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Research Article

Formulation and Evaluation of a Phytosomal Drug Delivery System of *Cyperus Rotundus* in Ointment Form

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ABSTRACT

Arthritis is a chronic inflammatory disease that is usually addressed with steroids and NSAIDs, but their long-term use is associated with considerable adverse deleterious consequences. To produce a safer topical alternative, a Phytosomal ointment of Nagarmotha (*Cyperus rotundus*) root, a plant known for its analgesic, antioxidant, and anti-inflammatory effects, was formulated. Due to the hydrophilic nature of the extract, Phytosomes were produced utilizing varying extract-to-phospholipid ratios via the rotary evaporation process to increase cutaneous penetration. The Phytosomal optimized formulation (F4) exhibited excellent physicochemical characteristics, including a particle size of 109.2 nm, zeta potential of -22.40 mV, 96% entrapment efficiency, and 94% drug content. This optimized Phytosome was incorporated into hydrophilic and oleaginous ointment bases and evaluated for in vitro drug release, viscosity, pH, spreadability, washability, non-irritancy, and organoleptic properties. The final formulation demonstrated better skin penetration and prolonged drug release, suggesting its potential as a safer and more effective topical treatment for arthritis.

INTRODUCTION

Herbal remedies have attracted a lot of interest because of their enormous therapeutic potential and minimal adverse effects. Nagarmotha (*Cyperus rotundus*) root is one such medicinal herb long renowned for its analgesic, antioxidant, and anti-inflammatory properties. [1] Arthritis, characterized by joint inflammation, stiffness,

edema, and restricted movement, principally includes osteoarthritis and rheumatoid arthritis. Although NSAIDs and corticosteroids relieve pain, their long-term use leads to detrimental effects, driving the quest for safer, natural alternatives. Although terpenoids, flavonoids, and essential oils are present in Nagarmotha, its hydrophilic nature prevents it from penetrating deeper skin layers when applied topically [2,3].

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Phytosome technology provides a solution by creating lipid-compatible complexes of phospholipids with water-soluble phytochemicals, enhancing solubility, permeability, and overall bioavailability. Due to their high molecular size or poor lipid solubility, several herbal ingredients show poor absorption [4,5]. Phytosomes promote membrane permeability through phosphatidylcholine-based amphiphilic complexes, allowing effective absorption across lipid-rich biological membranes [6]. The scientific justification for creating Nagarmotha Phytosomes is amply supported by numerous research studies that show better anti-inflammatory and anti-arthritic results using Phytosomal formulations as opposed to free extracts [7,8].

An ointment dosage form was chosen for targeted and localized relief of arthritic inflammation. Longer contact times, improved skin penetration, fewer systemic side effects, deeper diffusion into inflammatory joints, and a soothing protection base that lessens pain and stiffness are some of the medicinal benefits of Nagarmotha root extract.[9]

Additionally, during application, massage increases local blood flow, which facilitates better drug absorption. Every excipient was selected to ensure sustained skin retention and maintain compatibility with the Phytosomal complex. Nagarmotha Phytosomes were prepared with different extract-to-phospholipid ratios and evaluated for particle size, zeta potential, entrapment efficiency, and drug content in order to identify the optimal formulation. [10]

MATERIALS AND METHOD

Materials- Nagarmotha roots extract, Soy lecithin. Dichloromethane, N-hexane, Phosphate buffer, Tween 80, Span 80, White soft paraffin,

Liquid paraffin, Cetyl alcohol, Polyethylene glycol (PEG 400), Methyl and Propyl paraben.

Methods

A rotary evaporation technique was used to create the Nagarmotha Phytosome complex.

When phospholipids (soy lecithin) interact with the water-soluble bioactive components of Nagarmotha root extract, such as flavonoids and terpenoids, a lipid-compatible molecular complex known as the "Nagarmotha Phytosome complex" is formed. The goal of this combination is to improve the hydrophilic Nagarmotha extract's topical bioavailability by making it more soluble and permeable through lipid-rich biological membranes.

Extract and phospholipid ratios ranging from 1:1 to 1:6 were prepared using the rotary evaporation method. Both were dissolved in 30 mL of dichloromethane and refluxed for two hours at 50°C. After solvent evaporation a thin film was formed. 20ml n-hexane was added to precipitate the Phytosome. The precipitate was collected dispersed with Tween 80 and phosphate buffer pH 7.4 and stored at room temperature. [11]

Nagarmotha phytosomal ointment preparation (Oil in water)-

Cetyl alcohol, span 80, liquid paraffin, and white soft paraffin were melted at 70°C to create the oily phase. Methyl paraben, propyl paraben, PEG 400, and the Nagarmotha Phytosomes were separately dissolved in filtered water at 70°C to create the aqueous phase. To create a consistent, stable ointment, the aqueous phase was then gradually added to the oily phase while being constantly stirred.[12]

Formulation tables-



Table no. 01 Formulation table of Nagarmotha phytosomes

Batch No.	Ratio (mg) (Drug: Phospholipid)	Dichloromethane (ml)	n-hexane (ml)	Phosphate buffer (pH7.4) (ml)	Tween 80 (ml)
F1	100:100	30	20	20	2
F2	100:200	30	20	20	2
F3	100:300	30	20	20	2
F4	100:400	30	20	20	2
F5	100:500	30	20	20	2
F6	100:600	30	20	20	2

Table no. 02 Formulation table of phytosomal ointment

Ingredients	B1	B2	B3	B4	B5	B6
Nagarmotha phytosome (ml)	5	10	15	20	25	30
White soft paraffin (gm)	50	50	50	50	50	50
Liquid paraffine (ml)	10	10	10	10	10	10
Span 80 (ml)	4	4	4	4	4	4
Cetyl alcohol (gm)	2	2	2	2	2	2
Polyethylene glycol 400 (ml)	4	4	4	4	4	4
Methyl paraben (gm)	0.2	0.2	0.2	0.2	0.2	0.2
Propyl paraben (gm)	0.02	0.02	0.02	0.02	0.02	0.02
Purified water	q. s.	q. s.	q. s.	q. s.	q. s.	q. s.
Total (gm)	100	100	100	100	100	100

Evaluation Parameters of Nagarmotha Phytosomes-

A. Particle size-

The mean particle size and polydispersity index (PDI) of the Nagarmotha Phytosomes were determined using a Microtrac particle size analyzer and the Dynamic Light Scattering (DLS) technique. A little aliquot of the formulation was diluted with distilled water before being tested at a scattering angle of 90° at 25°C in order to ensure the correct particle concentration and avoid multiple scattering. ^[13]

B. zeta potential -

The greater stability of any dispersion is due to strong particle electrostatic repulsion. Zeta potentials are considered to have high physical stability if they are greater than +20 mV or less than -20 mV. A small sample was dissolved in clean water, sonicated for one minute, and then

placed into omega corvettes to measure the zeta potential. ^[14]

C. Entrapment efficiency-

Centrifuging the Phytosomes for 45 minutes at 12,000 rpm and -4°C released the untrapped medication. By measuring absorption at 267 nm, a UV-Visible spectroscopy was used to determine the free medication concentration in the supernatant. The ratio of drug encapsulate was calculated using the specific formula. ^[15]

Formula:

$$\text{Entrapment efficiency(\%)} = \frac{\text{Total amount of drug} - \text{Amount of free drug}}{\text{Total amount of drug}} \times 100$$

D. Drug content-

To determine the amount of drug incorporated in the Phytosome formulation, 1ml of the solution was diluted with nine ml of phosphate buffer (p^H



7.4). The drug was extracted and filtered using Whatman filter paper following a 15-minute sonication. The clear filtrate was then analysed at the extract's λ_{max} (267nm) using UV-visible spectroscopy.^[16]

Formula:

$$\text{Drug content (\%)} = \frac{\text{Practical Drug Content}}{\text{Theoretical Drug Content}} \times 100$$

E. Compatibility study

An FTIR compatibility investigation was conducted. The material's selective absorption in the infrared spectrum is what this technique depends on. The infrared spectrum is made up of absorption bands created by molecular vibrations brought on by absorbed infrared light. These bands aid in determining the composition of unknown materials by revealing the type of bonds and functional groups present.^[16]

F. In vitro drug release study

A dialysis tube containing Nagarmotha Phytosomes were placed in 250 mL of phosphate buffer (pH 7.4) at 37 ± 0.5 °C with agitation at 100 rpm in order to study drug release using a modified cellophane membrane. At intervals of up to 8 hours, samples (5 mL) were taken out and replaced with new buffer. An ultraviolet spectrophotometer was used for the analysis.^[17]

G. SEM

Scanning electron microscopy is utilized to identify the Phytosome Particle size distribution and surface morphology. For an electron microscope, the samples were mounted on a brass stub after being coated with gold using an ion sputter. Using a random scan of the stub, the loaded Phytosome was photographed digitally at

magnifications of 1,000, 5,000, 10,000, and 30,000 X.^[18]

Evaluation of Nagarmotha Phytosomal ointment-

A. Organoleptic characteristics

The physical properties of the drug-loaded and blank formulations, including phase separation, texture, color, and homogeneity, were examined visually. To check for texture and homogeneity, a small amount was rubbed between fingers; any stiffness, roughness, or greasiness was noted.^[19]

B. Viscosity-

The Brookfield viscometer, which used spindle number seven, was used to determine the viscosity of the mixtures at 100 RPM.

C. p^H-

1gm of sample was diluted in 50 ml of Purified water and constantly stirred to create a homogenous dispersion in order to determine the p^H of the ointment. The p^H of this dispersion was identified by using a calibrated digital p^H meter.^[20]

D. Spreadability-

The time (in seconds) required for two glass slides to separate under a constant weight is known as spreadability. The ointment was compacted into a uniform layer, and the separation time was recorded, in order to assess spreadability.^[22]

$$S = (M \times L) / T$$

Where, L=length of glass slides

M= Weight of the slides

T= Time taken by the slides to separate

E. Washability-



Following application to the skin, the formulation's simplicity of rinsing with water was tested.

F. Solubility-

In order to determine solubility, the necessary amounts of the produced ointments were dissolved in 10 ml of solvent, such as water, boiling water, alcohol, ether etc.

G. Loss on drying -

The moisture content was determined by heating 1 g of ointment to 105°C and monitoring weight loss over time. This indicates volatile material and validates the stability assessment.^[23]

H. Drug diffusion study-

Drug diffusion was investigated by using a Franz diffusion cell, which had a dialysis membrane separating the phosphate buffer in the receptor chamber from the ointment in the donor chamber. The temperature was maintained at 37 ± 0.5 °C with constant stirring. The samples were collected at specified intervals and evaluated using UV spectrophotometry. Cumulative drug release was plotted over time to assess diffusion.

I. Stability study -

Following ICH guidelines, a four-week stability study was conducted on the herbal ointment at 2°C, 25°C, and 37°C. The optimized formulation did not exhibit colour shift, texture variation, or phase separation at any temperature. Table 4 confirms consistent appearance, pH, viscosity, spreadability, and drug release, demonstrating good physical stability under both normal and accelerated conditions.^[24]

RESULTS AND DISCUSSION-

Table no. 03 Results of Nagarmotha phytosomes

Sr. No.	Test	Batch F4
1.	Particle size	109.2nm
2.	Zeta potential	22.7mV
3.	SEM	109.2nm
4.	Entrapment efficiency	96%
5.	In-vitro drug release	97%

Table no. 03 Results of phytosomal ointment

Sr. No.	Test	Batch F3
1.	Appearance	Good
2.	Colour	Light Brown
3.	Homogeneity	Homogeneous
4.	Consistency	Semisolid
5.	Texture	Smooth
6.	Odor	Characteristics
7.	pH	6.5
8.	Spreadability	4gm cm/sec
9.	Viscosity	2337cps
10.	Drug release	94.8%
11.	Drug diffusion	91.76%

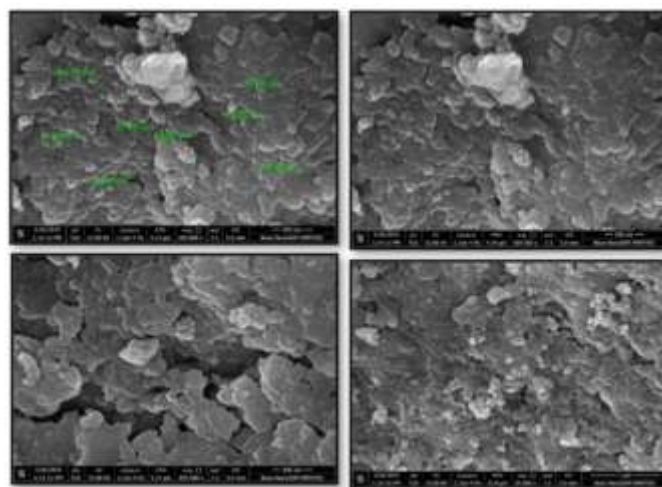


Fig. no. 01 SEM image under microscope

CONCLUSION

The current study concentrated on creating a Phytosomal ointment and Nagarmotha root extract. Acceptable physicochemical properties of the extract were confirmed by preformulation studies. Major bioactive compounds, including flavonoids, alkaloids, phenols, tannins, and terpenoids, were found by phytochemical analysis. Using the rotary evaporation method, soy lecithin was successfully used to create Phytosomes, which were then assessed for shape, color, weight variation, FTIR, SEM, in-vitro drug release, and entrapment efficiency. Based on evaluation parameters, F4 was determined to be the optimal Phytosome among all formulations.

REFERENCES

1. Ullah MA, Ali Hassan, Medical treatment of various diseases through Nagarmotha (Cyperus rotundus) plant. International Journal of Frontline Research in Pharmaceutical and Biological Sciences. 2022 Jul;1(1):1–12.
2. Kim C, Jung H, Song KH, et al. Nanoparticle encapsulation of the hexane fraction of Cyperus rotundus extract for enhanced antioxidant and anti-inflammatory activities in vitro. International Journal of Nanomedicine. 2024 00;19:1523–1540.
3. Imam H, Zarnigar, Firdous S, et al. The incredible benefits of Nagarmotha (Cyperus rotundus). International Journal of Nutrition, Pharmacology, Neurological Diseases. 2014 Mar;4(1):23–27.
4. Biradar S, Kangralkar VA, Mandavkar Y, et al. Anti-inflammatory, antiarthritic, analgesic and anticonvulsant activity of Cyperus essential oils. International Journal of Pharmacy and Pharmaceutical Sciences. 2010 Oct;2(4):112–115.
5. Kareparamban JA, Nikam PH, Jadhav AP, et al. Phytosome: a novel revolution in herbal drugs. International Journal of Research in Pharmacy and Chemistry. 2012;2(2):299–310.
6. Bombardelli E, Curri SB, Della Loggia R, et al. Complexes between phospholipids and vegetal derivatives of biological interest. Fitoterapia. 1989;60(1):1–9.
7. Lachman L, Liebermann H, Kanig J. The theory and practice of industrial pharmacy. 4th ed. New Delhi: CBS Publishers and Distributors Pvt. Ltd.; 2013.
8. Dwivedi S, Aggarwal A, Agarwal MP, et al. Role of Terminalia arjuna in ischaemic mitral regurgitation. International Journal of Cardiology. 2005 Apr 28;100(3):507–508.
9. Kalaivani P, Muralidharan SEL. Phytosome technology: a novel breakthrough for the health challenges. Cureus. 2024;16(2):e53874
10. Baki G, Alexander K. Introduction to cosmetic formulation and technology. 1st ed. Hoboken (NJ): John Wiley and Sons, Inc.; 2015.
11. Shaji J, Lal M. Preparation, optimization and evaluation of transfersomal formulation for enhanced transdermal delivery of a COX-2 inhibitor. International Journal of Pharmacy and Pharmaceutical Sciences. 2014;6(1):46–50.
12. Gupta A, Pandey R, Shah K. Curcumin phytosome topical gel for management of arthritis: enhancement of skin permeation and anti-inflammatory activity. Journal of Drug Delivery Science and Technology. 2021;63:102437.
13. Majeed M, Nagabhushanam K, Sivakumar A, et al. Boswellia serrata phytosome for osteoarthritis: improved absorption and clinical efficacy. Journal of Ayurveda and Integrative Medicine. 2020;11(3):356–362.



14. Sharma V, Kaur J, Aggarwal G. Phytosome-based herbal topical formulations: a novel approach for enhanced skin penetration and therapeutic efficiency. *International Journal of Pharmaceutical Sciences and Research*. 2022;13(5):2200–2210.
15. Patil S, Ayare P. Carica papaya: formulation and evaluation of new dosage form design. *International Journal of Pharmaceutical Sciences and Research*. 2019;10(4):1677–1685.
16. Shridhar S. Preparation and evaluation of curcumin Phytosome by rotary evaporation method. *SSRG International Journal of Pharmacy and Biomedical Engineering*. 2019;6(1):29–35.
17. Karimi N, Ghanbarzadeh B, Hamed H, et al. Phytosome and liposome: the beneficial encapsulation systems in drug delivery and food application. *Journal of Applied Food Biotechnology*. 2015;2(3):17–27.
18. Visht S. Effect of cholesterol and different solvents on particle size, zeta potential and drug release of eucalyptus oil phytosome. *Pharmacognosy Research*. 2023;15(3):578–590.
19. Gnananath K, Sri Nataraj K, Rao BG, et al. Preparation and evaluation of phytosomes of *Vitex negundo* Linn. *Novel Science International Journal of Pharmaceutical Sciences*. 2012;1(9–10):671–673.
20. Maiti K, Kumar G, Mukherjee K, et al. Determination of curcumin content in curcumin-phytosome using HPLC and evaluation of hepatoprotective activity. *Brazilian Journal of Pharmaceutical Sciences*. 2017;53(1):e16136.
21. Saharan V, Agarwal A, Kharb V. Process optimisation, characterisation and evaluation of resveratrol-phospholipid complexes using Box–Behnken statistical design. *International Current Pharmaceutical Journal*. 2014;3(7):301–308.
22. Lakshmi PK, Mounica V, Kumar YM, et al. Preparation and evaluation of curcumin invasomes. *International Journal of Drug Delivery*. 2014;6(2):113–120.
23. Dhase A, Saboo S. Preparation and evaluation of phytosomes containing methanolic extract of leaves of *Aegle marmelos* (Bael). *International Journal of PharmTech Research*. 2015;8(6):231–240.
24. Dalimbe A, Shinde S, Supekar A, et al. Formulation and evaluation of *Cyperus rotundus* herbal ointment for treatment of skin inflammation. *OEIL Research Journal*. 2024;22(11):385–399.

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