
**FORMULATION OF *COCOS NUCIFERA* LEAF SHEATH LOADED
PHYTOSOMAL GEL**

**BM Khadeejath Riswana*, Dr Arthi I, Mr. Josbin George, Afra, Ayshath Niha Pa
Fathimath Shamla Suraifa, Salmiyath Sahla**

Vels Institute of Science, Technology and Advanced Studies (VISTAS) Chennai -600117.

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*Corresponding Author: BM Khadeejath Riswana

Vels Institute of Science, Technology and Advanced Studies (VISTAS) Chennai -600117.

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ABSTRACT

The present study was aimed at the development and evaluation of a *Cocos nucifera* leaf sheath extract loaded phytosomal gel for enhanced wound healing activity. *Cocos nucifera* (family Arecaceae), commonly known as coconut palm, possesses various medicinal properties, and its leaf sheath is traditionally used for treating wounds and skin infections due to its antimicrobial and healing potential. However, the poor bioavailability of herbal extracts limits their therapeutic effectiveness. To overcome this limitation, a phytosomal drug delivery system was employed to improve the solubility, stability, and skin penetration of the bioactive phytoconstituents. Phytosomes were prepared using the solvent evaporation (thin-film hydration) method by complexing the leaf sheath extract with phospholipids. The prepared phytosomal complex was incorporated into a Carbopol-based gel to obtain a topical phytosomal gel. The formulation was evaluated for physical appearance, pH, spreadability, washability, viscosity, and compatibility using FTIR analysis. The formulated gel exhibited a pale brown color with smooth, uniform texture and good consistency. The pH of the formulation was found to be 5.49, which is compatible with skin pH. Spreadability was recorded as 25 g/cm/sec, indicating good ease of application. FTIR studies confirmed the absence of chemical interaction between the phytosomal complex and excipients, demonstrating good formulation compatibility and stability. The gel also showed good washability without leaving oily residues. Overall, the results suggest that the *Cocos nucifera* leaf sheath extract loaded phytosomal gel is a stable, skin-friendly, and effective topical formulation with promising potential for wound healing and related dermatological applications.

KEYWORDS: Phytosome, phospholipid, inflammation, solvent evaporation, spreadability.

INTRODUCTION

Cocos nucifera, commonly known as the coconut palm, is a tall, tropical tree belonging to the family Arecaceae.¹ It is often referred to as the “Tree of Life” because almost every part of it is useful to humans.

The *Cocos nucifera* leaf sheath is obtained from the coconut palm, scientifically known as *Cocos nucifera* Linn., belonging to the family Arecaceae (Palmae).²



Fig 1: *Cocos nucifera* leaf sheath.

The coconut leaf sheath has various medicinal uses, particularly in traditional and folk healing practices. Although less studied compared to other parts of the coconut tree, such as the oil or water, the leaf sheath is known for its antimicrobial and healing properties. The fibrous tissue of the sheath contains natural compounds that can help inhibit the growth of microorganisms, making it useful for preventing infections and preserving food when used as a natural wrapper. In some local traditions, the ashes or extracts obtained from burnt leaf sheaths are applied to minor wounds, cuts, and skin rashes to promote healing and reduce inflammation. These practices highlight the traditional medicinal value of the coconut leaf sheath and its potential role in natural, plant-based remedies.³

A phytosome is an advanced herbal drug-delivery system developed to enhance the bioavailability and therapeutic effectiveness of plant-derived phytoconstituents. It is formed by complexing active phytochemicals such as flavonoids, polyphenols, or terpenoids with phospholipids, most commonly phosphatidylcholine. In this system, the phytoconstituent is chemically bound to the phospholipid through hydrogen bonding, resulting in a lipid-compatible molecular complex. This unique structure improves the

solubility, stability, and membrane permeability of herbal compounds, leading to better absorption and higher bioavailability compared to conventional herbal extracts. Phytosomes are particularly useful for delivering poorly absorbed hydrophilic phytochemicals and are widely applied in pharmaceuticals, nutraceuticals, cosmetics, and topical formulations such as wound-healing gels due to their enhanced skin penetration, antioxidant, anti-inflammatory, and antimicrobial activities.⁴

A coconut leaf sheath loaded phytosomal gel is a novel topical herbal formulation designed to enhance wound healing, antioxidant, antimicrobial, and anti-inflammatory effects. In this system, bioactive constituents extracted from the coconut leaf sheath (such as polyphenols, flavonoids, and other phytochemicals) are complexed with phospholipids to form phytosomes, which improve solubility, stability, and skin penetration of the herbal actives.

The phytosomal complex is then incorporated into a gel base (commonly carbopol, hydroxypropyl methylcellulose, or other suitable gelling agents) to form a semisolid formulation suitable for topical application. The gel ensures sustained release of the phytoconstituents, enhances their retention at the wound site, and improves bioavailability compared to conventional herbal extracts. Such gels are especially useful in promoting faster wound closure, reducing inflammation, and preventing microbial infection due to the combined effects of the phytoconstituents and the phytosomal delivery system.⁵

METHODOLOGY

Solvent Evaporation (Thin-film hydration) method

PREPARATION OF PHYTOSOME

Dissolve the herbal extract and phospholipid in a common organic solvent (ethanol, methanol, or dichloromethane) to ensure complete mixing. Stir the solution under controlled temperature to allow interaction between the polar groups of the phytoconstituent and the phospholipid, forming hydrogen bonds and a stable molecular complex. Evaporate the solvent under reduced pressure using a rotary evaporator to form a thin, dry film of the phytoconstituent–phospholipid complex on the walls of the flask. Hydrate the thin film with a small volume of aqueous medium (distilled water or buffer) under gentle agitation, leading to spontaneous formation of Phytosome.⁶



Fig 2: Rotary evaporator.

PREPARATION OF GEL BASE

To prepare a gel base, a Carbopol 940, is slowly dispersed in distilled water with continuous stirring to ensure complete hydration and prevent lump formation. propylene glycol or glycerin, are added to improve the consistency, spreadability, and solubilization of the active components. The pH of the gel base is then adjusted, often using triethanolamine, which also aids in thickening and stabilizing the gel. The resulting gel base should be smooth, uniform, and free from air bubbles.⁷

Table 1: Composition of gel base

INGREDIENTS	QUANTITY
Carbopol 940	0.10g (1%)
Propylene glycol	1.00g
Glycerin	0.50g
Methyl paraben	0.20g
Propyl paraben	0.10g
Triethanolamine	q.s
Purified water	q.s

PREPARATION OF PHYTOSOMAL GEL

The pre-formed phytosome complex is then gradually incorporated into the hydrated gel base under gentle stirring to achieve uniform distribution without breaking the vesicles. The pH of the formulation is adjusted, usually between 5 and 7, using triethanolamine, which also helps in thickening the gel. Finally, the gel is homogenized or lightly sonicated to remove air bubbles, producing a smooth, consistent, and stable phytosomal gel suitable for topical application, such as wound healing.⁸



Fig 3: Cocos nucifera loaded Phytosomal gel.

EVALUATION OF PHYTOSOMAL GEL

Evaluation is the systematic process of assessing, measuring, and analyzing a product, process, method, or outcome to determine its quality, effectiveness, performance, and suitability for a specific purpose. The phytosomal gel is evaluated to ensure its quality, safety, stability, and therapeutic efficacy. The major evaluation parameters include the following:

- 1. Physical Appearance** - The phytosomal gel is examined visually for color, clarity, homogeneity, and the presence of any particulate matter or phase separation to ensure uniformity and patient acceptability.
- 2. pH Determination** - The pH of the gel is measured using a calibrated digital pH meter. The pH should be compatible with skin pH (generally 5.5–7.0) to avoid irritation and ensure suitability for topical application.
- 3. Viscosity** - Viscosity is determined using a Brookfield viscometer at a specified temperature and spindle speed. Appropriate viscosity ensures ease of application, good spreadability, and stability of the gel.
- 4. Spreadability** - Spreadability indicates the ease with which the gel spreads on the skin. It is measured using the glass slide method and reflects patient compliance and uniform drug distribution.
- 5. Extrudability** - Extrudability is assessed by measuring the force required to expel the gel from a collapsible tube. Good extrudability ensures convenient application of the formulation.
- 6. Entrapment Efficiency**- Entrapment efficiency is determined to quantify the amount of herbal extract or active constituent successfully incorporated into the phytosomes, indicating formulation effectiveness.
- 7. Compatibility study** - Record FTIR spectra of drug, all excipients and drug – excipient formulation compare characteristic peaks to identify possible interactions.

8. **Washability** - Apply a small amount of gel on skin (or glass slide), wash with measured water, and observe ease of removal, residue, and wash-off time.⁹

RESULTS

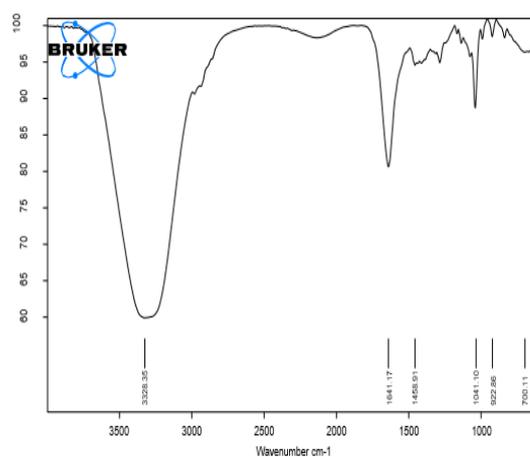
1. PHYSICAL EVALUATION

Parameter	Observation
Color	Pale brown
Odour	Mild, characteristic herbal odor
Appearance	Smooth, uniform, free from lumps
Texture	Smooth, non-gritty, non-greasy
Consistency	Uniform semisolid gel
Clarity/ Opacity	Translucent to opaque



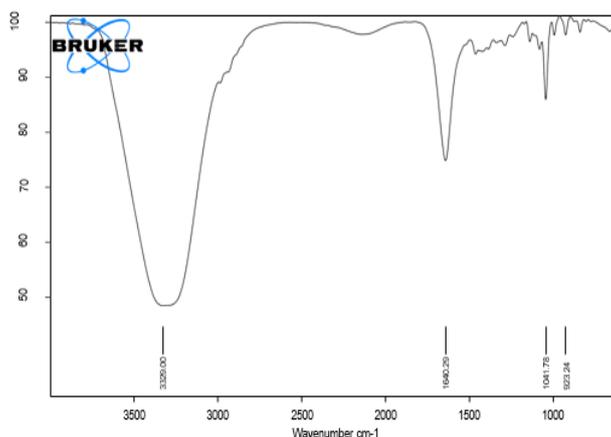
Fig 4: Phytosomal gel.

2. COMPATIBILITY STUDY



FTIR spectra of Excipients.

Functional Group	Observed Frequency (cm ⁻¹)
O–H stretching	~3282
C=O stretching	~1641
C–H bending	~1458
C–O stretching	~1041
C–O stretching	~922



FTIR Spectra of Phytosomal gel.

Functional Group	Observed Frequency (cm ⁻¹)
O–H stretching	~ 3282
C=O stretching	~ 1641
C–H bending	~ 1458
C–O stretching	~ 1041
C–O stretching	~ 922

- The FTIR spectrum of the phytosomal gel exhibited a broad peak at ~3288 cm⁻¹, corresponding to O–H stretching vibrations, indicating the presence of hydroxyl groups from phytoconstituents and phospholipids. The peak observed at ~1640 cm⁻¹ was attributed to C=O and C=C stretching vibrations. Peaks at ~1011 cm⁻¹ and ~923 cm⁻¹ correspond to C–O stretching vibrations, confirming the involvement of phospholipid functional groups in phytosome formation.
- The excipients showed characteristic absorption bands at ~3282 cm⁻¹ (O–H stretching), ~1641 cm⁻¹ (C=O stretching), ~1458 cm⁻¹ (C–H bending), and ~1041 cm⁻¹ and ~922 cm⁻¹ (C–O stretching).

- Comparison of the spectra revealed no significant shift, disappearance, or formation of new peaks in the phytosomal gel, indicating the absence of chemical interaction between the phytosomal complex and excipients. Minor changes in peak intensity were attributed to physical interactions such as hydrogen bonding.
- Overall, the FTIR study confirmed the successful formulation of the phytosomal gel and demonstrated good compatibility and stability of the formulation.

3. SPREADABILITY

$$S = \frac{M \times L}{T}$$
$$S = M \times L / T$$
$$= 500 \times 7.5 / 150$$
$$= 25\text{g/cm/sec}$$

Where, S is the spreadability

M = Mass applied

L = Length moved

T = Time taken

Spreadability of gel=25g/cm/sec, indicating good spreadability and acceptable for topical gel formulation.



Spreadability testing

4. PH

The pH of the formulated *Cocos nucifera* leaf sheath extract loaded phytosomal gel was determined using a calibrated digital pH meter and was found to be 5.49. This pH value

is close to the physiological pH of human skin, indicating that the formulation is unlikely to cause skin irritation and is suitable for topical application.



pH meter.

6. WASHABILITY

This study indicated that the phytosomal gel was easily washable with water, leaving no oily residue on the skin. Good washability improves user comfort and acceptability and confirms the suitability of the formulation for topical application.

CONCLUSION

The present study successfully formulated and evaluated a *Cocos nucifera* leaf sheath extract loaded phytosomal gel as a novel topical delivery system for wound healing applications. The phytosomal approach effectively enhanced the solubility, stability, and potential bioavailability of the herbal phytoconstituents, thereby overcoming the limitations associated with conventional herbal extracts.

The prepared phytosomal gel exhibited desirable physicochemical properties, including smooth texture, uniform appearance, appropriate viscosity, good spreadability, and excellent washability. The pH of the formulation (5.49) was found to be compatible with the physiological pH of the skin, indicating that the formulation is safe and suitable for topical use. FTIR compatibility studies confirmed the absence of any significant chemical interactions between the phytosomal complex and excipients, suggesting good formulation stability.

Overall, the findings demonstrate that the *Cocos nucifera* leaf sheath extract loaded phytosomal gel is a stable, user-friendly, and effective formulation with promising potential for enhancing wound healing through its antioxidant, antimicrobial, and anti-inflammatory properties. This formulation may serve as a valuable herbal alternative for wound

management and could be further explored through in vivo studies and clinical evaluations for therapeutic validation.

REFERENCE

1. Evans WC. *Trease and Evans' pharmacognosy*. 16th ed. London: Saunders Elsevier; 2009.
2. Trease GE, Evans WC. **Pharmacognosy**. 16th ed. London: Saunders Elsevier; 2009. p. 47–49.
3. DebMandal M, Mandal S. Coconut (*Cocos nucifera* L.: Areaceae): In health promotion and disease prevention. *Asian Pac J Trop Med*. 2011;4(3):241–247..
4. Bombardelli E, Curri SB, Della Loggia R, Del Negro P, Tubaro A, Gariboldi P. Complexes between phospholipids and vegetal derivatives of biological interest. *Fitoterapia*. 1989;60(1):1–9.
5. Mohare A, Guddad A, H HK, Dasankoppa F, Meti V. *Herbal phytosomal gels: Benefits, challenges, and future directions: A review*. *IP Int J Compr Adv Pharmacol*. 2025;10(1):3–15.
6. Bombardelli E, Curri SB, Della Loggia R, Del Negro P, Tubaro A, Gariboldi P. Complexes between phospholipids and vegetal derivatives of biological interest. *Fitoterapia*. 1989;60(1):1–9.
7. Rowe RC, Sheskey PJ, Quinn ME. *Handbook of Pharmaceutical Excipients*. 6th ed. London: Pharmaceutical Press; 2009.
8. Bombardelli E, Curri SB, Della Loggia R, Del Negro P, Gariboldi P, Tubaro A. Complexes between phospholipids and vegetal derivatives of biological interest. *Fitoterapia*. 1989;60(1):1–9.
9. Semalty A, Semalty M, Rawat MSM, Franceschi F. Supramolecular phospholipids–polyphenolics interactions: the phytosome strategy to improve the bioavailability of phytochemicals. *Fitoterapia*. 2010;81(5):306–314.