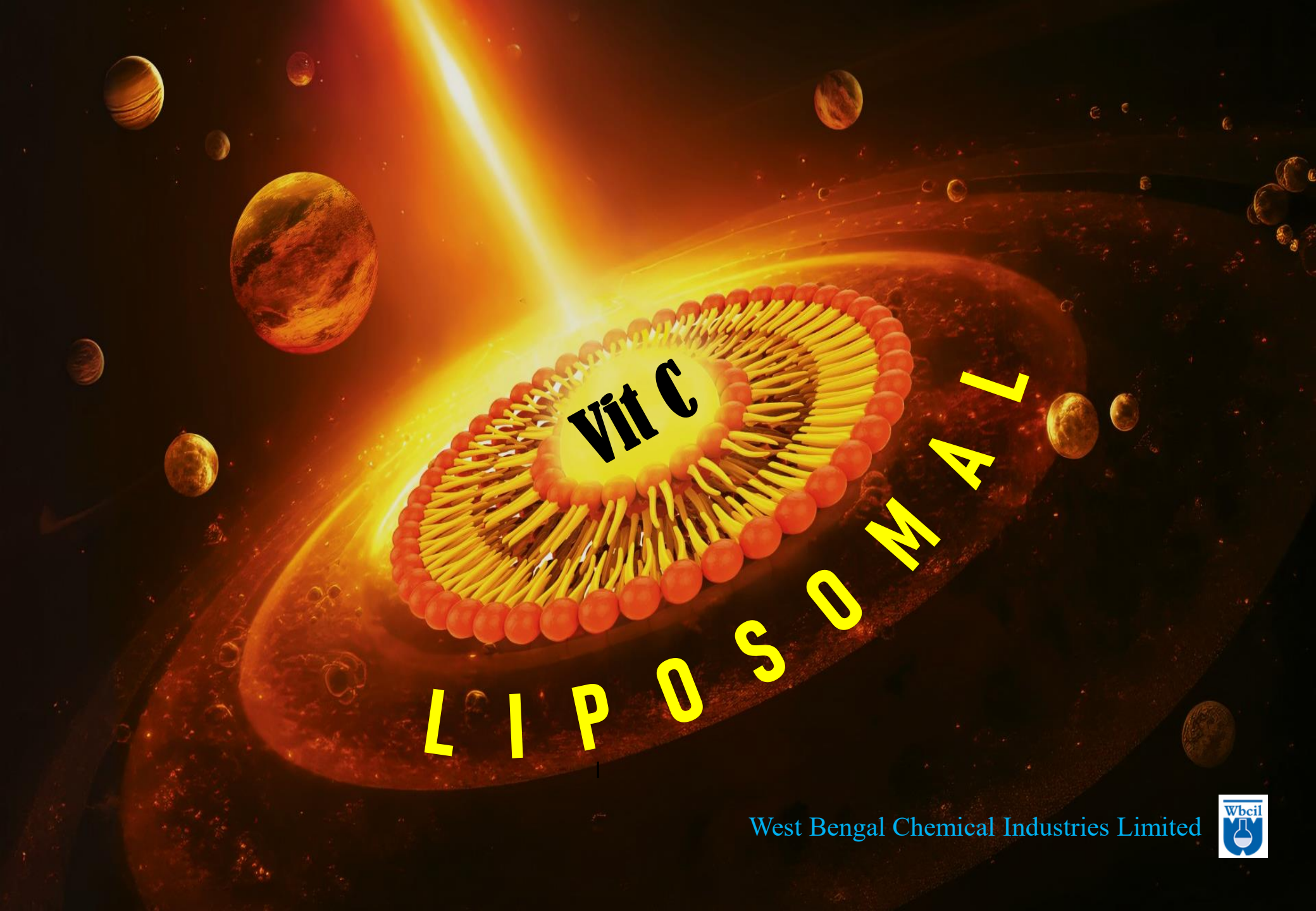


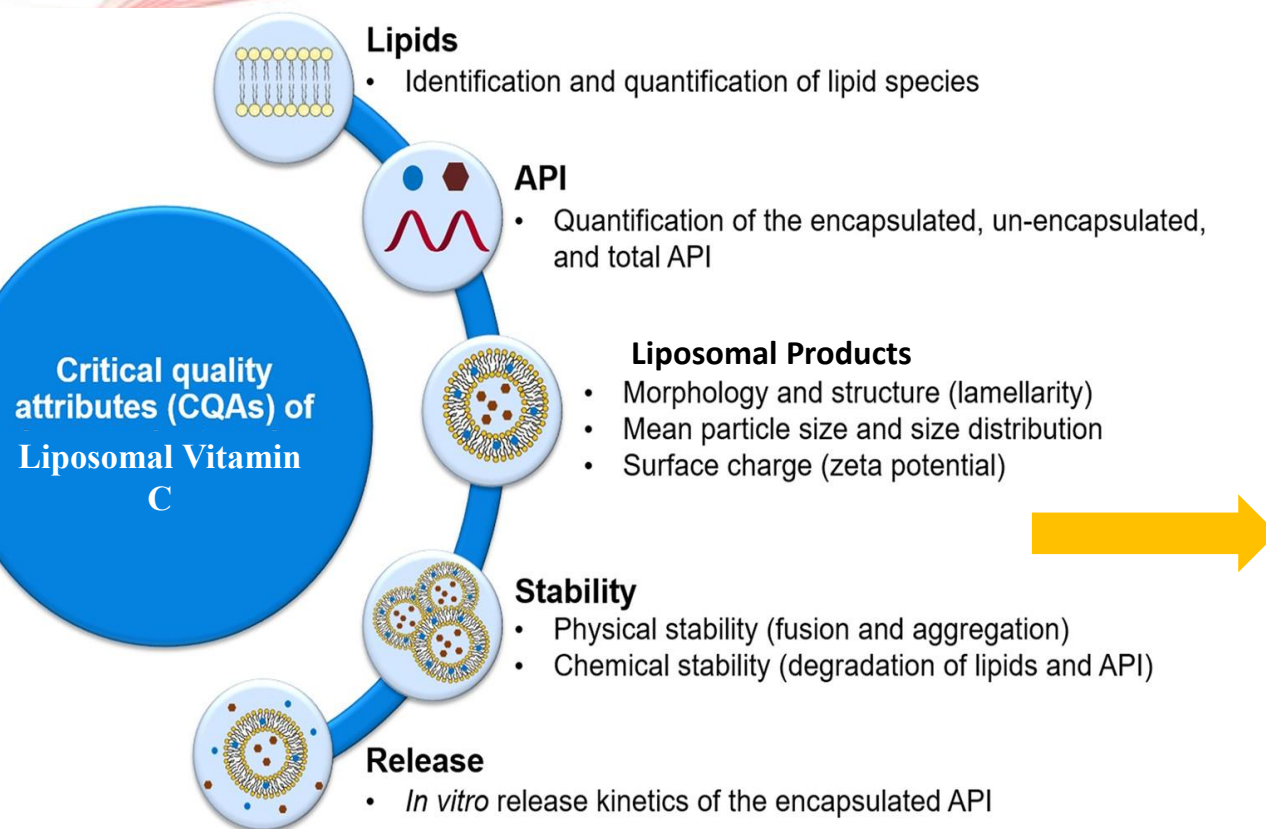


vit c
LIPOSOMAL

West Bengal Chemical Industries Limited

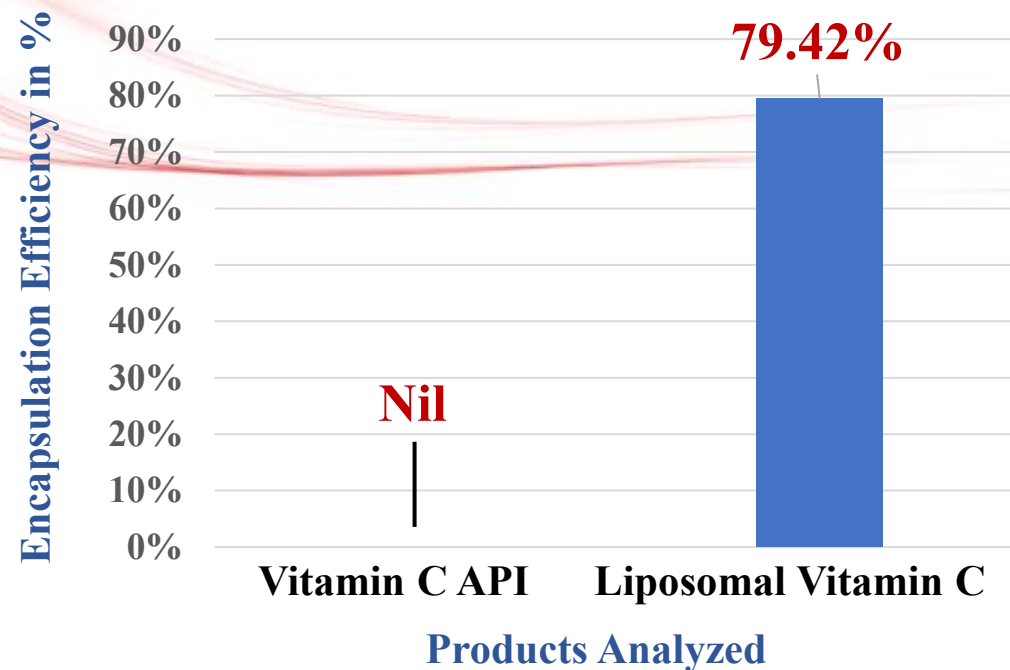


Summary of Characterizations Performed on Liposomal Vitamin C



1. *Encapsulation efficiency of Liposomal Vitamin C*
2. *Analysis of particle size and uniformity of Liposomal Vitamin C using DLS*
3. *Behavior of Liposomal Vitamin C particles in liquid medium using DLS Zeta-sizer*
4. *FTIR analysis of Liposomal Vitamin C composition*
5. *Elemental Analysis of Liposomal Vitamin C*
6. *Morphology analysis of Liposomal Vitamin C using SEM*
7. *Analysis of Vitamin C leakage from Liposomes*
8. *Stability analysis of Liposomes at 105° C temperatures*

1. Encapsulation Efficiency of 55.76% Liposomal Vitamin C



❖ Acceptance criteria:

- Assay : **NLT 50%**
- Encapsulation efficiency : **NLT 70%**

Encapsulation Efficiency measured by validated HPLC analytical data

- Liposomal encapsulation ensures **79.42% efficiency**.
- Efficient encapsulation minimizes **mineral loss**, improving **bioavailability** and **therapeutic efficacy**.
- Offers **protection against oxidation and gastrointestinal irritation**, common with conventional vitamin C forms.

2. Dynamic Light Scattering Analysis of Liposomal Vitamin C

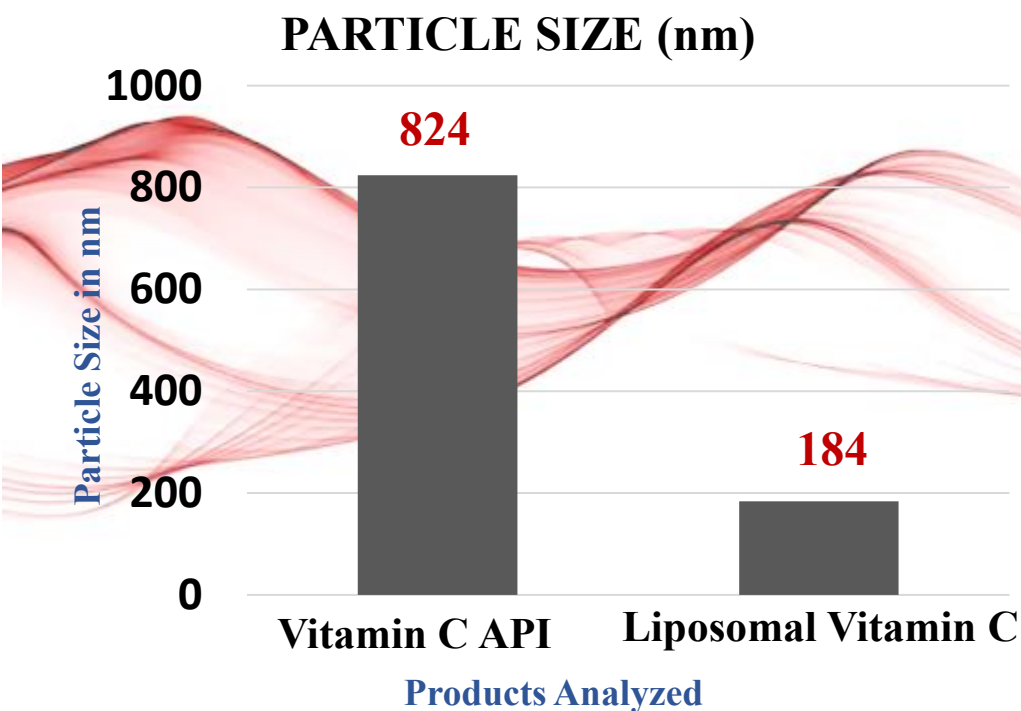


Figure 1 – Chart showing the particle size of Vitamin C API with Liposomal Vitamin C

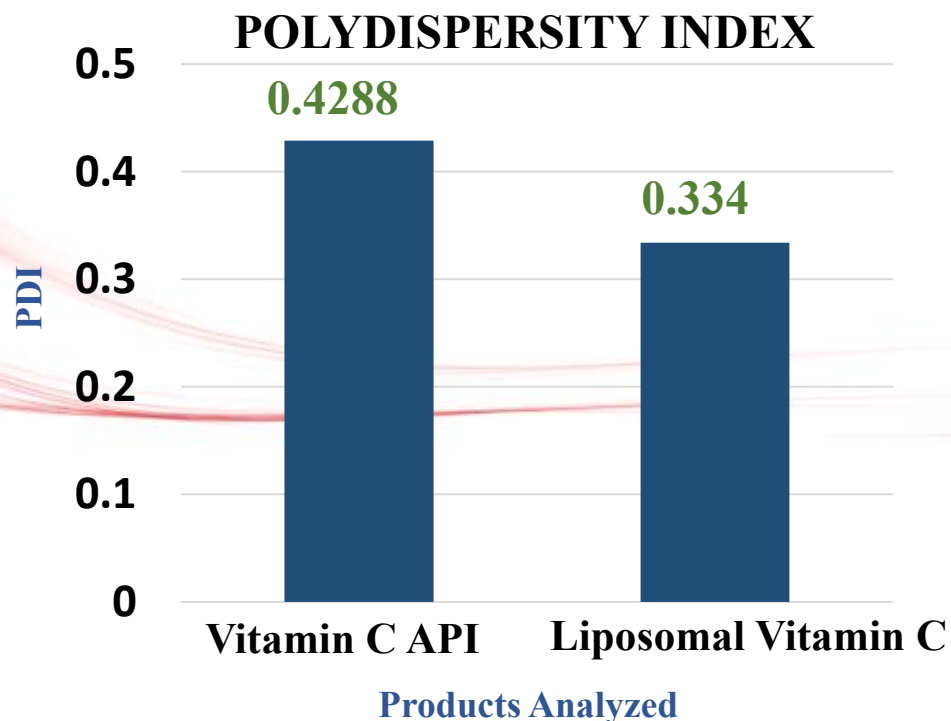


Figure 2 – Polydispersity Index (PDI) of Liposomal Vitamin C in solution

- Nanosized, uniform particles offer greater colloidal stability and improved shelf life.
- Smaller particles (particle size: 184 and PDI 0.334) support **increased mucosal permeability** and cellular uptake.
- DLS characterization confirms high formulation control and **batch-to-batch reproducibility**.

❖ Acceptance criteria:

- Particle Size : **< 220 nm**
- Polydispersity Index : **<1**

3a. Behavior of Liposomal Vitamin C

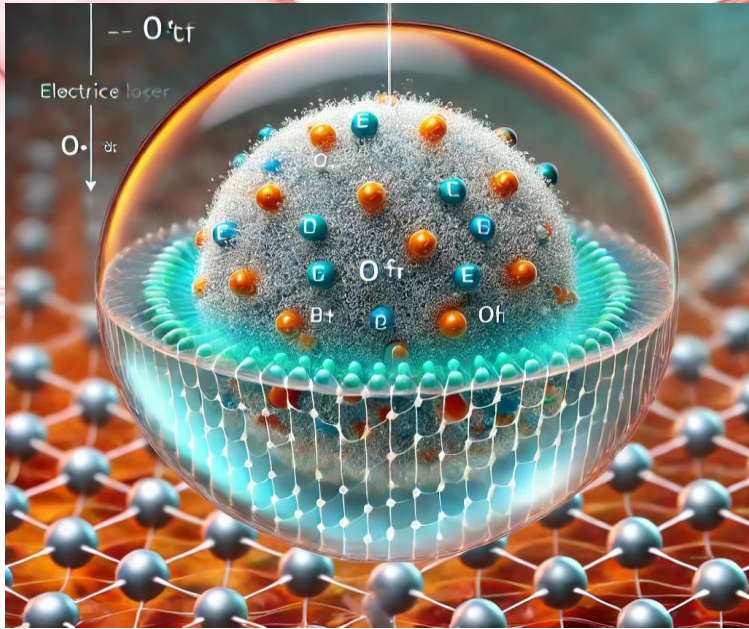


Figure 1 – Zeta potential visualization showing a negatively charged particle suspended in a liquid solution, surrounded by a well-defined electric double layer of positively charged ions.

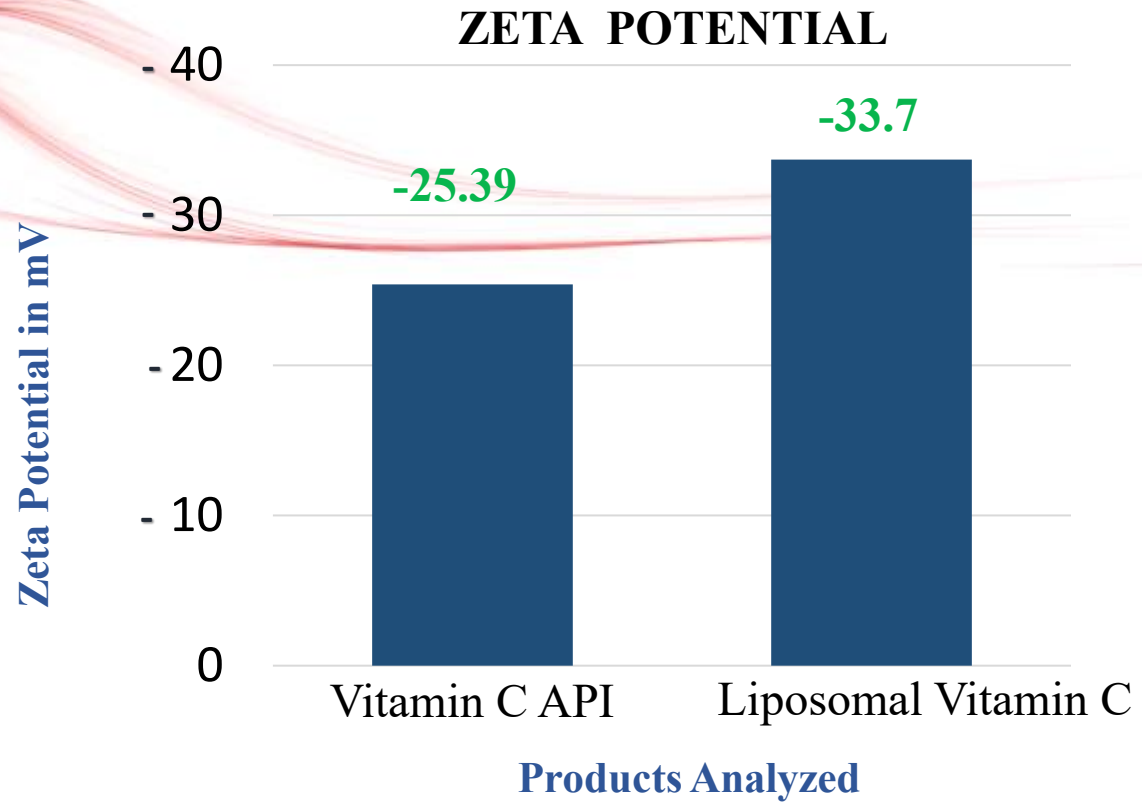


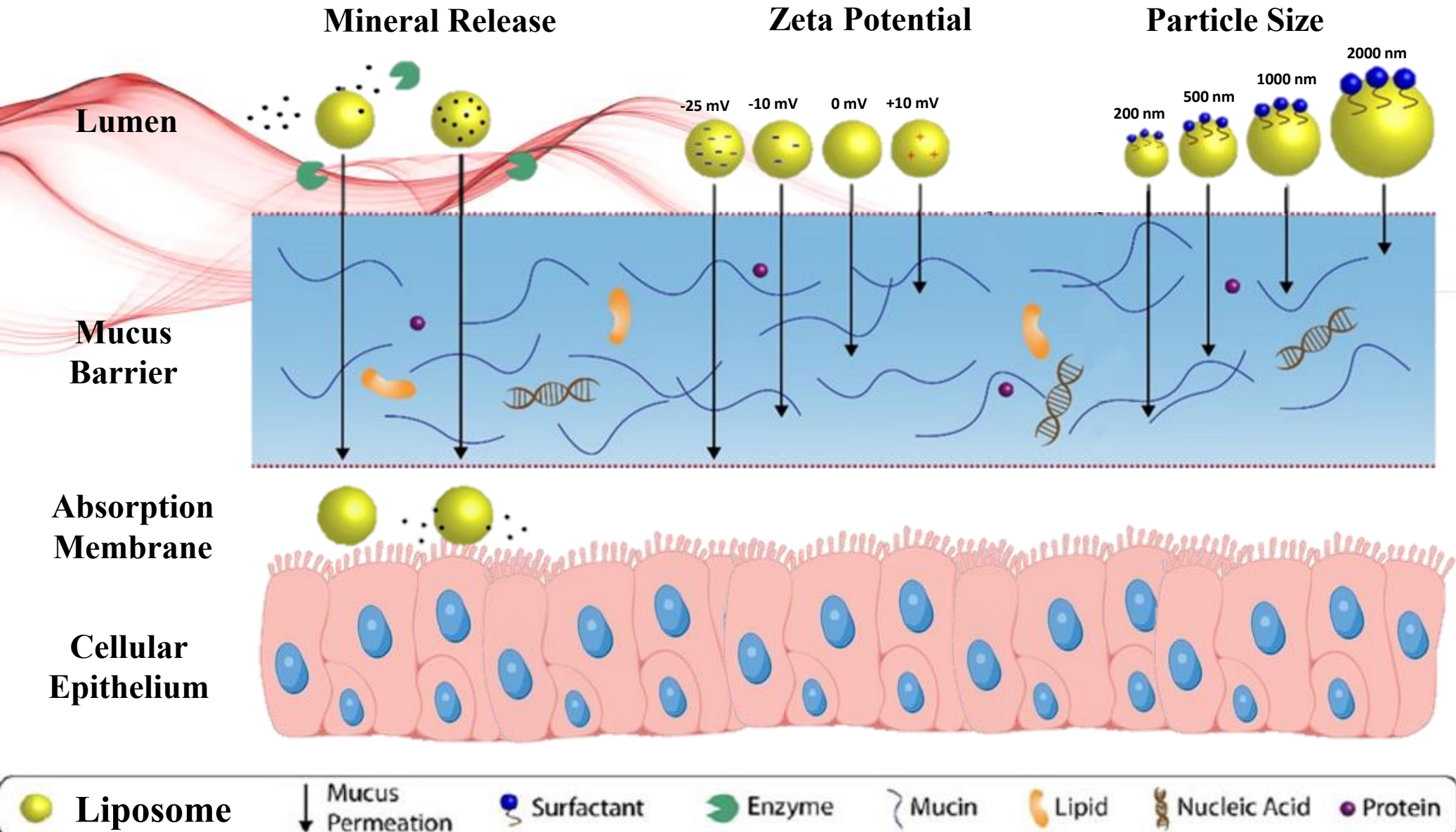
Figure 2 – Chart comparing the Zeta potential of Vitamin C API and Liposomal Vitamin C showing Vitamin C in Liposomal form is stable and less prone to agglomerate in solution.

❖ Acceptance criteria:

- **Zeta Potential : < -30 mV**

- Liposomal Vitamin C shows **high zeta potential (-33.7 mV)** → excellent colloidal stability.
- Prevents particle aggregation → ensures **uniform suspension**.
- Enhances **product shelf life** and **bioavailability** in liquid form.

3b. Absorption of Liposomal Vitamin C Represented Schematically on a Cellular Cross-Section



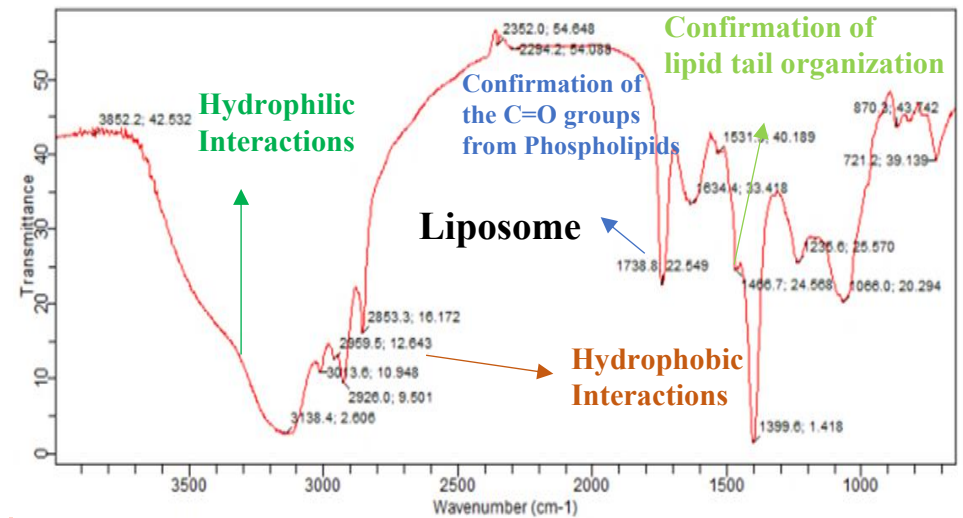


Figure 1: IR Transmission spectrum showing bands at different wavelengths of Vitamin C API

Figure 2: Hydrophobic and Hydrophilic interactions within Empty Liposome

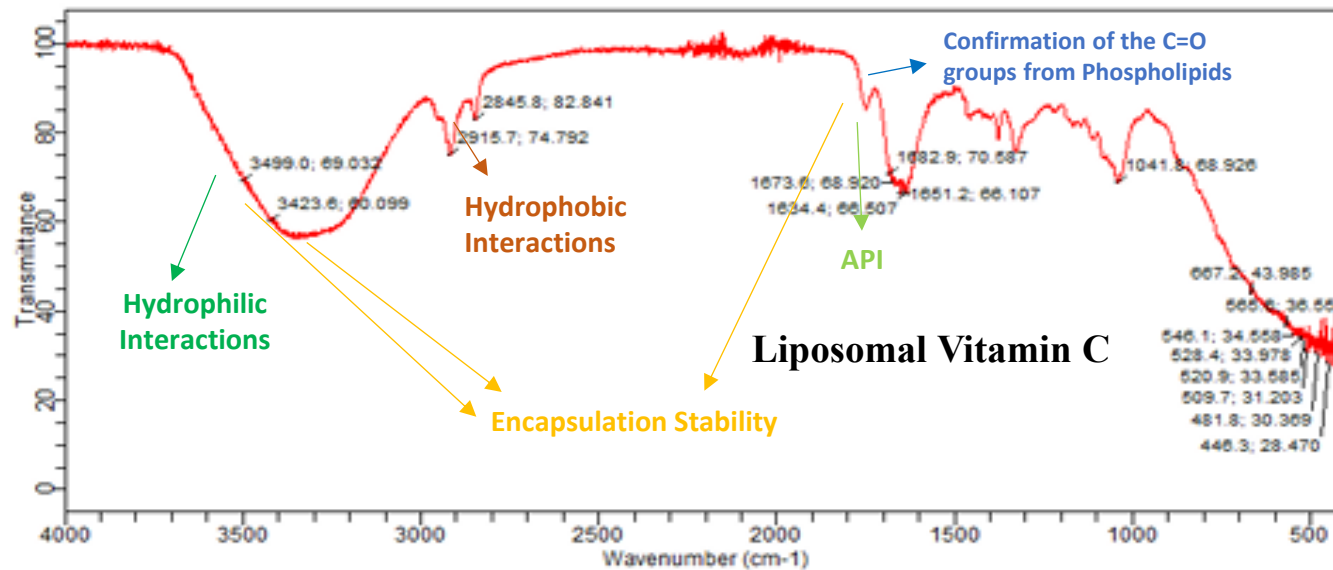


Figure 3: IR Transmission spectrum of Liposomal Vitamin C is shown

4b. Summary of FTIR Analysis of Liposomal Vitamin C

1. **Confirmation of the C=O and OH groups** – C=O stretch from ester group of phospholipids at **1734 cm⁻¹** , confirming the presence of phospholipids
2. **Hydrophobic Interactions** - C-H stretch around **2915 cm⁻¹** and **2845 cm⁻¹** , alkyl chains of phospholipids, hydrophobic interactions) (C-H bending at **1450 cm⁻¹** , further confirming hydrophobic interactions
3. **Hydrophilic Interactions** - O-H stretching around **3499 cm⁻¹** and C=O stretch at **1073 cm⁻¹** and **1041 cm⁻¹** suggesting water and polar group interactions.
4. **API** - O–H stretching peak at **3423.6 cm⁻¹** and C=O stretching at **1634.4 cm⁻¹** confirm the presence of ascorbic acid.
5. **Encapsulation Stability** - C=O stretch at **1734 cm⁻¹** and the O-H stretching at **3499 cm⁻¹** and **3423 cm⁻¹** confirm the encapsulation of Vitamin C within the Liposomal bilayer.

5. Elemental Analysis of Liposomal Vitamin C

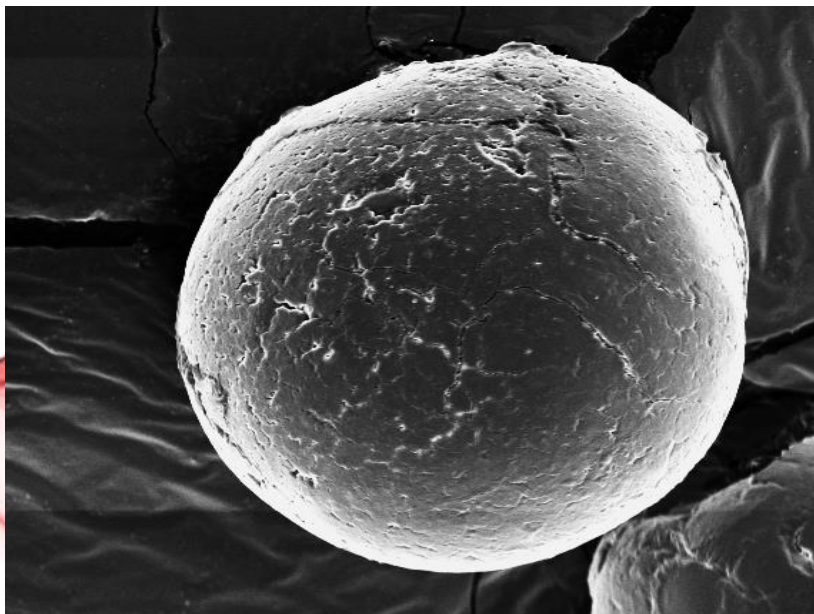
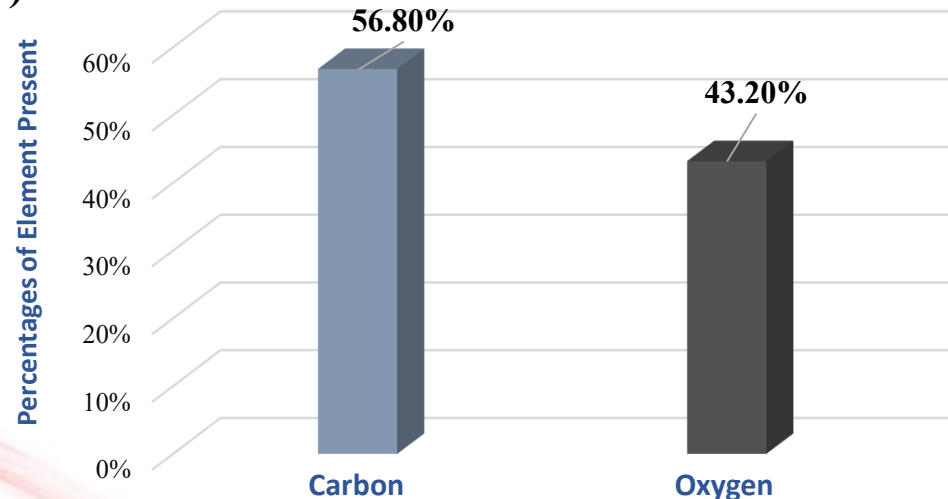


Figure 1 – SEM image of Liposomal Vitamin C showing the area scanned using Energy Dispersive X-Ray Spectroscopy (EDAX)

- **EDAX scan** shows that only the liposomal shell elements are detected, proving that the Vitamin C core is completely encapsulated within the liposome.

(a) ELEMENTAL COMPOSITION OF VITAMIN C API



(b) ELEMENTAL COMPOSITION OF LIPOSOMAL VITAMIN C

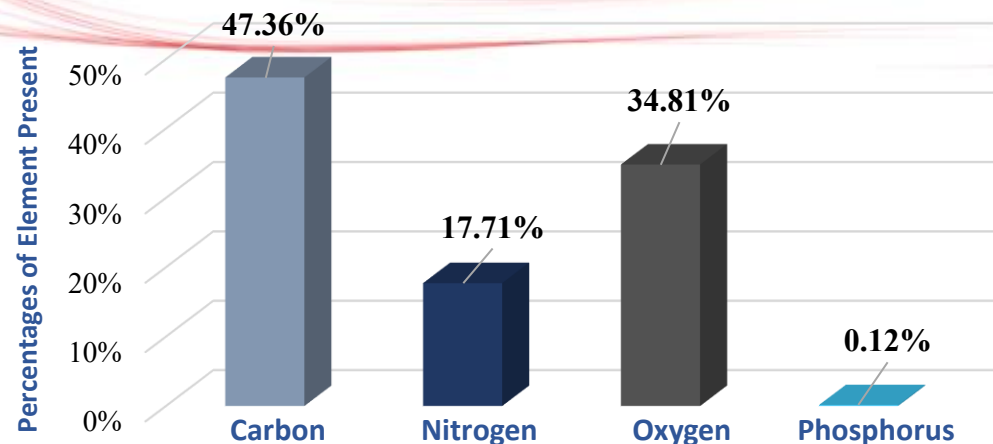


Figure 2 – A graphical representation of the percentages of elements composing (a) Vitamin C API and (b) Liposomal Vitamin C

6. Morphology of Liposomal Vitamin C As Viewed Under a Scanning Electron Microscope

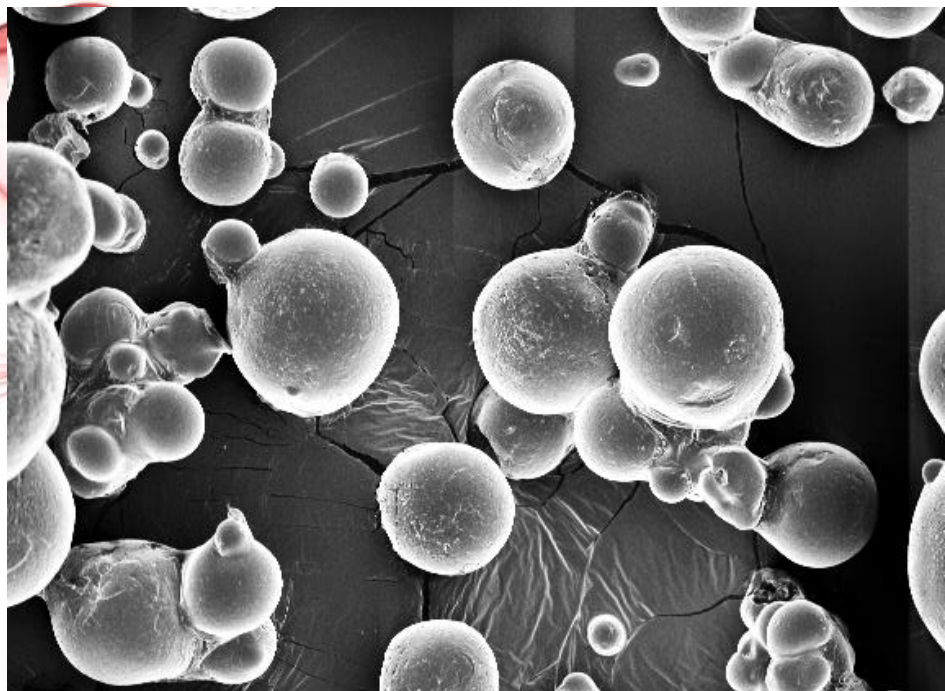
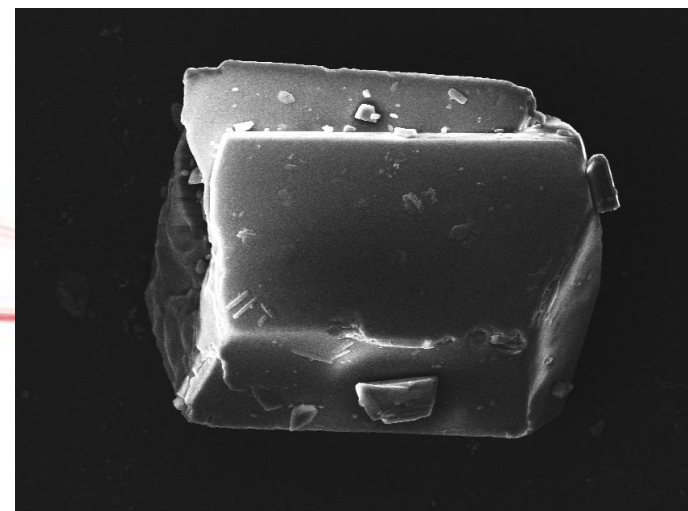


Figure 1 – SEM image showing several Vitamin C Liposomes scattered within the field of view under observation

- Spherical morphology observed in liposomal Vitamin C particles.
- Uniform size distribution seen across the field (Figure 1).
- Particles appear smooth-surfaced.
- Spherical and uniform morphology enhances **stability, encapsulation efficiency, and cellular uptake**, making it ideal for liposomal drug delivery.

(a)



(b)

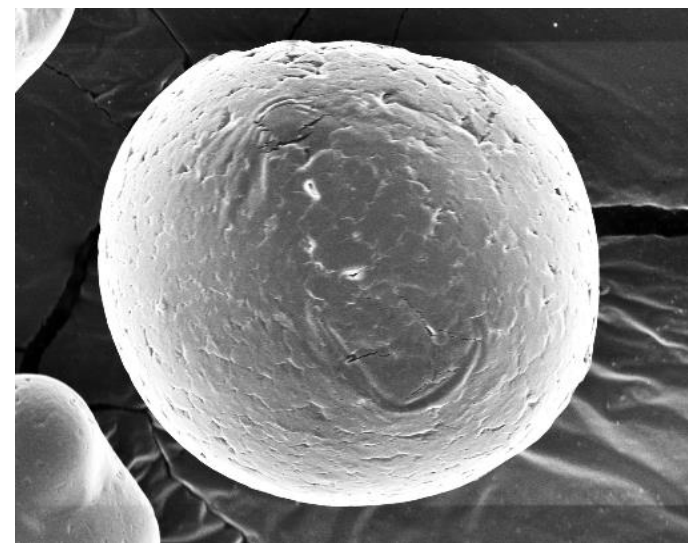


Figure 2 – SEM panels showing transformation from (a) Vit C API to (b) Liposomal Vit C after encapsulation.

7. Leakage of Liposomal Vitamin C



Figure 1 – An image representing the storage of formulations in shelves

- Encapsulation efficiency remains high (~79%) throughout 3 years of storage, indicating stable liposome structure.
- Assay values for free Vitamin C remain low (~55%), showing minimal leakage over time.
- The formulation shows **excellent retention of Vitamin C**, confirming its suitability for long-term shelf storage.

MINERAL LEAKAGE ASSAY

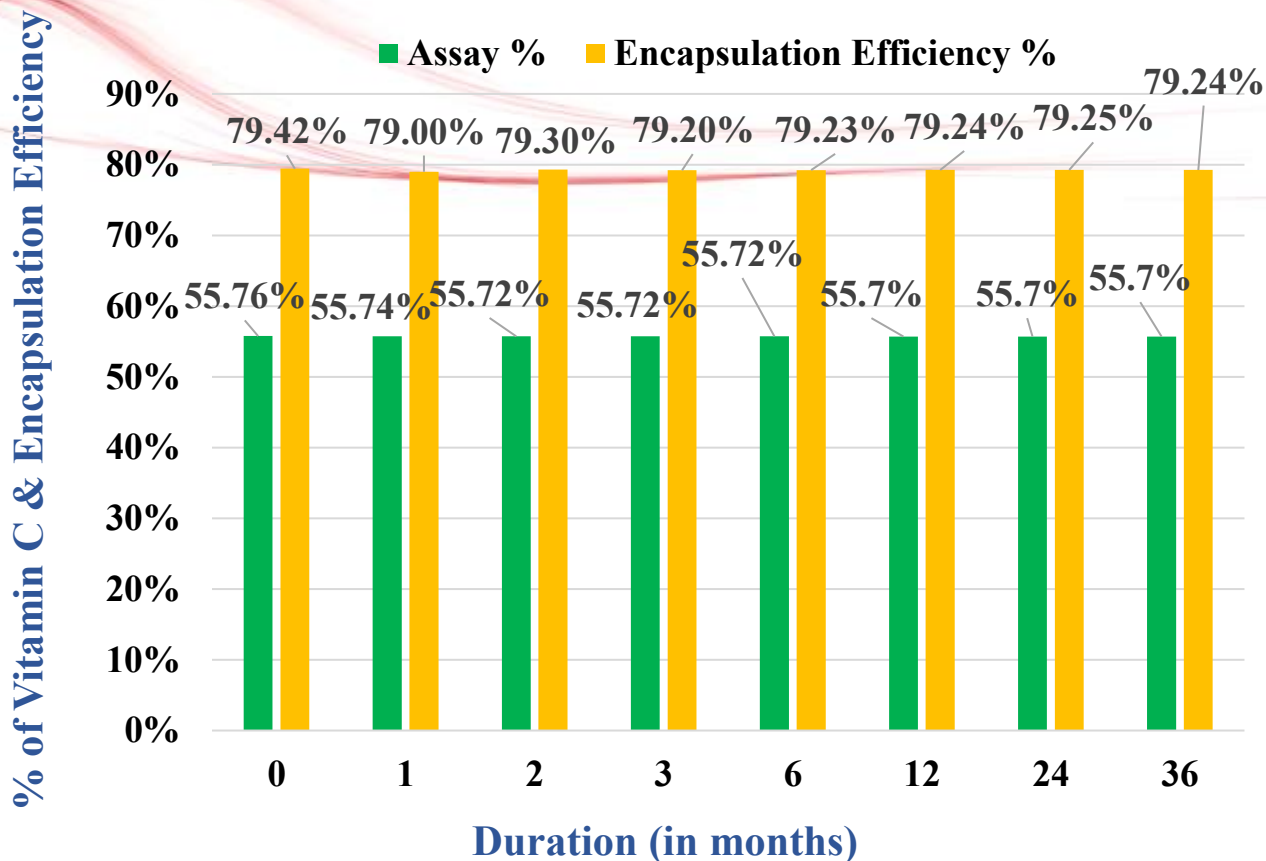


Figure 2 – Chart comparing the stability of Liposomal Vitamin C stored over a period of 3 years at $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and a relative humidity of $75\% \pm 5\%$.

8. Stability of Liposomal Vitamin C at Elevated Temperatures



Figure 1 – An image representing the transport of formulations at elevated temperatures.

- Encapsulation efficiency remains high ($\approx 78\%$) even after exposure to 105°C for 4 hours.
- Assay values ($\sim 55.76\%$ at RT vs. $\sim 55.73\%$ at 105°C) show minimal variation, indicating **negligible Vitamin C leakage**.
- Demonstrates **thermal robustness**, making the formulation suitable for transport and storage in hot climates.

TEMPERATURE EXPOSURE STUDY

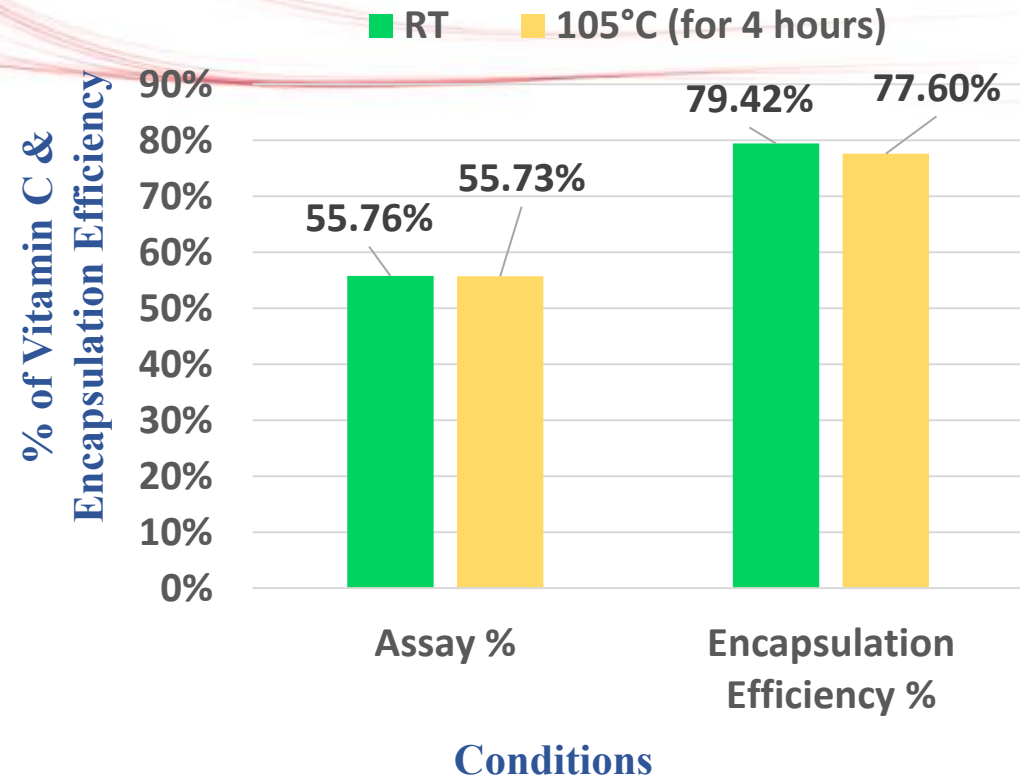


Figure 2 – Chart comparing the stability of Liposomal Vitamin C both at room temperature (RT) and at 105°C exposure for 4 hours.

A decorative graphic consisting of several overlapping, wavy, translucent red lines that flow from the left side of the image towards the right, creating a sense of movement and elegance.

Thank You!!!

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