# FORMULATION, OPTIMIZATION AND EVALUATION OF QUERCETIN PHYTOSOMAL CONTAINING HYDROGEL FOR PSORIASIS

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**ABSTRACT**
Psoriasis is an inflammatory disease that causes painful, scaly, itchy skin as well as deformities. Numerous studies have been conducted on natural products with anti-psoriatic properties due to the lack of a potential remedy and related drawbacks in allopathic medications. One of the most common polyphenolic flavonoids in fruits and vegetables is quercetin (QT), which has a number of biological and health-promoting effects in a range of conditions. In order to formulate, optimise, and assess quercetin phytosomal gel's anti-psoriasis activity, quercetin-loaded phytosomes were made using the thin-film hydration method. Factorial design (32) was used to optimise the formulations using Design-expert® software (Version 7.0.0, Stat-Ease Inc., Minneapolis, USA). Particle size determination (Y1) and entrapment efficiency (Y2) were the reactions to two distinct independent variables: the amount of soy lecithin (X1) and cholesterol (X2). A 1.5% quercetin phytosomal gel was made using the optimised formulation of quercetin phytosomes and tested for drug content, pH, spreadability, and viscosity using a Carbapol 934 gel base. The maximum EE percentage of the

synthesised quercetin phytosomes was 78.54%, the particle size was 57.4 nm, and the spreadability value was 11.6 cm. A good content uniformity of 82.2±1.43% was obtained in the produced phytosomal gel. It was discovered that the viscosity was 2108 cps. For the phytosomal gel, the cumulative percentage of drug release was 92.11±7.32%. Compared to standard drug amphotericin-B, the results suggested that phytosomal hydrogel might be a useful transdermal delivery system for quercetin in the treatment of psoriasis.
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## INTRODUCTION

Psoriasis is a skin condition that results in thick, red skin patches with silvery scales, as well as scaling and inflammation (pain, swelling, heat, and redness). These areas may itch or hurt. An important factor in psoriasis is the immune system. White blood cells, which defend the body against infection, are produced by the immune system. T cells, a subset of white blood cells, cause aberrant skin inflammation in psoriasis. On the skin's outer surface, they also result in skin cells growing more quickly than usual and piling up in elevated areas [1]. Normally, skin cells that originate in the human skin's deepest layers rise to the surface. Cell turnover is the term for this process. They develop, shed from the body's exterior, and are replaced by fresh skin cells that grow from below. [2] It takes around a month to complete this cycle. However, the immune system triggers a faster-than-normal skin cell cycle in psoriasis patients. Because the body does not eliminate these extra skin cells, they accumulate on the skin's surface and cause lesions. Numerous studies have been conducted on natural products with anti-psoriatic properties due to the lack of a potential remedy and related drawbacks in allopathic medications. [3] The review of the literature shows that while a lot of study has been done on psoriasis treatment, not much has been done on herbal medications for the condition. [2, 3]

A recently developed patented method called the phytosomal drug delivery system was created to create lipid-compatible molecular complexes by incorporating standardised plant extracts or water-soluble phytoconstituents into lipids. [4, 5] The most effective stoichiometric ratio for creating phospholipid complexes is thought to be 1:1. These complexes protect the important component of herbal extract from being broken down by gut bacteria and digestive secretions while also increasing the bioavailability of the active ingredients. Consequently, they outperformed traditional herbal extracts in terms of absorption as well as pharmacological and pharmacokinetic aspects.[6]

Typically, plants' active ingredients are polar or soluble in water. However, because of their poor lipid solubility or bigger molecular size, which acts as a barrier in passive diffusion, water-soluble phytoconstituents such as flavonoids, glycosidal aglycones, tannins, etc., are poorly absorbed and have low bioavailability. One plant flavonoid that belongs to the polyphenol flavonoid family is quercetin. Numerous fruits, vegetables, grains, seeds, and leaves contain it. It is frequently found in large quantities in foods like kale, capers, and red onions. It is used in meals, beverages, and dietary supplements and has a bitter flavour. [7, 8] Its anti-inflammatory and anti-allergy qualities are what make it most famous. Because it stabilises mast cell membranes and inhibits the production of histamine and other inflammatory chemicals, it is commonly used to treat food and inhalant allergies, asthma, eczema, psoriasis, gout, and ulcerative colitis. Because of its antioxidant properties, quercetin can also inhibit inflammatory processes that are mediated by lysosomal

enzymes, hyaluronidase (enzymes that break down collagen), and "leukotrienes" (inflammatory effects a thousand times stronger than histamines) [9, 10, 11, 12].

## MATERIALS AND METHODS

**Materials:** We received gift samples of quercetin and soy lecithin from Central Drug House (p) Ltd in Bombay, India. We bought carbopol 934, dichloro-methane, sodium hydroxide, and cholesterol from SD Fine-Chem Limited in India. We bought chloroform, methanol, and triethanolamine from Fischer Scientifics in Mumbai, India.

**UV Spectroscopy:** Using matching 10 mm quartz cuvettes, the standard calibration curve of Quercetin UV spectrophotometers (UV-1900) and UV-visible spectroscopy were used to determine the absorption maxima (λmax). Quercetin was analysed using ethanol. [13]

**Fourier Transform Infrared Spectroscopy (FTIR):** FTIR spectroscopy analysis was utilised to examine the compatibility and interaction of the physical mixture of drug and excipients, as well as the pure drug, lipid, and surfactant employed in TE production. Both liquid and solid samples were analysed using an FTIR spectrometer. (Bruker Alpha II, USA; SHIMADZU IR Affinity 1/8000, Japan). The transmission method was used for the inspection, and wave numbers between 4000 and 400 cm-1 were used. [14, 15]

**Preparation of Phytosomes:** The thin-film technique was used to create the quercetin phytosomes. In a dry, round-bottom flask, a precise amount of soy lecithin, cholesterol, and quercetin were dissolved in a dichloromethane: methanol mixture (2:1v/v). To form a thin lipid coating on the round-bottom flask wall, the organic solvent combination was allowed to evaporate for 15 minutes under low pressure in a rotary evaporator set to 60 rpm and 40°C. The film was rotated at 60 rpm for one hour at room temperature in order to hydrate it with phosphate buffer pH7.4. After being sonicated for 30 minutes with the ultrasonic probe sonicator to decrease their size, the multilamellar lipid vesicles (MLVs) were kept at 4°C for additional research. [16, 17]

**Table 1: Formulation Design of Quercetin Phytosomes**

| Ingredients | QF1 | QF2 | QF3 | QF4 | QF5 | QF6 | QF7 | QF8 | QF9 |
|---|---|---|---|---|---|---|---|---|---|
| Quercetin(mg) | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Soyalecithin | 100 | 100 | 100 | 200 | 200 | 200 | 300 | 300 | 300 |
| Cholesterol | 25 | 50 | 75 | 25 | 50 | 75 | 25 | 50 | 75 |
| Chloroform or methanol (2:1ml) | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| Phosphate buffer (7.4) | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Distilled water (v/v) | Q.S | Q.S | Q.S | Q.S | Q.S | Q.S | Q.S | Q.S | Q.S |

**Design of Experiment:** Design-expert® software (Version 7.0.0, Stat-Ease Inc., Minneapolis, USA) was used to build a three-level factorial design, which required an experiment to be conducted at all possible combinations of the three levels of each component taken into consideration. The levels of soy lecithin (X2) and cholesterol (X1) were the independent variables. Nine quercetin phytosome formulations were produced after the independent factors were screened using a multilevel factorial design (32). To find the ideal formulation, all of the formulations were made using the thin film hydration method. Particle size (Y1) and entrapment efficiency (Y2) were then assessed. [18]

**Table 2: Independent Variables**

| Coded values level | Independent variables | |
|---|---|---|
| | X1, Cholesterol | X2, Soy lecithin |
| -1 | 25 | 100 |
| 0 | 50 | 200 |
| +1 | 75 | 300 |

**Table 3: Formulation Of Quercetin Phytosomes Suspension**

| Formulation | Drug | Cholesterol | Soy lecithin | Chloroform |
|---|---|---|---|---|
| QF1 | 100 | 25 | 100 | 30 |
| QF2 | 100 | 50 | 200 | 30 |
| QF3 | 100 | 75 | 300 | 30 |
| QF4 | 100 | 25 | 100 | 30 |
| QF5 | 100 | 50 | 200 | 30 |
| QF6 | 100 | 75 | 300 | 30 |
| QF7 | 100 | 25 | 100 | 30 |
| QF8 | 100 | 50 | 200 | 30 |
| QF9 | 100 | 75 | 300 | 30 |

**Evaluation parameter of quercetin loaded phytosome**

**Percentage Entrapment Efficiency (%EE):** The centrifugation method can be used to test the drug's ability to entrap other drugs. Centrifugation is used to separate the unentrapped medication, and a liquid supernatant is produced at the end of the process. It is computed how much substance is ensnared. [19]

**Particle size and PDI:** The Malvan zeta sizer technique was used to evaluate the particle size and PDI of the produced quercetin-loaded phytosme formulations using a particle size analyser (Nanopartica SZ-100, HORIBA Scientific, USA). After being diluted with distilled water, the nanovesicles were examined at room temperature. Three measurements of the diluted samples' particle size and PDI were made, and the average ± standard was used to present the results.

**Determination of Zeta Potential of optimized batch:** The measurement of the electric charge on the surface of a nanoparticle, which indicates the physical stability of the system, is called zeta potential. Using an electrophoretic light scattering technique and a particle size analyser (Nanopartica SZ-100, HORIBA Scientific, USA), the Zeta potential of an optimised batch of phytosme was ascertained. The samples were diluted with double-distilled water prior to analysis. The analysis was conducted in triplicate, and the results were displayed as mean ± standard deviation. [20, 21, 22]

**In vitro Drug release study:** Phytosome samples were placed in dialysis bags, sealed, and immersed in a solution. The drug release investigation was carried out for two hours at 37±0.5º and 100 rpm using the USP Dissolve Test Apparatus, Type II. At each interval, 5 mL of sample were extracted and swapped out for fresh buffers. The materials were evaluated spectrophotometrically after being diluted appropriately. [23]

**Preparation of quercetin loaded phytosme hydrogel:** Soy lecithin and 1% Carbopol 934 were used as a gelling agent to create the quercetin-loaded phytosomal hydrogel. The synthesised phytosomal hydrogel contained 1.5% w/w of quercetin. [24]

**Evaluation of Quercetin-Loaded hydrogel**

**pH:** The pH of the hydrogel was measured using a digital pH meter. The pH of the mixture was measured after 1 g of hydrogel was agitated in distilled water until a homogeneous suspension was reached. [25]

**Spreadability:** 50 g of weight was placed on slides for 5 seconds after an excess of hydrogel (2 g) was sandwiched between petri dishes to compress the sample to a uniform thickness. Spreadability was measured as the amount of time (in seconds) needed to separate the two slides. [26, 27] The following formula was used to calculate it:

$$S=M.\ L/T$$

Where, S=spreadability, M=weight tied to upper slide, L=length of glass slide, T=time taken in min

**Viscosity:** A Brookfield viscometer (LV) of the Di type was used to measure the hydrogel's viscosity. The fourth spindle is used because it is non-Newtonian. Viscosity was measured for two minutes at a fixed speed of 0.3 rpm. [28]

**Anti-Microbial Activity:** Aspergillus niger (2079) and Candida albicans (NCIM-2708) standard cultures were acquired from Owaisi Hospital and Research Centre in Hyderabad, Telangana. The organisms were kept alive by subculturing them in nutrient agar medium every 24 hours. [29, 30]

**Preparation of Test and Standard Solutions:** The Phytosome test solutions were dissolved in DMSO, while the solvent control, 200 µg/0.1 ml of DMSO, was obtained by dissolving the Amphotericin-B standard in sterilised water. Standard Inoculum Preparation: The amounts of the various materials listed above were precisely weighed and dissolved in the corresponding volume of distilled water. The prepared media was autoclaved for 15 minutes at 121 °C to sterilise it. [31]

**Anti-fungal Screening by Cup Plate Method:** The foundation of this technique is the diffusion of antifungal components from the reservoir hole to the nearby inoculated nutrient agar medium, which inhibits fungal growth in the area surrounding the hole.

**Procedure:** Cups with a diameter of 10 mm were made in the agar medium containing the bacteria using a sterile borer. Using the spread plate approach, 0.1 ml of inoculums (of $10^4$ to $10^6$ CFU/ml population) were applied to an agar plate. The inoculums were prepared from a standardised culture and adjusted with peptone water. Using a micropipette, precisely measured (0.1 ml) solutions of each sample and standard were added to the cups. For two hours, all of the plates were refrigerated between 2 and 8°C to ensure that the test compounds and standards diffused effectively. They were then incubated for 24 hours at 37 °C. Fungal activity was demonstrated by the appearance of distinct zones of inhibition surrounding the cup. [32, 33]

**RESULTS AND DISCUSSION**

**Determination of absorption Maxima ($\lambda_{max}$) by UV-visible spectroscopy:** Quercetin's absorption maxima were measured using wavelengths between 200 and 400 nm. The maximum absorption was measured and used at 373 nm. The λmax was shown in Figure 1.

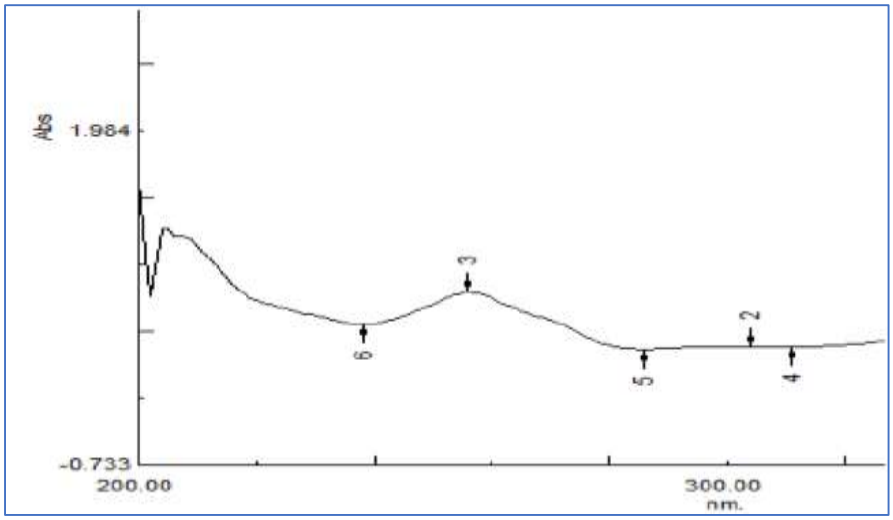


**Figure 1: UV Spectra of Quercetin**

**FTIR Study:** Figure 2 displays the FTIR spectra of pure quercetin and its physical characteristics. All of the distinctive peaks were evident in the quercetin FTIR spectra. Quercetin was successfully added to the hydrogel formulation, and all of the drug's characteristics stayed mostly the same.

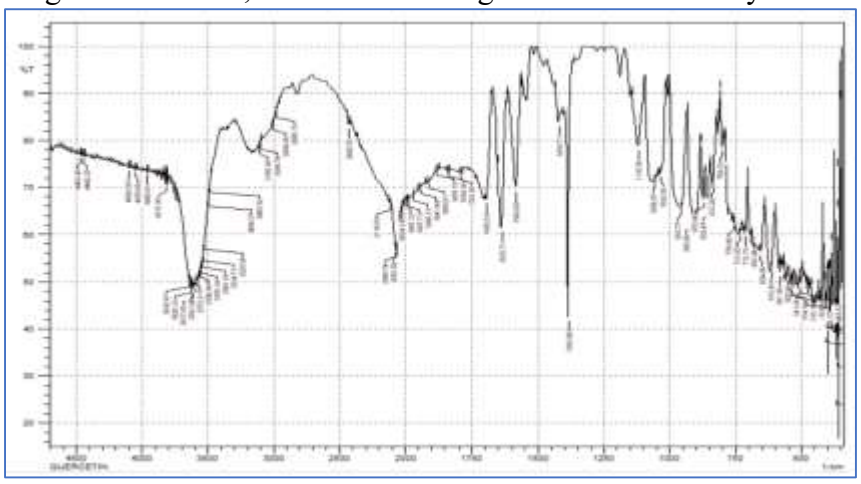

**Figure 2: FTIR spectra of quercetin**

**Evaluation of quercetin loaded phytosomes**

**Entrapment efficiency:** The range of entrapment efficiency was 53.53 to 78.54%.

**Particle size and PDI:** As shown in Figure 3, the particle size was determined to be 57.4 nm and the PDI to be 1.

**Table 4: Composition And Characteristics of Formulations**

| Formulation | X1, Cholesterol | X2 Soy lecithin | Y1, Particle size (nm) | Y2, Entrapment Efficiency (%) |
|---|---|---|---|---|
| QF1 | 25 | 100 | 604 | 53.53 |
| QF2 | 50 | 200 | 71.2 | 61.64 |
| QF3 | 75 | 300 | 61.5 | 70.43 |
| QF4 | 25 | 100 | 63.2 | 55.64 |
| QF5 | 50 | 200 | 70.5 | 63.22 |
| QF6 | 70 | 300 | 63.8 | 72.43 |
| QF7 | 25 | 100 | 68.4 | 59.64 |

| | | | | |
|---|---|---|---|---|
| QF8 | 50 | 200 | 70.1 | 65.54 |
| QF9 | 75 | 300 | 57.4 | 78.54 |

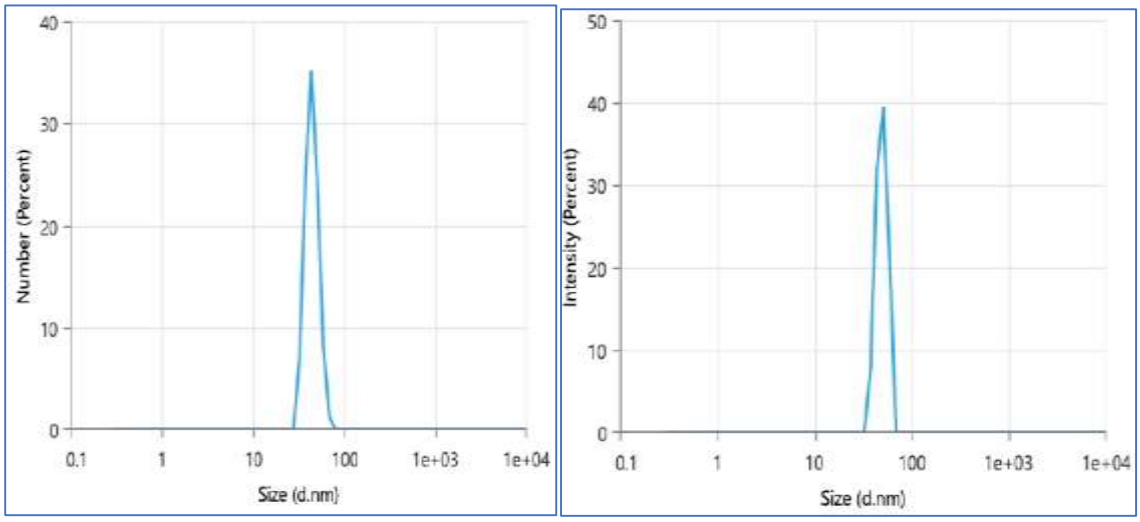


**Figure 3: Determination of particle size and PDI (QF9)**

**Zeta potential:** Following triplicate examination, the zeta potential of the optimised formulation was determined to be 0.38.

**In-vitro Diffusion Studies:** All formulations underwent ten hours of diffusion investigations using a dialysis membrane, and samples were examined using a double-beam UV Visible Spectrophotometer.

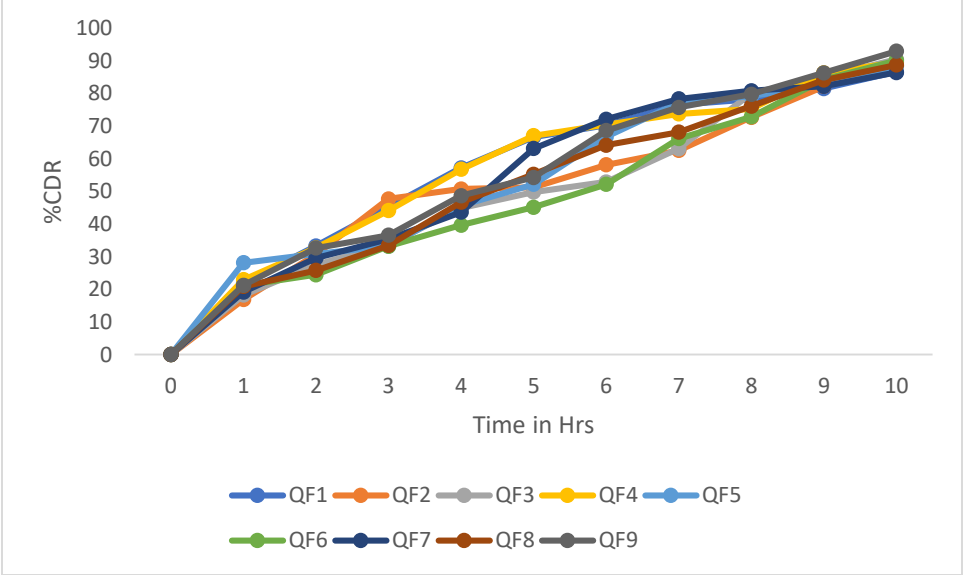


**Figure 4: % Drug release of formulation QF1-QF9**

**Evaluation of Hydrogel**

The phytosomal hydrogel injected with quercetin was uniformly smooth. The soy lecithin phytosomal hydrogel of quercetin may be optimised on the skin surface with minimal stress, as evidenced by the spreadability value of 11.6 cm. It was determined that the 1.5% quercetin soy lecithin phytosomal gel had a viscosity of 2108 cps. At 7.2 ± 0.11, the pH value is within the typical

range for topical treatments. It was discovered that the quercetin phytosomal hydrogel's real drug content was 82.2±1.43%, indicating good content uniformity. The drug release measured in vitro was 92.11±7.32.

**Activity of Phytosomes against *Candida albicans*:** Table 5 displays the antifungal activity of several phytosomes (QF9) and hydrogel. In comparison to normal Amphotericin-B at 200µg/ml, which demonstrated a 16.3 mm zone of inhibition, quercetin phytosome (QF9) and hydrogel of quercetin demonstrated antifungal activity of 9.7 mm and 12.1 zone of inhibition.

**Activity of Phytosomes against Aspergillus niger:** Table 5 displays the antifungal activity of various phytosomes, including hydrogel and QF9. In comparison to normal Amphotericin-B at 200µg/ml, which exhibited a 14.4 mm zone of inhibition, quercetin phytosome (QF9) and hydrogel demonstrated antifungal activity of 12.1 mm and an 11.2 mm zone of inhibition.

**Table 5: Zone Of Inhibition On Quercetin Formulation Against C. Albicans And A. Niger**

| S. No. | Formulation | *C. albicans* (Mm) | *A. niger* (Mm) |
|---|---|---|---|
| 1 | Quercetin Phytosome QF9 | 9.7 | 9.2 |
| 2 | hydrogel | 12.1 | 11.2 |
| 4 | Amphotericin- B | 16.3 | 14.4 |

## CONCLUSION

The purpose of the study is to create, refine, and assess quercetin phytosomal hydrogel 's anti-psoriasis properties. One of quercetin's many medicinal benefits is its antifungal action. It can be inferred from the quercetin phytosome hydrogel study that each formulation has unique benefits and drawbacks. Compared to hydrogel, quercetin phytosome hydrogel demonstrated greater skin penetration and quercetin retention. This is explained by the phytosome's superior penetration capacity, which enables the medicine to easily pass through the stratum corneum and reach deeper epidermal layers because of its small particle size and high entrapment efficiency. The phytosome formulation QF9, which showed reduced particle size and increased entrapment efficiency, was determined to be the study's ideal formulation. The phytosomal hydrogel of was prepared that exhibited better antifungal activity, which can be beneficial in treating various skin disorders.

## REFERENCES

1. Gudjonsson JE and Elder JT. Psoriasis. In: Wolff K, Goldsmith LA, Katz SI, et al. Fitzpatrick's Dermatology in General Medicine. 7thed New York: McGraw Hill Medical 2008; 169-93.
2. W Torinuki and H Tagami. Incidence of skin cancer in Japanese psoriatic patients treated with either methoxsalen phototherapy, Goeckerman regimen or both therapies. A 10-year follow-up study. J Am Acad Dermatol 1988; 18(6): 1278-1281. http://dx.doi.org/10.1016/S0190-9622(88)70135-8
3. SN Horwitz, RA Johnson, J Sefton and P Frost. Addition of a topically applied corticosteroid to a modified Goeckerman regimen for treatment of psoriasis: effect on duration of remission. J Am Acad Dermatol 1985; 784-791. http://dx.doi.org/10.1016/S0190-9622(85)70224-1
4. Vishvakrama P, Sharma S. Liposomes: an overview. Journal of Drug Delivery and Therapeutics. 2014 Jun 24:47-55.
5. Vishvakarma P. Design and development of montelukast sodium fast dissolving films for better therapeutic efficacy. Journal of the Chilean Chemical Society. 2018 Jun;63(2):3988-93.

6. Vishvakarma P, Mandal S, Verma A. A review on current aspects of nutraceuticals and dietary supplements. International Journal of Pharma Professional's Research (IJPPR). 2023;14(1):78-91.
7. JosephA. Kareparamban, Aruna P Jadhav: Phytosome A Novel Revolution in Herbal Drugs, Int J Res Pharma Chemistry. 2012;2(2):299-300.
8. GarimaSinghalR.B, KunalKasariya,:"Biosynthesis of silver nanoparticles using Ocimum sanctum (Tulsi) leaf extract and screening its antimicrobial activity. "JNanopart Res, 2011.13: p.2981-2988.
9. Amzad H.M., Kabir S.M., Salehuddin S.M et al., 2010. Antibacterial properties of essential oils and methanol extracts of sweet basil Ocimum basilicum occurring in Bangladesh. Pharma Biol.48, 504–511.
10. Prabhakar Vishvakarma, Jaspreet Kaur, Gunosindhu Chakraborthy, Dhruv Kishor Vishwakarma, Boi Basanta Kumar Reddy, Pampayya Thanthati, Shaik Aleesha, Yasmin Khatoon. Nephroprotective Potential of Terminalia Arjuna Against Cadmium-Induced Renal Toxicity by In-Vitro Study. J. Exp. Zool. India Vol. 28, No. 1, pp. 939-944, 2025
11. Prabhakar V, Agarwal S, Chauhan R, Sharma S. Fast dissolving tablets: an overview. International Journal of Pharmaceutical Sciences: Review and Research. 2012;16(1):17.
12. Vishvakarma P, Mandal S, Pandey J, Bhatt AK, Banerjee VB, Gupta JK. An Analysis Of The Most Recent Trends In Flavoring Herbal Medicines In Today's Market. Journal of Pharmaceutical Negative Results. 2022 Dec 31:9189-98
13. Ibrahim ESA, Hassan MA, El-Mahdy MM, Mohamed AS. Formulation and evaluation of quercetin in certain dermatological preparations. J Drug Deliv Sci Technol. 2007;17(6):431-6.
14. Chen C, Zhou J, Ji C. Quercetin: A potential drug to reverse multidrug resistance. Life Sci. 2010;87(11-12):333-8.
15. Keerthi, Prasuna Sundari, Dr.Prathima: Formulation and Evaluation of Capsules of Ashwagandha Phytosomes, Int.J.Pharm.Sci.Rev.Res.2014;29(2):138- 141.
16. M. Sunitha Reddy, Tangella Srividya lalitha: Formulation and Evaluation of Fast Disintegrating Tablets of Lamivudine using Ocimum basilicaum seed mucilage as superdisintegrant, World Journal of Pharmaceutical Research. ISSN227-7105
17. Gupta V, Sanyogita KM, Manigauha A. Novel Formulation of Aloe vera and Quercetin in the Management of Dermal Disease: Eczema. Journal of Pharmaceutics and Drug Research JPDR [Internet]. 2021;4(2):480-7. Available from: www.scitcentral.com
18. Hatahet T, Morille M, Hommoss A, Devoisselle JM, Müller RH, Bégu S. Quercetin topical application, from conventional dosage forms to nanodosage forms. European Journal of Pharmaceutics and Biopharmaceutics. 2016;108:41-53.
19. Shi GJ, Li Y, Cao QH, Wu HX, Tang XY, Gao XH, et al. In vitro and in vivo evidence that quercetin protects against diabetes and its complications: A systematic review of the literature. Biomedicine and Pharmacotherapy. 2019;109:1085-99.
20. BarkatAlikhan, Shafi Ullah, MKhalid Khan: Formulation and Evaluation of Ocimum basilicum- based emulgel for wound healing using animal model. Saudi pharmaceutical journal.2020.
21. Hyun Jee Han, MS: Development of an effective formulation for an acne treatment cream with Ocimum basilicum using Invasomes, J. Cosmet Med 2018: 2(2):69-75
22. Prasuna Sundari Pingali, Prathima Srinivas: Miconazole Loaded Novel Phytosomal Topical Gels, WJPPS. 2015;4 (10):2305-2320.

23. HH Roenigk, Jr R Auerbach, H Maibach et al. Methotrexate in psoriasis: consensus conference. J Am Acad Dermatol 1998; 38(3): 478-485. http://dx.doi.org/10.1016/S0190-9622(98)70508-0
24. Ebrahimpour S, Zakeri M, Esmaeili A. Crosstalk between obesity, diabetes, and alzheimer's disease: Introducing quercetin as an effective triple herbal medicine. Ageing Res Rev. 2020;62.
25. Rudra Pratap Singh, Ramakant Narke: Preparation and Evaluation of Phytosome of Lawsone,IJPSR.2015;6(12):5217-5225.
26. A.Sumathi, R. Senthamarai: Design and Development of Phytosomes Containing Methanolic Extract of Nymphaea nouchali and Trihosanthes Dioica, WJPR. 2015;4(4):1211-1221.
27. Layzon Antonio Lemos de Silva, Luciano Soares: Spectrophotometric determination of the total flavonoid contentin Ocimum basilicum L. leaves, Phytochemistry.2014.
28. Majid Saeedi, Katayoun Morteza: Evaluation of Ocimum basilicumL. Seed mucilage as rate controlling matrix for sustained release of propranolol HCl,Pharm Biomed Res 2015:1(1):18-25
29. Nagasamy Venkatesh, Sumanraj: Phytosomes: A Review. IJPS.2014;4(4):621-623.
30. Javanmardi J, Khalighi A, Vivanco J.M: Chemical characterization of basil (Ocimum basilicumL.) found in local accessions and used in traditional medicines in Iran. J. Agric. Food Chem., v.50, n.21, p.5878-5883, 2002.
31. Priya P. Munshi, D.S. Mohale, R. Akkalwar, A.V. Chandewar. Formulation and Evaluation of Diclofenac gel. Research J. Pharm. and Tech. 4(9): Sept. 2011; Page 1394-1399.
32. Gupta Amit, M.S Ashawat, Saraf Swarnalata: Phytosome A Novel Approach Towards Functional Cosmetics,J Plant Sci.2007;2(6):644-647.
33. Amrita Jadhav, VilasArsul, Swarakar: Phytosome A Novel Approach in Herbal Drug Delivery System, Int J Pharma Drug Analysis.2014;2(5):479- 481.