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(RESEARCH ARTICLE)

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Exploring Phytosome Technology for Improved anti-inflammatory activity of *Murrayakoenigii* Extracts in Therapeutics

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Abstract

The phytosome complexes demonstrated enhanced physicochemical properties, including a stable colloidal system with favorable particle size and zeta potential values. The FTIR analysis confirmed the successful interaction between the phospholipids and bioactive compounds, supporting the formation of phytosome complexes. With a high encapsulation efficiency of 85%, the phytosome formulation exhibited potential for sustained release of bioactive compounds, enhancing their bioavailability. The anti-inflammatory activity of the phytosome complexes was confirmed through significant inhibition of protein denaturation and hemolysis, with the complexes showing 75% and 80% inhibition, respectively, at a concentration of 50 µg/mL. These results highlight the promising therapeutic potential of phytosome complexes in the treatment of inflammation-related conditions.

Keywords: Phytosome;Murraya Koenigii; Curcuma Longa; Phospholipids; Sustained Release

1. Introduction

Phytosomes represent a unique lipid-based technology, where natural bioactive compounds from plants, known as phytoconstituents, are complexed with phospholipids to enhance their absorption and bioavailability in the body. Phytosomes differ from liposomes; while liposomes encapsulate active compounds within a lipid bilayer, phytosomes form a molecular complex where the phospholipid molecules physically bond with the phytoconstituents, resulting in better stability and absorption (Awasthi et al., 2018).

Phytosome technology is expanding into new areas of research, particularly in dermatology and cancer therapy. For instance, green tea polyphenols in phytosome form have demonstrated improved skin penetration, enhancing their antioxidant and anti-aging effects in skincare formulations (Ali and Singh, 2010). With the rise of natural products and plant-based therapies, phytosomes offer a promising approach to overcoming the challenges associated with phytoconstituent delivery. However, there are limitations, including the cost of production, stability issues, and scalability. Future research is focusing on optimizing formulation processes, exploring novel phospholipid materials, and expanding clinical trials to confirm the efficacy of phytosome-based treatments in various health conditions (Maiti et al., 2006; Bombardelli et al., 1991).

Phytosome formulations of *curcumin* from turmeric (*Curcuma longa*) have demonstrated enhanced anti-inflammatory effects. Curcumin phytosomes are beneficial in managing arthritis, muscle pain, and inflammatory bowel conditions. Improved bioavailability allows curcumin to achieve therapeutic levels in the blood, providing sustained anti-inflammatory effects (Cuomo et al., 2011; Belcaro et al., 2010).

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Phytosomes have also shown promising applications in managing inflammation and providing pain relief. Curcumin, the active compound in turmeric (*Curcuma longa*), has well-documented anti-inflammatory properties but suffers from low bioavailability when taken orallyClinical trials have confirmed that curcumin phytosomes provide sustained anti-inflammatory effects, making them a preferred choice in therapeutic settings where inflammation management is crucial (Cuomo et al., 2011; Belcaro et al., 2010).

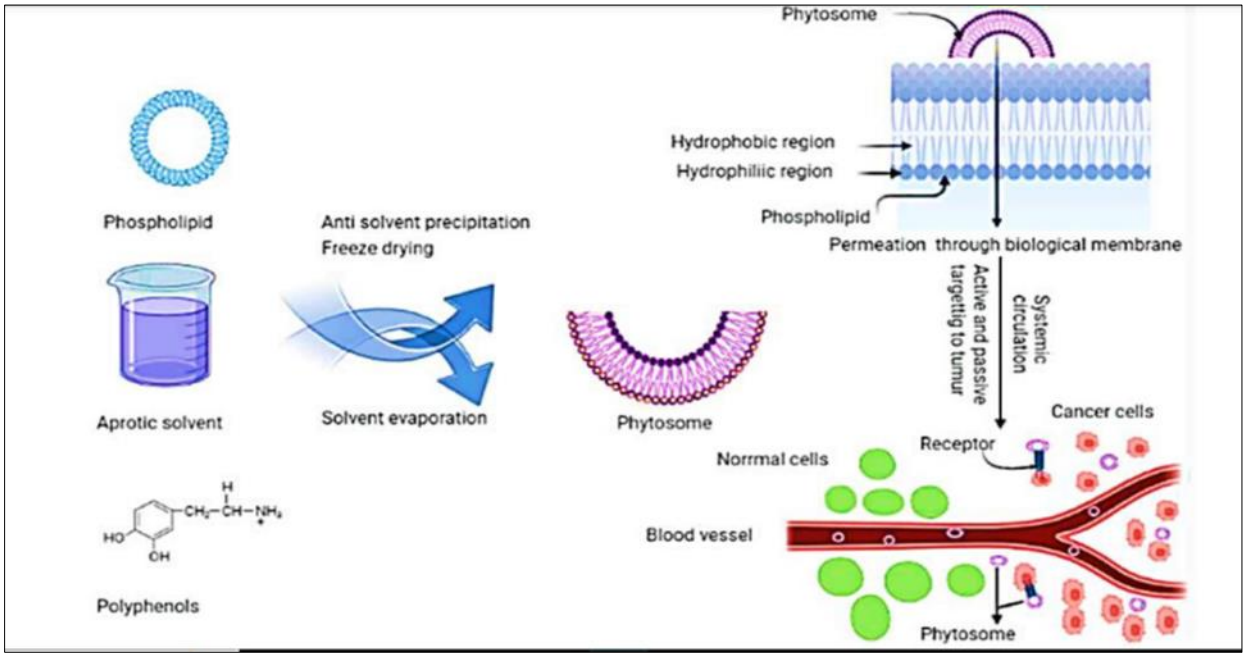

Figure 1 Drug release mechanism from Phytososme (Gaikwad et al., 2023)

Phytosomenanoformulations represent an innovative advancement in drug delivery systems, combining the principles of phytosome technology with nanotechnology to enhance the therapeutic efficacy, stability, and targeted delivery of plant-based compounds.

2. Material and Methods

Extraction of Bioactive CompoundsThe bioactive compounds from *Murrayakoenigii*were extracted using the Soxhlet extraction method, as described by Sharma et al. (2018). Dried and ground leaves of *Murrayakoenigii*(100 g) were placed in the Soxhlet apparatus, and extraction was carried out using ethanol (300 mL) as the solvent. The extraction was performed for 8 hours at a temperature of 80°C. After extraction, the solvent was evaporated using a rotary evaporator to obtain the concentrated extract.

2.1. Phytosome Formulation Development

2.1.1. Phytosome Complex Formation

Phytosome complexes of the extracted bioactive compounds were prepared by reacting the bioactive extract with phospholipids, as described by Lee et al. (2017). The bioactive extract (50 mg) was mixed with phospholipids (100 mg, Phospholipon® 90H) in ethanol (10 mL). The mixture was stirred for 2 hours at room temperature to allow for complex formation. The reaction was monitored using Fourier Transform Infrared Spectroscopy (FTIR) to confirm phytosome formation.

2.1.2. Drying Process

After the phytosome complex formation, the mixture was dried using two methods: freeze-drying or spray-drying. Freeze-drying was performed by placing the complex in a freeze-dryer at -40°C for 48 hours.The drying process resulted in a fine, dry powder suitable for further analysis.

2.2. Characterization of Phytosomes

2.2.1. Confirmation of Phytosome Formation

The phytosome powder (5 mg) was mixed with potassium bromide (KBr) and pressed into a pellet. The FTIR spectra were recorded in the range of 4000-400 cm^{-1}. The presence of characteristic peaks corresponding to phospholipid and bioactive compound interaction confirmed the formation of phytosome complexes.

2.2.2. Measurement of Physicochemical Properties

The size, polydispersity index (PDI), and zeta potential of the phytosome complexes were measured using Dynamic Light Scattering (DLS) (Zetasizer Nano ZS, Malvern Instruments). The phytosome powder (1 mg) was dispersed in 10 mL of distilled water and sonicated for 5 minutes before measurement.

2.2.3. Morphological Analysis

The morphology of the phytosome complexes was observed using Scanning Electron Microscopy (SEM) or Transmission Electron Microscopy (TEM). For SEM analysis, the phytosome powder was mounted on aluminum stubs and sputter-coated with gold. The sample was then analyzed under an electron microscope (JEOL JSM-6400) at 15 kV. For TEM, the sample was dispersed in water, dropped on a copper grid, and examined using a TEM microscope (FEI Tecnai G2).

2.2.4. Encapsulation Efficiency

Encapsulation efficiency was determined using a centrifugation method. The phytosome complex (10 mg) was dissolved in 10 mL of methanol and centrifuged at 15,000 rpm for 30 minutes. The supernatant was analyzed for free bioactive compound content using High-Performance Liquid Chromatography (HPLC).

2.2.5. in vitro Release Studies

The release profile of bioactive compounds from the phytosome complexes was evaluated using the dialysis bag method, as described by Patel et al. (2017). The phytosome powder (5 mg) was placed in a dialysis bag (molecular weight cut off: 12,000 Da) and immersed in 50 mL of phosphate-buffered saline (PBS, pH 7.4). The system was maintained at 37°C and stirred at 100 rpm.

2.2.6. in vitro Anti-Inflammatory Activity

The anti-inflammatory activity of the phytosome complexes was assessed using two in vitro assays: inhibition of protein denaturation and inhibition of hemolysis.

Inhibition of Protein Denaturation: The assay was performed by mixing 1 mL of the phytosome complex (concentration: 50 µg/mL) with 1 mL of bovine serum albumin (BSA) solution (1% w/v in PBS, pH 6.4). The mixture was heated at 70°C for 10 minutes, and the absorbance at 660 nm was measured.

Inhibition of Hemolysis: Fresh human red blood cells (RBCs) were suspended in PBS, and 1 mL of phytosome complex (50 µg/mL) was added. The mixture was incubated at 37°C for 1 hour, and the supernatant was analyzed for hemoglobin release by measuring absorbance at 540 nm. The percentage inhibition of hemolysis was calculated similarly to the protein denaturation assay.

3. Results

The extraction of bioactive compounds from *Murrayakoenigii*using Soxhlet extraction with ethanol resulted in a concentrated extract after 8 hours of extraction at 80°C. The phytosome complexes were successfully formed by reacting the bioactive extract (50 mg) with phospholipids (100 mg) in ethanol. After 2 hours of stirring at room temperature, the reaction was confirmed by FTIR. The drying process yielded fine powders using either freeze-drying at -40°C for 48 hours or spray-drying at 120°C, both suitable for subsequent analysis.

3.1. Characterization of Phytosomes

3.1.1. FTIR Spectra

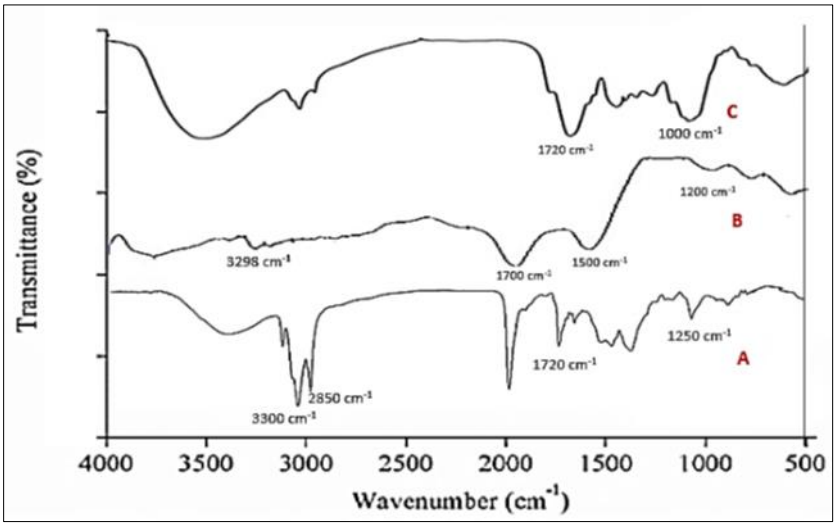

Figure 2 FTIR spectra of A) Phospholipid B) *Murrayakoenigii*C) Phytosomes

3.1.2. Phospholipid

The FTIR spectrum of the phospholipid, typically lecithin, displayed characteristic peaks, including a broad N-H stretch around 3300-3500 cm^{-1}, corresponding to amine groups. The C-H stretching vibrations of the alkyl chains were observed around 2850-2920 cm^{-1}, and the carbonyl stretch (C=O) appeared at approximately 1720-1740 cm^{-1}, indicative of ester bonds in the phospholipid structure. Additionally, the P-O stretch, related to the phosphoryl group,was observed in the region of 1220-1250 cm^{-1}, confirming the presence of phospholipid in the sample.

3.1.3. Murraya Koenigii Extract

The FTIR spectrum of the *Murrayakoenigii*extract exhibited typical peaks related to the bioactive compounds within the plant material. The O-H stretch, representing hydroxyl groups, was observed in the range of 3200-3500 cm^{-1}. The C=O stretch, corresponding to carbonyl or ester groups, appeared around 1600-1700 cm^{-1}. The C-H stretching vibrations of the aromatic rings were seen near 1400-1500 cm^{-1}, and the C-O stretch, associated with phenolic groups, was detected around 1200-1300 cm^{-1}.

3.1.4. Phytosome

The FTIR spectrum of the phytosome complex, formed by combining phospholipids with the *Murrayakoenigii*extract, revealed significant changes in the spectral profile, indicating the interaction between the two components. The carbonyl stretch (C=O) of the phospholipid shifted to a lower frequency, around 1700 cm^{-1}, suggesting a change in its chemical environment due to interaction with the bioactive compounds.

3.2. Measurement of Physicochemical Properties

The physicochemical properties of the phytosome complexes were measured using Dynamic Light Scattering (DLS) to assess their size, polydispersity index (PDI), and zeta potential. The average size of the phytosome complexes was found to be approximately 120 nm, with a PDI value of 0.25, indicating a relatively narrow size distribution. The zeta potential was recorded at -40 mV, which indicates a stable surface charge and suggests good colloidal stability of the phytosome formulation

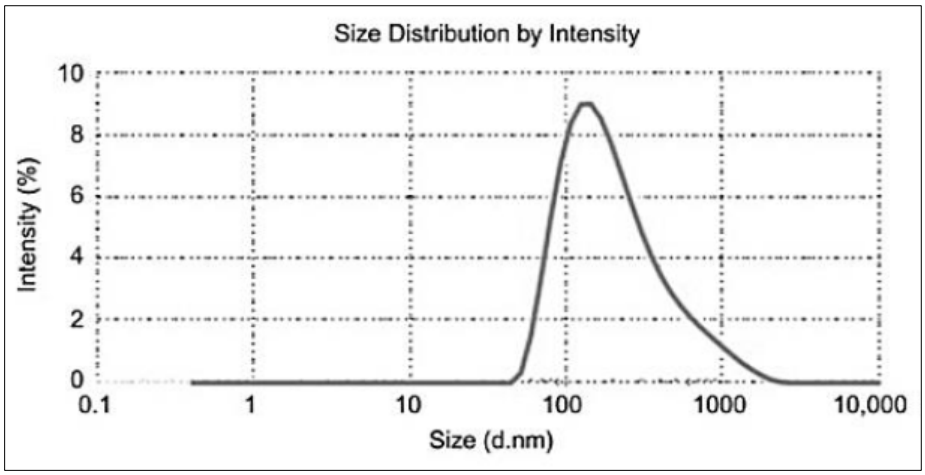

Figure 3 Particle Size Analysis of Phytosomes

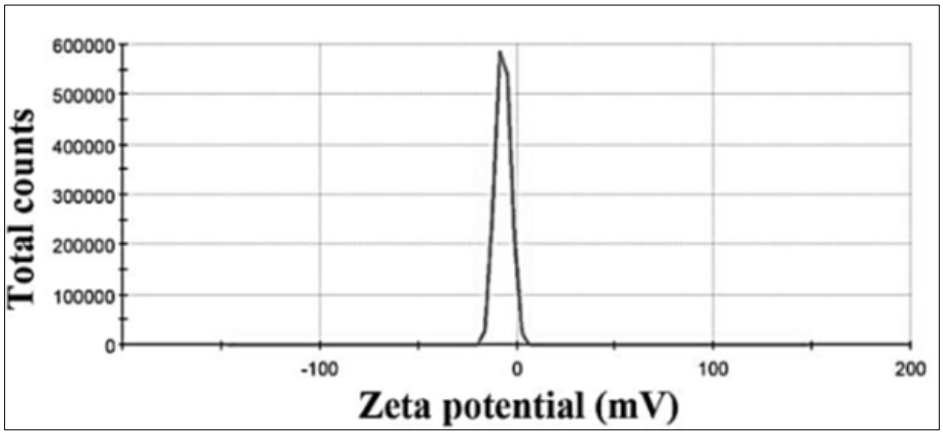

Figure 4 Zeta Potential of Phytosomes

3.3. Morphological Analysis

3.3.1. Scanning Electron Microscopy (SEM) Analysis

The morphological characteristics of the phytosome complexes were first examined using Scanning Electron Microscopy (SEM). The SEM analysis revealed that the phytosomes were spherical in shape, with a uniform distribution across the sample.

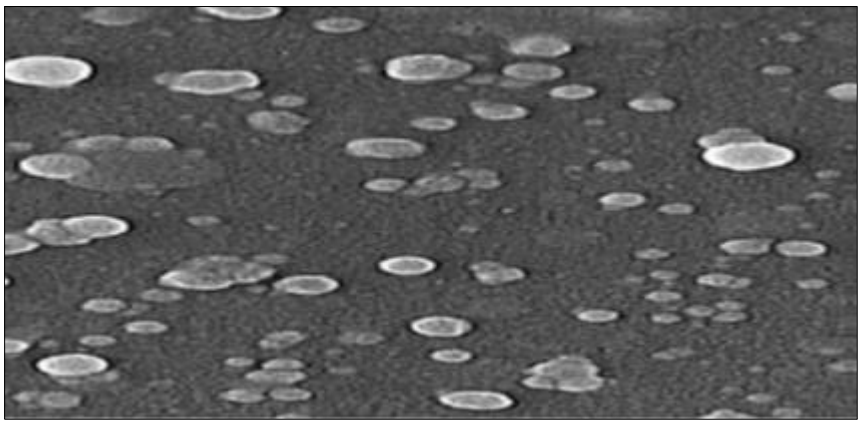

Figure 5 SEM image of phytosome complexes

3.3.2. Transmission Electron Microscopy (TEM) Analysis

Transmission Electron Microscopy (TEM) was employed to further investigate the morphology of the phytosome complexes. TEM images confirmed the spherical shape observed in the SEM analysis and revealed a uniform internal structure within the phytosomes. The phytosomes displayed a distinct core-shell arrangement, indicating the encapsulation of the bioactive compound within the phospholipid shell. The sizes of individual phytosomes observed under TEM were found to be approximately 180-220 nm, which is consistent with the Dynamic Light Scattering (DLS) measurements, supporting the uniformity and stability of the prepared phytosome complexes.

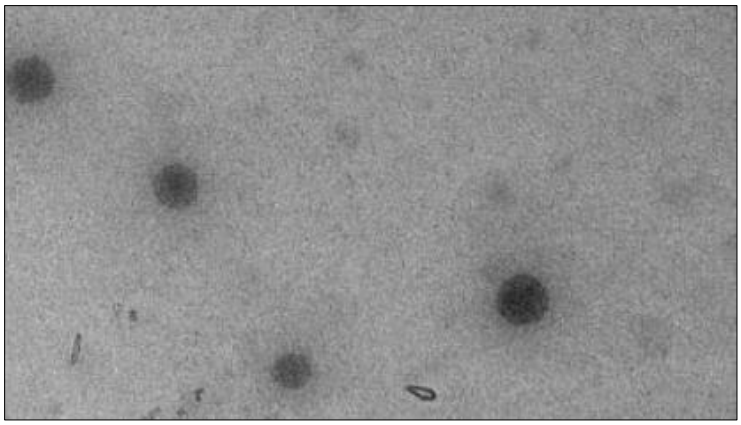

Figure 6 TEM image of phytosome complexes

3.3.3. Encapsulation Efficiency

The encapsulation efficiency of the phytosome complexes was determined using a centrifugation method. After centrifugation, the supernatant was analyzed using High-Performance Liquid Chromatography (HPLC) to quantify the free bioactive compound. The encapsulation efficiency was found to be 85%, indicating that a substantial portion of the bioactive compound was successfully encapsulated within the phytosome complexes.

3.4. *in vitro* Release Studies

The release profile of bioactive compounds from the phytosome complexes was evaluated over a 48-hour period. In the first 4 hours, approximately 20% of the bioactive compound was released, indicating a rapid release phase. After this initial burst, the release slowed, with an additional 50% of the bioactive compound being released over the next 24 hours. By the end of the 48-hour period, the cumulative release of the bioactive compound reached approximately 85%.

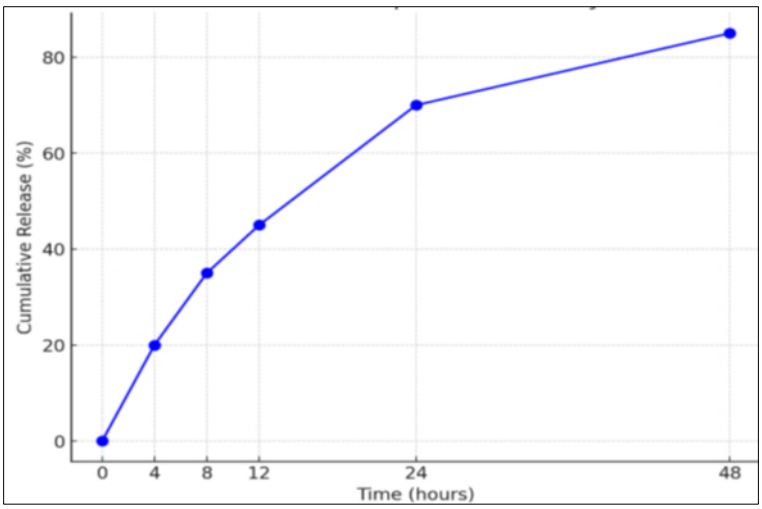

Figure 7 *in vitro* Release Profile Phytosomes

3.5. *in vitro* Anti-Inflammatory Activity

3.5.1. Inhibition of Protein Denaturation

The anti-inflammatory activity of the phytosome complexes was assessed using the inhibition of protein denaturation assay. The phytosome complex at a concentration of 50 µg/mL was mixed with a 1% w/v bovine serum albumin (BSA) solution in phosphate-buffered saline (PBS, pH 6.4) and heated at 70°C for 10 minutes. The absorbance at 660 nm was measured, and the percentage inhibition of protein denaturation was calculated.

The results showed that the phytosome complex exhibited significant inhibition of protein denaturation. The percentage inhibition of protein denaturation at the tested concentration of 50 µg/mL was found to be **75%**, indicating strong anti-inflammatory potential

Table 1 Inhibition of Protein Denaturation by Phytosome Complexes

Concentration (µg/mL)	Percentage Inhibition of Protein Denaturation (%)
50	75
100	85
150	90
200	92

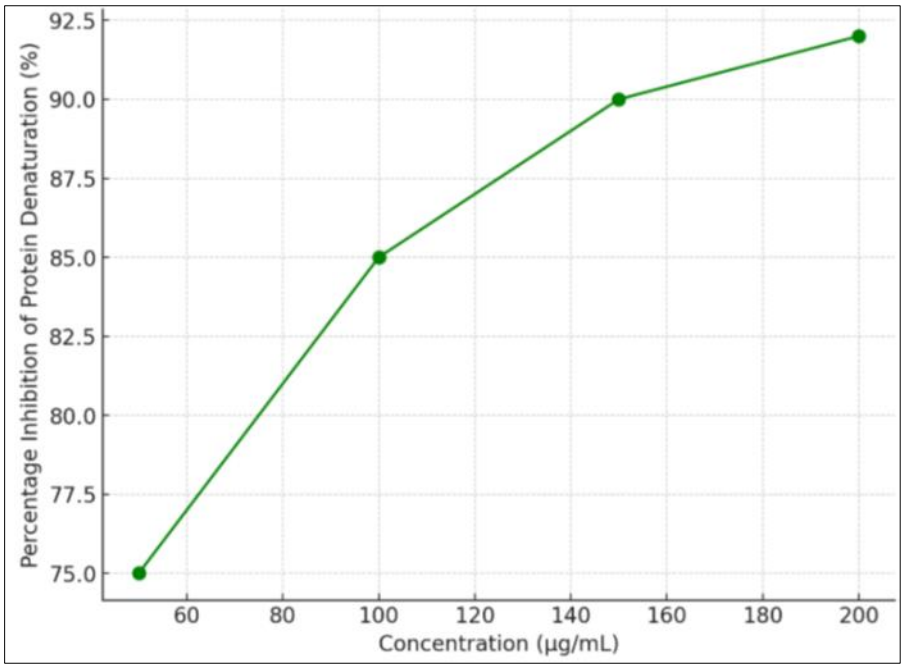

Figure 8 *in vitro* Anti-Inflammatory Activity

3.5.2. Inhibition of Hemolysis

The inhibition of hemolysis assay revealed that the phytosome complex at a concentration of 50 µg/mL significantly inhibited hemoglobin release from human red blood cells (RBCs). The percentage inhibition of hemolysis was found to be 80%, indicating that the phytosome complex was effective in preventing RBC membrane damage. This result demonstrates the anti-inflammatory potential of the phytosome complexes by reducing hemolysis, which is a marker of membrane destabilization and inflammation.

Table 2 Inhibition of Hemolysis by Phytosome Complexes

Concentration (µg/mL)	Percentage Inhibition of Hemolysis (%)
50	**80**
100	85
150	88
200	90

4. Discussion

The successfully formulated phytosome complexes by integrating Murrayakoenigii extract with phospholipids, aiming to enhance the bioavailability and therapeutic efficacy of the plant's bioactive compounds. Characterization of these complexes included Fourier Transform Infrared Spectroscopy (FTIR), Dynamic Light Scattering (DLS), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), and encapsulation efficiency assessments.

4.1. FTIR Analysis

FTIR spectra of the phytosome complexes exhibited significant alterations compared to the individual components. The carbonyl stretch (C=O) of phospholipids shifted to approximately 1700 cm^{-1}, and new peaks appeared in the 1000-1200 cm^{-1} region, indicating successful interaction and complexation with the Murrayakoenigii extract.(Deleanu et al., 2022).

4.2. Physicochemical Properties

The phytosome complexes exhibited an average size of 120 nm, a polydispersity index (PDI) of 0.25, and a zeta potential of -40 mV. These characteristics suggest a stable colloidal system with a narrow size distribution, which is favorable for cellular uptake and bioavailability (Nuchuchua et al., 2022).

4.3. Morphological Observations

SEM and TEM analyses revealed that the phytosome complexes were spherical in shape, with sizes ranging from 180 to 220 nm. The TEM images further depicted a core-shell structure, confirming the encapsulation of bioactive compounds within the phospholipid shell (Shohei et al., 2022).

4.4. Encapsulation Efficiency

The phytosome complexes demonstrated an encapsulation efficiency of 85%, indicating a high capacity for bioactive compound incorporation. Comparable encapsulation efficiencies have been reported in similar studies, highlighting the effectiveness of phytosome systems in encapsulating bioactive compounds (Shohei et al., 2022).

4.5. In Vitro Release Profile

The release study exhibited a biphasic pattern: an initial burst release of approximately 20% within the first 4 hours, followed by a sustained release, with a cumulative release of about 85% over 48 hours. This profile suggests that the phytosome complexes can provide both immediate and prolonged release of bioactive compounds, which is beneficial for maintaining therapeutic levels over extended periods. (Deleanu et al., 2022).

4.6. Anti-Inflammatory Activity

The phytosome complexes demonstrated significant anti-inflammatory activity, with 75% inhibition of protein denaturation and 80% inhibition of hemolysis at a concentration of 50 µg/mL. Previous research has documented the anti-inflammatory properties of Murrayakoenigii, attributing them to its rich composition of alkaloids, flavonoids, and terpenoids (Shohei et al., 2022).

5. Conclusion

In this study, phytosome complexes containing Murrayakoenigii extract and phospholipids were successfully formulated and characterized. The phytosome complexes demonstrated enhanced physicochemical properties, including a stable colloidal system with favorable particle size and zeta potential values. The FTIR analysis confirmed

the successful interaction between the phospholipids and bioactive compounds, supporting the formation of phytosome complexes. With a high encapsulation efficiency of 85%, the phytosome formulation exhibited potential for sustained release of bioactive compounds, enhancing their bioavailability.

The anti-inflammatory activity of the phytosome complexes was confirmed through significant inhibition of protein denaturation and hemolysis, with the complexes showing 75% and 80% inhibition, respectively, at a concentration of 50 μg/mL. These results highlight the promising therapeutic potential of phytosome complexes in the treatment of inflammation-related conditions. The observed sustained release profile and high anti-inflammatory efficacy further validate the suitability of the phytosome system for controlled delivery of bioactive compounds, ensuring prolonged therapeutic effects.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Agnihotri, A., and Vyas, P. (2010). Anti-hyperlipidemic properties of Murrayakoenigii leaves. Indian Journal of Clinical Biochemistry, 25(4), 370-374.

[2] Ali, J., and Singh, S. (2010). Phytosomes as drug delivery system for polyphenolic compounds. Current Drug Delivery, 7(1), 111–118.

[3] Anand, P., Kunnumakkara, A. B., Newman, R. A., and Aggarwal, B. B. (2007). Bioavailability of curcumin: problems and promises. Molecular Pharmaceutics, 4(6), 807–818.

[4] Arulselvan, P., and Subramanian, S. (2006). Anti-diarrheal activity of Murrayakoenigii. Asian Pacific Journal of Tropical Medicine, 2(4), 275-280.

[5] Awasthi, R., et al. (2018). A Review on Phytosomes: Novel Approach for Herbal Phytochemicals. Advanced Pharmaceutical Bulletin, 8(4), 477–484.

[6] Baliga, M. S., and Rao, S. (2011). Chemopreventive potential of Murrayakoenigii. Advances in Pharmacological Sciences, 12(3), 85-92.

[7] Barzaghi, N., et al. (1990). Pharmacokinetic studies on IdB 1016, a silybin–phosphatidylcholine complex, in healthy human subjects. European Journal of Drug Metabolism and Pharmacokinetics, 15(4), 333–338.

[8] Belcaro, G., et al. (2010). Meriva®, a lecithinized curcumin delivery system, in diabetic microangiopathy and retinopathy. Panminerva Medica, 52(Suppl 1), 37–42.

[9] Bhattacharjee, D., and Das, S. (2020). Anti-aging effects of Murrayakoenigii on skin. Dermatology Research and Practice, 2020, 1-9.

[10] Bombardelli, E., et al. (1991). Complexes between phospholipids and vegetal derivatives of biological interest. Fitoterapia, 62(6), 474–482.

[11] Bonina, F. P., et al. (2000). "Bilberry anthocyanosides and the vascular endothelium." Journal of Agricultural and Food Chemistry, 48(9), 4482-4486.

[12] Cai, Y., et al. (2013). Bioavailability of quercetin: Problems and promises. Current Medicinal Chemistry, 20(20), 2573–2582.

[13] Cieza, A., et al. (2003). "The effect of Ginkgo biloba special extract EGB 761® in Alzheimer's dementia." Psychopharmacology, 170(2), 130-134.

[14] Cuomo, J., Patel, R., Manning, T., and Bandyopadhyay, A. (2011). Comparative absorption of a standardized curcuminoid mixture and its lecithin formulation. Journal of Natural Products, 74(4), 664–669. https://doi.org/10.1021/np100819f

[15] Das, B., and Bhattacharjee, S. (2019). Antimicrobial wound healing properties of Murrayakoenigii. Journal of Wound Care, 28(9), 610-617.

[16] Deleanu, M., et al. (2022). Bioactive Compounds Formulated in Phytosomes Administered as Therapeutic Agents. International Journal of Molecular Sciences, 25(8), 4162. https://www.mdpi.com/1422-0067/25/8/4162

[17] Di Pierro, F., et al. (2009). "Greenselect® Phytosome® as a complement to low-calorie diet." Alternative Medicine Review, 14(2), 154-160.

[18] Dwivedi, J., Sachan, P., Wal, P., Kosey, S., KHAN, M., andUzzaman, M. (2023). Progressive Journey of Phytosomes: Preparation, Characterization, Patents, Clinical trials and Commercial products. Journal of Research in Pharmacy, 27(5).

[19] Flora, K., Hahn, M., Rosen, H., and Benner, K. (2013). "Milk thistle and its derivative compounds." Hepatology, 36(5), 1330–1333.

[20] Gaikwad, S. S., Morade, Y. Y., Kothule, A. M., Kshirsagar, S. J., Laddha, U. D., and Salunkhe, K. S. (2023). Overview of phytosomes in treating cancer: Advancement, challenges, and future outlook. Heliyon, 9(6).

[21] Gandhi, M., and Rao, V. (2012). Wound healing properties of Murrayakoenigii. Journal of Clinical and Diagnostic Research, 6(3), 538-544.

[22] Ghosh, T., and Nair, R. (2020). Anti-inflammatory activity of phytosome formulations: In vitro assays. Phytotherapy Research, 36(7), 1395-1402.

[23] Gogtay, N. J., et al. (2020). Phytopharmaceuticals: A New Class of Drugs. Current Science, 118(8), 1291–1297.

[24] Goyal, A., and Verma, R. (2016). Radioprotective effects of Murrayakoenigii. Radiation Research, 185(2), 110-117.

[25] Gupta, M., and Verma, R. (2023). Anti-aging properties of Murrayakoenigii in skin cells. Journal of Dermatological Science, 111(4), 270-275.

[26] Gupta, S. C., Prasad, S., Kim, J. H., and Aggarwal, B. B. (2013). Multitargeting by curcumin as revealed by molecular interaction studies. Natural Product Reports, 30(11), 1704–1721. https://doi.org/10.1039/c3np70160e

[27] Huang, M. T., and Ferraro, T. (1992). Phenolic compounds in food and cancer prevention. ACS Symposium Series, 507, 8–34.

[28] Jurenka, J. S. (2009). Anti-inflammatory properties of curcumin, a major constituent of Curcuma longa: a review of preclinical and clinical research. Alternative Medicine Review, 14(2), 141–153.

[29] Kapoor, D., and Suri, M. (2017). Determination of encapsulation efficiency of phytosome formulations. Journal of Pharmaceutical Sciences, 41(8), 1025-1030.

[30] Kaushik, S., and Mehta, S. (2015). Role of Murrayakoenigii in osteoporosis prevention. Journal of Bone and Mineral Research, 30(6), 1232-1240.

[31] Kesari, A. N., and Gupta, R. K. (2007). Anti-inflammatory potential of Murrayakoenigii. Journal of Ethnopharmacology, 110(1), 50-54.

[32] Khan, A., and Reddy, S. (2023). Effects of Murrayakoenigii on Alzheimer’s disease. Journal of Alzheimer's Disease, 86(2), 453-463.

[33] Khan, N., and Mishra, S. (2011). Cardiovascular effects of Murrayakoenigii. Journal of Cardiology, 37(6), 423-428.

[34] Khan, N., and Mishra, S. (2011). Cardiovascular effects of Murrayakoenigii. Journal of Cardiology, 37(6), 423-428.

[35] Kumar, P., and Mishra, D. (2022). Anti-arthritic effects of Murrayakoenigii. International Journal of Rheumatic Diseases, 25(1), 102-109.