ORIGINAL ARTICLE

Formulation and Evaluation of *Wrightia tinctoria* Emulgel for the Treatment of Psoriasis

Priyanka Jurel, Meenakshi Bajpai, Shiv Bahadur

Institute of Pharmaceutical Research, GLA University, Mathura, Uttar Pradesh, India

Abstract

Aim: Psoriasis can be a debilitating condition, but there may be a solution. Recently, several studied showed that emulsion-based topical drug delivery system could be a promising approach for the treatment of psoriasis. Hence, in the present study, *Wrightia tinctoria* (WT) oil-based emulgel was developed for the enhancement of effectiveness against psoriasis. **Materials and Methods:** This breakthrough treatment could be an alternative technique for the management of psoriasis. WT oil was used to prepare emulsions, which was loaded into a gel base. The concentration different excipients varied to prepare various emulsion formulations and evaluated for different parameters. The developed formulations were evaluated for the various parameters such as drug content, particle size, zeta potential, viscosity, pH and percentage drug release. **Results and Discussion:** The optimized formulation (F4) was found to have droplet size of 3218 ± 1.24 nm, 0.0175 ± 1.78 V zeta potential, entrapment efficiency of 59.53 ± 8.42%, and spreadability of 2.901 ± 0.12 mm. The pH and viscosity of optimized WT oil-based emulgel was found to be 6.1 ± 0.578 and 94,374 ± 198 cp, respectively. *In vitro* release of WT oil from optimized emulgel was found to be 98.87 ± 1.15% in 10 h. In 3-(4, 5-dimethylthiazolyl-2)-2, 5-diphenyltetrazolium bromide cytotoxicity study indicated no significant difference between the WT oil and its emulgel. Thus, suggested no loss of anti-proliferation activity of WT oil on formulation in emulgel. **Conclusion:** This study showed that the emulgel formulation has the potential to significantly enhance the efficacy of WT oil in treating psoriasis. These findings provide exciting new possibilities for improving psoriasis treatment and highlight the importance of continued research in this area.

Key words: Bioavailability, emulgel, human epidermal keratinocyte cell line, psoriasis, topical formulation, *Wrightia tinctoria*

INTRODUCTION

Psoriasis is a chronic autoimmune, non-communicable inflammatory, incurable, disfiguring, and life-long sickness of the skin and joints.[1] National Psoriasis Foundation states that about 7.5 million people have been suffering from psoriasis in US.[2] The serious global problem of psoriasis in countries among 0.08–12%, making psoriasis a critical worldwide hassle.[3,4] Psoriasis is a non-contagious hereditary skin disease expressed by sever itching, thickened, stinging, inflamed, scaly and deformed are all symptoms of lesions that in 70% of cases appear in mild-to-moderate form.[5] The condition causes of psoriatic skin to be stress, cold weather, dry skin, vaccination, β-blocker, lithiums, upper respiratory infection, smoking, diet, and alcohol.[6-10] Hyperkeratosis known as thickening of the stratum corneum (SC) and parakeratosis known as abnormal maturation of the SC is two typical of the SC in psoriatic skin.[11] Psoriasis can rises at any age but it generally arrives in two stages. The first stage is between the ages of 20 and 30 years, and the second stage is between the ages of 50 and 60 years.[12] Psoriasis is a skin disorder known to be characterized by genetic and environmental aspects such as mental stress, infection, alcohol, smoking, and trauma but its causes are still not completely understood.[13] The quality of patient life with psoriasis is often spoiled because of the flawed appearance, loss of confidence and social stigmatization.[14] *Wrightia tinctoria* (WT) R.Br., a

Address for correspondence:
Priyanka Jurel, Institute of Pharmaceutical Research, GLA University, Mathura, Uttar Pradesh, India.
Phone: +91-8394800734.
E-mail: priyankasinghjurel@gmail.com

Received: 22-08-2024
Revised: 21-11-2024
Accepted: 03-12-2024

member of the *Apocynaceae* family, is a deciduous tree that is widely distributed throughout the world, including in India. Its bark and seeds have been used for centuries in traditional Indian medicine to treat diarrhea, dysentery, and psoriasis.[15] Scientific studies have confirmed the presence of significant amounts of wrightial, triterpenoid phytochemical, as well as other compounds such as cycloartenone, cycloeucalenol, β-amyrin, and β-sitosterol which have been isolated from the plant.[16] In addition, WT contains several pharmacological activities including anti-psoriatic, anti-cancer, anti-diabetic, anti-microbial, antispasmodic, anti-inflammatory, and anti-ulcer, free radical scavenging activities[17] while there have been no reports of toxic compounds in WT, it is important to note that high dosages over an extended period can lead to serious illnesses.[18] Make sure to use WT responsibly to enjoy its numerous health benefits. Different formulations of are WT prepared such as psorolin ointment, bio wright shampoo, and psorolite cream.[19,20] Topical formulations such as creams, ointments, and lotions often suffer from instability, stickiness, and low spreading coefficient.[21] However, there is a new solution the emulgel. This innovative formulation combines the best features of both emulsions and gels to create a superior product.[22] When formulating WToil, an emulgel was used because it offers several advantages. Emulsions are great for dissolving hydrophobic drug molecules while gels offer faster drug release and a higher spreading coefficient than other semi-solid preparations.[23] Gels form cross-linked networks that capture small drug particles and release them in a controlled manner. They also exhibit mucoadhesive properties that provide a longer contact time for the formulation on the skin.[24] Emulgels are dual control release systems that combine the properties of both emulsions and gels. Topical gels, like the emulgel, offer a range of benefits such as being greaseless, easily spreadable, easily removed, emollient, and water-miscible. This makes them an excellent choice for topical applications.[25] Incorporating gel into an emulsion has been proven to significantly enhance the stability and penetration ability of the emulsion through its thixotropic action. Emulgel, a combination of gel and emulsion, offers several advantages over traditional topical treatments. It is highly accepted by patients due to its non-greasy nature and requires no excessive rubbing. Emulgel is a stable system and an optimal vehicle for delivering hydrophobic drug molecules to the skin.[26] The study aimed to demonstrate that emulgel is an effective method of administering WT for the management of psoriasis.

MATERIALS AND METHODS

Materials

The following chemicals were obtained such as span 20 and carbopol from Research – laboratories fine chem industries (Mumbai, India), liquid paraffin, propylene glycol, and tween 80 from chemco, *Wrightiatinctoria* oil was purchased from stallion while other ingredients and solvents were of analytical grade.

Gas chromatography/mass spectrometry (GC/MS) analysis

The Thermo Finnigan Trace GC/Trace DSQ/A1300, equipped with an SGE-BPX5 MS fused silica capillary column was used to analyze the essential oil. The GC-MS detection system utilized an electron ionization process with ionization energy of 70eV and helium as the carrier gas with a flow rate of 1 mL/min. The injector and MS transfer line temperatures were set to 220°C and 290°C, respectively.[27] The oven temperature was programmed to gradually increase from 50°C to 150°C at a rate of 3°C min and held at a constant temperature for 10 min before being raised to 250°C at a rate of 10°C/min. The diluted samples of 1.0 μL were manually injected in the split less mode. Individual compounds were identified by precisely comparing their relative retention times with those of authentic samples on the SGE-BPX5 capillary column. Mass spectra were matched with those obtained from authentic samples, the Wiley 7N, and TRLIB libraries spectra, as well as published data.[28]

Selection of surfactants and co-surfactants

For optimal mixing, add 10 mL of WT oil to each vial containing 1 mL of an acceptable medium. The solution should be kept at 25°C for 48 h in an orbital shaking incubator to ensure solubility and equilibrium. After centrifuging at 500 rpm for 15 min, the filtered sample is mixed with ethanol. Ultraviolet (UV) spectrophotometer was used to determine the concentration of WT oil by measuring its absorbance at 266 nm.[29]

Development of gel

To make the gel base, carbopol 934 was stirred into water until it swelled and formed a uniform gel. This base was mixed with a solution to create the final homogeneous gel.[30,31] Composition of *Wrightia tinctoria* oil-based gel has been shown in Table 1.

Development of WT oil-based emulsion and loading into gel

The spontaneous method is the simplest way to prepare an emulsion. In this method, the emulsion mixture is stirred directly to create a uniform mixture. All the ingredients were weighed accurately. First, mix WT oil with span 20 and liquid paraffin to form the oil phase. Then, vortex the mixture and add the surfactant propylene glycol and co-surfactant. Finally, 20 mL of water was added with constant stirring to obtain a perfect emulsion. To produce an emulgel, a measured amount of gelling reagent was dissolved in water to create the base of the gel.[32] Then, it was gradually mixed with the emulsion by magnetic stirrer for 5 min at 700 rpm to get a uniform emulgel. The details of the specific compositions of WT oil-based emulgel are shown in Table 2.

Table 1: Composition of *Wrightia tinctoria* oil-based gel

Constituents	F1	F2	F3	F4	F5	F6	F7
Carbopol 934 (g)	1.00	1.50	1.00	1.50	1.00	1.50	1.00
Ethanol (mL)	2.00	2.50	2.00	2.50	2.00	2.50	2.00
Water (mL)	q.s	q.s	q.s	q.s	q.s	q.s	q.s

Table 2: Composition of *Wrightia tinctoria* oil-loaded emulgel

Composition	F1	F2	F3	F4	F5	F6	F7
Wrightia tinctoria oil	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Liquid paraffin	1.50	2.00	1.50	2.00	1.50	2.00	1.50
Methanol	0.75	1.00	0.75	1.00	0.75	1.00	0.75
Span 20	0.25	0.30	0.25	0.30	0.25	0.30	0.25
Propylene glycol	1.25	1.50	1.00	1.25	1.50	1.00	1.25
Tween 80	0.25	0.30	0.25	0.30	0.25	0.30	0.25
Water	q.s	q.s	q.s	q.s	q.s	q.s	q.s

Characterization of emulgel

Physical appearance

The emulgel formulations were visually assessed for physical appearance, color, and consistency. The formulation exhibiting desirable results underwent further examination and characterization.[33]

pH determination

The pH values were measured using a calibrated meter at room temperature. 1 g of emulgel was distributed in 100 mL of distilled water. Digital pH meter was used to determine the dispersion's pH value.[34]

Viscosity measurement

The cone and plate viscometer with spindle seven was used to determine the viscosity of batches. Temperature was maintained at 25°C using a thermostatically controlled water flow.[35,36]

Spreadability determination

The spreadability apparatus is a device which specifically designed to measure the spreadability of transdermal preparations. 1g of emulgel was taken with the combination of two horizontal glass slides (25 × 25 cm), 500 g load was applied for a minute and spreadability was calculated using the formula Spreadability = Mass (g) × Length (cm)/Time (s).[37]

Centrifugation test

To evaluate stability, emulgel formulations undergo a centrifugal test. Both formulations were subjected to 5000 rpm for 10 min at 25°C. After the process, the products are visually inspected for signs of phase separation or creaming.[38]

Particle size, polydispersity index (PDI), and zeta potential

The particle size, PDI, and zeta potential are crucial factors to consider when assessing the quality of a WT oil-based emulgel. Therefore, a dynamic light scattering instrument was used to investigate these vital parameters after diluting the compositions over 100 times with distilled water to ensure accurate results. The light scattering was evaluated at 90° room temperature for optimal performance. Laser Doppler electrophoresis also measures the zeta potential after vigorous mixing and a 200-fold dilution in distilled water.[30,39]

Fourier transform infrared spectroscopy (FTIR) studies

FTIR spectroscopy was conducted to evaluate the medication's interaction and compatibility with other ingredients. A spectrometer was used to observe FTIR spectra of WT oil and excipients mixed with potassium bromide. The analysis used transmission mode scanning with wavenumbers ranging from 4000 to 400 cm^{-1}.[40]

Drug content

1 g of emulgel was dissolved in 10 mL of methanol. The resulting solution was diluted as required and its absorbance majored by UV spectrometer. Lupeol was selected as a marker compound for the quantitative analysis of WT oil in the formulation. The calibration curve was plotted at different concentration of marker compound at the wavelength of 255 nm. Drug content = (concentration × dilution factor × volume taken) × conversion factor to find the amount of drug present in each formulation. Choose the formulation with the most drug content for further examination and characterization.[41]

In vitro drug release study

Drug release was studied using Franz diffusion cells using egg membranes. 1 g of formulation was applied to the membrane and clamped between the donor and receptor chambers. The medium used was 200 mL of 25% methanol phosphate buffer at pH 7.4, warmed and stirred at 37 ± 1°C and 100 rpm. Samples were taken and replaced with fresh medium at fixed intervals and analyzed at 255 nm using a UV spectrophotometer.[42]

Stability studies

Stability assessments evaluated the physicochemical properties of WT oil-based products. Gel and emulgel formulations were stored for 3 months at 4°C and 25°C with 60% relative humidity. Physical analysis was conducted to evaluate the samples.[31]

Determination of *in vitro* antipsoriatic effect of extract on cultured human epidermal keratinocyte (HaCaT) cell line

3-(4, 5-dimethylthiazolyl-2)-2, 5-diphenyltetrazolium bromide (MTT) assay was used to determine cell viability in HaCaT cells. WT oil-based emulgel was used for this purpose. The cells cultured of Dulbecco Eagle medium supplemented with heat-activated fetal bovine serum using 10% (v/v). The cells were maintained at 37°C with a CO_2 concentration of 5% and harvested by trypsinization technique. In every 3 days, the growth media was replaced. The experiment showed that WT oil-based emulgel accurately determined cell viability in HaCaT cells.[43,44]

Statistics

Data presented as mean values with standard deviation, based on $n = 3$. The statistical analysis was conducted using GraphPad Prism 5 software. The data have been expressed as mean ± standard error mean. A one-way analysis of variance (ANOVA), followed by post-Dunnett's analysis, was performed. Significance was determined at $P < 0.05$.

RESULTS

GC/MS analysis

In GC/MS analysis, the hydrodistillation of the analysis of WT oil, greenish oil was obtained with a yield of 0.29% (w/w). Chromatograms of the GC-MS analysis of WT oil are shown in Figure 1. The list of identified components including their retention time and relative percentages is shown in Table 3.

Screening and selection of different surfactants and co-surfactants

The solubility of WT oil has been extensively investigated across various mediums such as surfactants and co-surfactants. Moreover, among the surfactants tested, tween 80 has shown remarkable potential for enhancing the solubility with WT oil compared to other surfactants, as illustrated in Figure 2a. In addition, the use of propylene glycol as a co-surfactant has been discovered to significantly increase the solubility with WT oil, as indicated in Figure 2b.

Physical appearances

The transdermal WT oil-based emulgel was meticulously evaluated for its physical properties, such as color, consistency, and homogeneity. The result is an off-white color emulgel that boasts excellent uniformity and consistency, providing a smooth and even application. The emulgel does not produce unpleasant odor or oily residue, after a month of development, WT oil-based emulgel formulation showed no signs of change or deterioration, proving to be a reliable and long-lasting product.

Measurement of pH

The WT oil-based emulgel pH value was found to be 6.1 ± 0.578, ensuring that it is safe for use and will not cause skin irritation.

Viscosity measurement

Viscosity is crucial for the stability of any composition. Brookfield viscometer was used to measure the viscosity of formulations. The produced topical optimization formulations were assessed, as shown in Table 4.

Spreadability

The spreadability of optimization formulations was determined by their "slip" and "drag" qualities, which are crucial for drug absorption and penetration through the skin. Table 4 displays the results of these qualities. Emulgel should be easily spreadable, improving patient compliance.

Percentage entrapment efficiency

The encapsulation efficiency of optimization formulation was studied with varying initial amounts of essential oil. Results showed the % entrapment efficiency was found to be 60.67 ± 7.56%, indicating successful entrapping of a relatively high amount of WT oil in the emulgel.

Centrifugation test

After conducting the visual centrifugation test, it was confirmed that all formulation batches were stable. No phase separation was observed, indicating excellent stability.

Particle size, PDI and zeta potential

The formulation (F4) was optimized based on particle size, zeta potential, and PDI which resulted in a stable dispersion with a smaller globular size. The results of each formulation are shown in Table 5.[45] Zeta potential and globule size of the optimized formulation have been depicted in Figure 3a and b.

FTIR studies

In FTIR studies, WT oil-based emulgel of optimized formulation is shown in Figure 4a and WT oil is shown in Figure 4b.

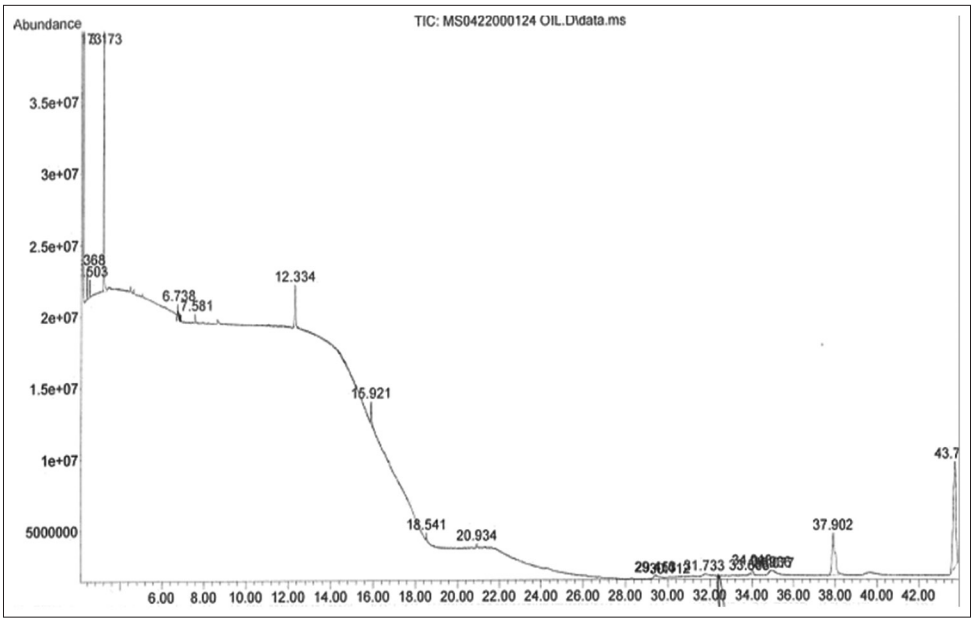

Figure 1: Chromatograms of the Gas chromatography-mass spectrometry analysis of *Wrightia tinctoria* oil

Table 3: Chemical composition of the essential oil of *Wrightia tinctoria*

Peak	Retention time (time)	Components	Peak area %
1	2.173	1-Pentene 1-hexene	42.21
2	2.368	Ethylene oxide urethane	0.07
3	2.505	3-Hydroxy-4-methylpent-4-enenitrile	0.120
4	3.173	Toluene	34.12
5	6.738	Acetamide	0.55
6	7.581	Ethylene oxide	0.26
7	7.234	Lupeol	1.77
8	5.99 1	N-(3-Methylbutyl) acetamide	0.85
9	18.541	1-Heptadecanamine	0.20
10	20.934	Acetaldehyde	0.34
11	29.410	Cystine	0.06
12	29.453	1-(1-adamantyl)-3-[4-(4-fluorophenoxy) butyl] urea	0.05
13	30.112	2-Ethylacridine	0.04
14	31.723	Trimethyl-(3-trimethylsilylphenyl) silane	0.06
15	33.880	Tetrasiloxane, decamethyl-	0.10
16	34.712	3-Methylcaprolactam	0.40
17	34.936	Tetrasiloxane	0.16
18	35.077	Carvacrol	0.05
19	37.902	N-(4-chlorophenyl)-3-(3,4-dihydro-2H-quinolin-1-yl) propanamide	5.64
20	43.731	Decanoic acid, 1,2,3-propanetriyl ester	12.56

Drug content

The drug content of each formulation of WT oil-based emulgel has been listed in Table 6. The formulation code F4 indicates higher drug content compared to other formulations.

In vitro release study

WT oil-based emulgel of released formulation is 94.89 ± 0.51% (F2) showed lower release and 98.87 ± 1.15% (F4) showed higher release at 10-h period, as shown in Figure 5 and Table 7.[46]

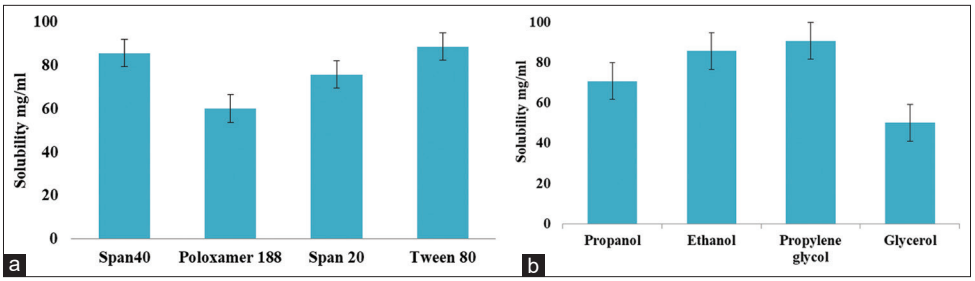

Figure 2: (a) Solubility of *Wrightia tinctoria* oil in surfactants, (b) Solubility of *Wrightia tinctoria* oil in co-surfactants

Table 4: Viscosity, spreadability, entrapment efficiency, and pH of *Wrightia tinctoria* oil-based emulgel (mean±standard deviation, *n*=3)

Formulations	Viscosity (cp)	Spreadability	Entrapment efficiency (%)	pH
F1	89,244±438	1.761±0.18	56.43±0.21	6.5±0.44
F2	86,489±675	2.203±0.56	54.33±0.89	6.1±0.73
F3	90,174±267	2.241±1.34	51.21±1.35	6.2±0.78
F4	94,374±198	2.943±0.45	60.67±7.56	6.1±0.578
F5	91,500±832	1.901±0.12	55.53±0.76	6.4±0.467
F6	85,233±345	2.267±0.88	49.89±1.12	5.5±0.34
F7	90,394±437	1.802±0.79	57.59±0.89	6.3±0.48

Table 5: Particle size, polydispersity index, and zeta potential of *Wrightia tinctoria* oil-based emulgel (mean±standard deviation, *n*=3)

Formulations	Particle size	PDI	Zeta potential
F1	3516±1.25 nm	1.20±0.67	−6.89±1.23 V
F2	3078±0.87 nm	0.9±0.89	−2.78±0.88 V
F3	4123±1.87 nm	0.5±1.45	−0.76±0.35 V
F4	3218±1.24 nm	1.00±0.89	0.0175±1.78V
F5	4056±0.27 nm	1.25±1.68	−14.1±1.89 V
F6	5123±1.68 nm	0.89±0.78	−9.2±0.76 V
F7	6234±0.43 nm	1.50±1.45	0.25±1.23 V

Table 6: Drug content of various formulation of emulgel (mean±standard deviation, *n*=3)

S. no.	Formulation	Drug content in emulgel (%)
1.	F1	89.5±1.56
2.	F2	93.8±0.67
3.	F3	85.7±1.56
4.	F4	98.3±0.89
5.	F5	96.2±0.67
6.	F6	89.67±1.45
7.	F7	95.98±1.23

Stability studies

The optimized formulation underwent rigorous 3-months testing at 60% relative humidity and temperatures of 4°C and 25°C, with the results showed in Table 8.

Determination of *in vitro* anti-psoriatic effect of extract on cultured HaCaT cell line

The IC_{50} value was found to be 89.64 ± 15.44 µg/mL and 84.72 ± 12.34 µg/mL WT oil and its emulgel, respectively. The result indicated that a concentration of 6.25 µg/mL was not able to reduce the cell viability significantly as compared to untreated cells. However, on increasing the concentration of WT oil, least significant reduction in the cell viability is shown in Figure 6a. Thus, indicated anti-proliferation effect against the HaCaT cell line and hence, it could be effective for the treatment of psoriasis. Furthermore, WT emulgel also showed a significant reduction in the cell viability at concentration from 12.5 µg/mL to 100 µg/mL showed in Figure 6b. In null hypothesis, mean percentage cell viability of all treated groups is not significantly differing while alternative hypothesis indicated a significant difference in the mean percentage cell viability among the groups. The ANOVA results rejected the null hypothesis. Therefore, there is a significant difference between ****$P < 0.01$ versus the control untreated group.

DISCUSSION

In GC/MS analysis, the oil was subjected to GC-MS analyses, which resulted in the detection of 20 components, exhibiting 100% of the complete oil. Chromatograms of the GC-MS analysis of WT oil are shown in Figure 1. The list

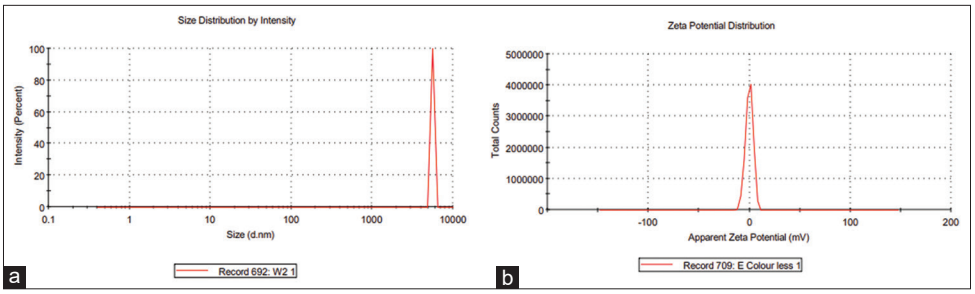

Figure 3: (a) Particle size of optimized formulation, (b) Zeta potential of optimized formulation

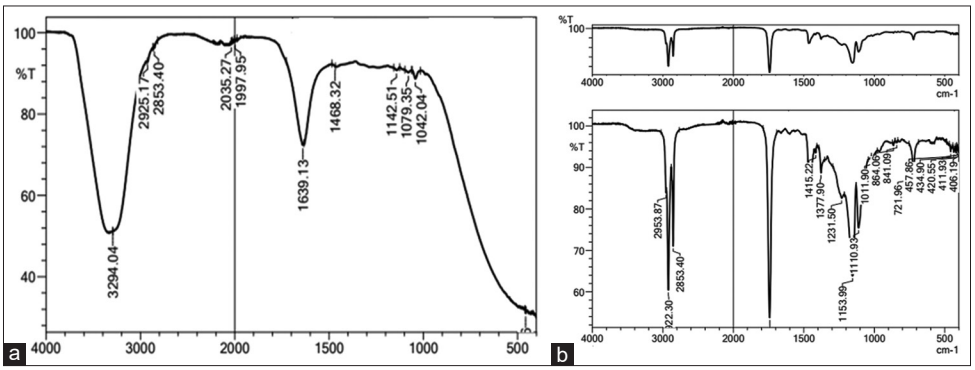

Figure 4: (a) Fourier transform infrared spectroscopy spectra of *Wrightia tinctoria* oil-based emulgel of optimized formulation, (b) Fourier transform infrared spectroscopy spectra of *Wrightia tinctoria* oil

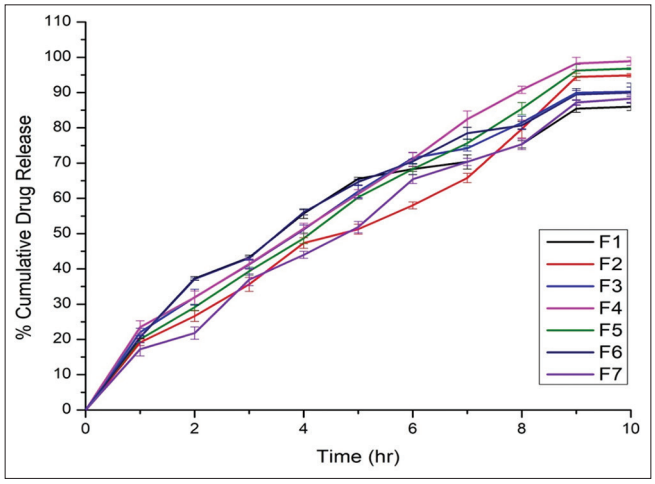

Figure 5: Percentage cumulative drug release of *Wrightia tinctoria* oil-based emulgel

of identified components, including their retention time and relative percentages. In Table 3, the oil was characterized by relatively high content of carbonic acid, eicosyl vinyl ester representing 14.84% of the oil. 1-bromotridecane (12.94%) and piperidinone (9.59%) are the main active constituents of the oil. Furthermore, heptane (7.07%), dihydroandroaterone (5.29%), and tricosaze (5.37%) were found to be predominant monoterpenes in WT oil. As far as our literature survey could ascertain, one report on the chemical composition of WT essential oil has been previously reported.[47] In Table 3, the oil was characterized by the relatively high content of 1-pentene 1-hexene representing 42.21% of the oil. Toluene is the main active constituents of oil (34.12%). As far as our literature survey could ascertain, one report on chemical composition of WT essential oil has been previously reported. Decanoic acid, 1,2,3-propanetriyl ester (12.56%), N-(4-chlorophenyl)-3-(3,4-dihydro-2H-quinolin-1-yl) propanamide (5.64%), 3-hydroxy-4-methylpent-4-enenitrile (0.120%), acetamide (1.77%), N-(3-methylbutyl) acetamide (0.85%), ethylene oxide urethane (0.07%), acetamide (0.55%), 3-methylcaprolactam (0.40%), acetaldehyde (0.34%), 1-heptadecanamine (0.20%), ethylene oxide (0.26 %), tetrasiloxane (0.16%), tetrasiloxane, decamethyl (0.10%), cystine (0.06%), trimethyl-(3-trimethylsilylphenyl) silane (0.06%), 1-(1-adamantyl)-3-[4-(4-fluorophenoxy) butyl] urea (0.05%), carvacrol (0.05%), 2-ethylacridine (0.04%). In Screening and selection of different surfactants and co-surfactants, non-ionic surfactants such as Tween 80 are widely used in topical nanoemulsion. These findings can have a significant impact on the development of new and effective formulations for WT oil-based products. Using the appropriate combination of surfactants and co-surfactants, a safe and effective nanoemulsion can be developed to enhance the bioavailability and efficacy in WT oil. FTIR analysis was conducted to investigate the possible conflict between WT oil and other inactive components used in the composition of the emulgel. The study revealed that WT oil is a rich source of keto and enol functional groups at the peak of 1639.13 cm^{-1}, the peak of 1468.32 cm^{-1} showed the presence of O-H bending and carboxylic acid functional groups, and the peak of 1142.51 cm^{-1} showed the presence of C-O stretching and aliphatic ether functional groups. These properties make WT oil a highly effective and versatile ingredient in the formulation of emulgel. Refer to Figure 4a

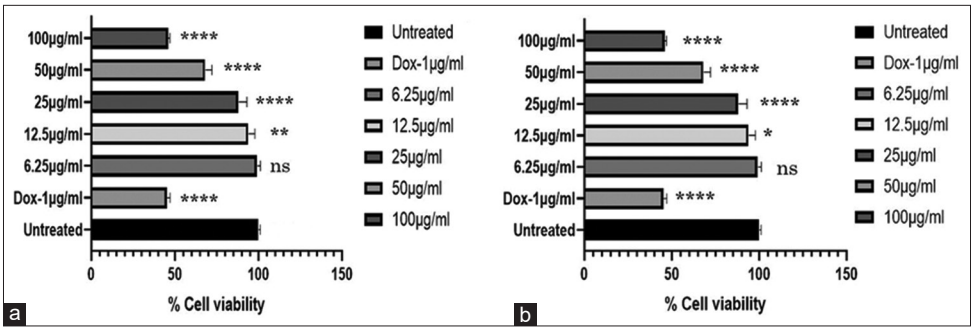

Figure 6: (a) Overlaid bar graph showed the % cell viability values of human epidermal keratinocyte cell lines treated with different concentrations of *Wrightia tinctoria* oil by 3-(4, 5-dimethylthiazolyl-2)-2, 5-diphenyltetrazolium bromide study. Data are presented as mean ± standard error mean (n = 3). ****P < 0.001 versus the control group,(b) Overlaid bar graph showed the % cell viability values of human epidermal keratinocyte cell lines treated with different concentrations of emulgel by 3-(4, 5-dimethylthiazolyl-2)-2, 5-diphenyltetrazolium bromide study. Data are presented as mean ± standard error mean (n = 3). ****P < 0.001 versus the control group

Table 7: *In vitro* release study of various formulation of emulgel (mean±standard deviation, n=3)

Time	F1	F2	F3	F4	F5	F6	F7
0	0	0	0	0	0	0	0
1	20.68±0.39	19.18±0.94	22.06±1.10	23.49±1.82	20.07±1.01	20.68±0.39	17.23±1.93
2	37.3±0.56	26.59±1.50	31.97±2.26	31.89±1.84	29.1±0.85	37.11±0.28	21.82±1.74
3	43.23±0.71	35.62±2.01	41.23±1.19	41.42±1.44	39.33±1.15	43.05±0.43	36.91±1.66
4	55.66±1.33	47.33±1.52	51.18±1.28	51.45±1.50	48.67±1.53	56.05±0.73	43.99±1.01
5	65.57±0.38	51.27±1.42	61.93±1.70	61.26±1.22	60.33±0.58	64.67±0.84	51.87±1.62
6	68.34±0.68	58.01±1.01	71.44±1.50	71.11±1.93	68.33±1.53	70.45±0.68	65.45±1.22
7	70.34±2.01	65.78±1.31	74.18±0.74	82.45±2.31	75.67±1.17	78.45±1.73	70.35±1.00
8	75.34±1.01	79.67±2.52	81.48±1.78	90.76±1.02	85.45±1.70	80.67±1.13	75.34±1.53
9	85.45±1.06	94.45±1.02	89.97±0.61	98.24±1.73	96.23±1.69	89.45±1.69	87.16±0.77
10	85.95±1.04	94.89±0.51	90.22±1.35	98.87±1.15	96.78±0.26	89.98±2.74	88.25±1.09

Table 8: Stability study of various formulation of emulgel (mean±standard deviation, n=3)

Properties	Temperature	WToil-based emulgel
Color and homogeneity	4°C	off-white and homogenous
	25°C	off-white and homogenous
pH	4°C	6.1±0.233
	25°C	6.1±0.578
Viscosity (cp)	4°C	94,374±198
	25°C	93,894±677
Spreadability (mm)	4°C	2.943±0.45
	25°C	2.854±0.34
Centrifugation test	4°C	No phase separation
	25°C	No phase separation
Drug content	4°C	95.8±0.79%
	25°C	98.3±0.89%

for a clear illustration of the results. The FTIR spectra graph in Figure 4b reveals the impressive complexity of WT oil. Its spectrum is a testament to the many functional groups present within the oil. The peak at 1415.22 cm^{-1} indicates both keto and enol functional groups, while the peak at 1377.90 cm^{-1} suggests the presence of O-H bonding and carboxylic acid functional groups. In addition, the peak at 721.96 cm^{-1} indicates C-O stretching and aliphatic ether functional groups. The richness of WT oil molecular composition is genuinely remarkable. Remarkably, all the drug peaks were found in the nanoemulsion formulation, which indicates that the drug is entirely intact in the formulation, and there are no potential interactions between the drug and the formulation ingredients. This is a significant achievement demonstrating the nanoemulsion formulation's robustness and stability. The formulation (F4) was optimized based on particle size, zeta potential, and PDI was found to be 3218 ± 1.24 nm, 0.0175 ± 1.78 V, and 1.00 ± 0.89, respectively, which resulted in a stable dispersion with a smaller globular size. *In vitro* release study, optimized formulation showed a higher release 98.87 ± 1.15% (F4) as comparison to other formulations at 10 h which is shown in Figure 6. *In vitro* HaCaT cell line, the result showed no significant difference between the WT oil and its emulgel. Thus, suggested no loss of anti-proliferation activity of WT oil on formulation in emulgel.

CONCLUSION

WT is a medicinal plant with diverse pharmacological properties. Some of its chemical constituents have anti-cancer, anti-HIV, and anti-diabetic (type 2) effects. In recent years, traditional hydrogels have been losing their effectiveness in combating bacteria due to increased antibiotic resistance. This has led to a rise in demand for natural and cost-effective solutions, such as gel-based formulations, WT a herb with excellent anti-inflammatory properties and anti-psoriatic activity, is the main active ingredient in this study. The researchers aimed to develop an herbal emulgel for managing psoriasis by WT oil as the active ingredient. WT oil-based emulgel has undergone a series of rigorous tests and evaluations, which include physical properties, pH, viscosity, encapsulation efficiency, and *in vitro* release. The results have demonstrated its remarkable colloidal stability, high encapsulation efficiency, and biocompatibility with HaCaT, making it a strong candidate for combating psoriasis. The emulgel also exhibited potent anti-inflammatory properties, making it a better alternative to pure oil due to its small particle size and large surface area that enhances its interaction with inflammation. This study introduces a new, cost-effective topical emulgel solution containing WT that can potentially treat psoriatic skin. The research also opens fresh avenues for further studies on the mechanisms of action of WT in the treatment of skin infections like psoriasis.

ACKNOWLEDGMENT

The authors acknowledge the GLA University, Mathura for providing PriyankaJurel with a fellowship and the required resources. The authors additionally thank the Sophisticated Analytical Instrumentation Facility at Jamia Hamdard, New Delhi for providing the appropriate instrumental facilities.

CONSENT FOR PUBLICATION

None

AUTHOR'S CONTRIBUTION

All authors have an equal contribution.

REFERENCES

1. Sarac G, Koca TT, Baglan T. A brief summary of clinical types of psoriasis. North Clin Istanb 2016;3:79-82.
2. Urban K, Chu S, Giesey RL, Mehrmal S, Uppal P, Delost ME, *et al*. Burden of skin disease and associated socioeconomic status in Asia: A cross-sectional analysis from the Global Burden of Disease Study 1990-2017. JAAD Int 2020;2:40-50.
3. Danielsen K, Olsen AO, Wilsgaard T, Furberg AS. Is the prevalence of psoriasis increasing? A 30-year follow-up of a population-based cohort. Br J Dermatol 2013;168:1303-10.
4. Harden JL, Krueger JG, Bowcock AM. The immunogenetics of psoriasis: A comprehensive review. J Autoimmun 2015;64:66-73.
5. Kimmel GW, Lebwohl M. Psoriasis: Overview and diagnosis. Evidence-Based Psoriasis 2018;16:1-16.
6. Merola JF, Tian H, Patil D, Richardson C, Scott A, Chen YH, *et al*. Incidence and prevalence of psoriatic arthritis in patients with psoriasis stratified by psoriasis disease severity: Retrospective analysis of an electronic health records database in the United States. J Am Acad Dermatol 2022;86:748-57.
7. Chalmers R, O'Sullivan T, Owen CM, Griffiths CE. WITHDRAWN: Interventions for guttate psoriasis. Cochrane Database Syst Rev 2019;4:CD001213.
8. Micali G, Verzì AE, Giuffrida G, Panebianco E, Musumeci ML, Lacarrubba F. Inverse psoriasis: From diagnosis to current treatment options. Clin Cosmet Investig Dermatol 2019;12:953-9.
9. Benjegerdes KE, Hyde K, Kivelevitch D, Mansouri B. Pustular psoriasis: Pathophysiology and current treatment perspectives. Psoriasis (Auckl) 2016;6:131-44.
10. Singh RK, Lee KM, Ucmak D, Brodsky M, Atanelov Z, Farahnik B, *et al*. Erythrodermic psoriasis: Pathophysiology and current treatment perspectives. Psoriasis (Auckl) 2016;6:93-104.
11. Sato Y, Ogawa E, Okuyama R. Role of innate immune cells in psoriasis. Int J Mol Sci 2020;21:6604.
12. Mosca M, Hong J, Hadeler E, Brownstone N, Bhutani T, Liao W. Scalp psoriasis: A literature review of effective therapies and updated recommendations for practical management. Dermatol Ther (Heidelb) 2021;11:769-97.
13. Bahadur S, Sharma M. Liposome based drug delivery for the management of psoriasis-A comprehensive review. Curr Pharm Biotechnol 2023;24:1383-96.
14. Rendon A, Schäkel K. Psoriasis pathogenesis and treatment. Int J Mol Sci 2019;20:1475.
15. Ghosh A, Sarkar A, Mitra P, Banerji A, Banerji J, Mandal S, *et al*. Crystal structure and DFT calculations of 3,4-seco-lup-20 (29)-en-3-oic acid isolated from *Wrightia tinctoria*: Stacking of supramolecular dimmers in the crystal lattice. J Mol Struct 2010;980:7-12.
16. Reddy MB, Reddy KR, Reddy MN. A survey of plant crude drugs of Ananthapur District, Andhra Pradesh, India. Int J Crude Drug Res 1989;27:145-55.
17. Suba Sri M, Subhashini M, Devi MK, Devi RJ, Usha R. Green synthesis of nanohydroxy apatite using *Calotropis procera* and *Wrightia tinctoria* plant latex serum extract for biomedical application. Biomass Convers Biorefinery 2023;16:1-5.
18. Delmas PD. Treatment of post-menopausal osteoporosis. Lancet 2002;359:2018-26.
19. Devi SL, Divakar MC. Pharmacognostical evaluation on

the leaves of *Wrightia tinctoria* (Roxb.) R. Br. Hygeia 2012;4:104-11.
20. AL-Hakiem MM, Mustafa AQ, Adnan R, Elias RS. Synthesis, characterization, and antibacterial activity study of novel curcuminoids derivatives. Iraqi J Pharm Sci 2024;33:154-62.
21. Cerulli A, Masullo M, Montoro P, Piacente S. *Wrightia tinctoria* (*Glycyrrhiza glabra*, *G. uralensis,* and *G. inflata*) and their constituents as active cosmeceutical ingredients. Cosmetics 2022;9:7.
22. Desai J, Patel R, Desai D. Investigation on potential of Karanjin loaded emulgel for improved efficacy against psoriasis. Ind J Pharm Educ Res 2023;57:393-400.
23. Malavi S, Kumbhar P, Manjappa A, Disouza J, Dwivedi J. Emulgel for improved topical delivery of tretinoin: Formulation design and characterization. Ann Pharm Fr 2022;80:157-68.
24. Chaturvedi S, Garg A. Development and optimization of nanoemulsion containing exemestane using box-behnken design. J Drug Deliv Sci Technol 2023;80:104151.
25. He E, Li H, Li X, Wu X, Lei K, Diao Y. Transdermal delivery of indirubin-loaded microemulsion gel: Preparation, characterization and anti-psoriatic activity. Int J Mol Sci 2022;23:3798.
26. Marwaha TK, Bhise K. Formulation development of anti-psoriatic topical babchi oil emulgel. Res Rev J Herbal Sci 2013;2:1-0.
27. Bhardwaj S, Gaur PK, Tiwari A. Development of topical nanoemulgel using combined therapy for treating psoriasis. Assay Drug Dev Technol 2022;20:42-54.
28. Adams RP. Identification of Essential Oil Components by Gas Chromatography-Mass Spectrometry. Vol. 4. Carol Stream, Ill, USA: Allured Publishing Corp; 2007.
29. Sarikurkcu C, Sabih Ozer M, Cakir A, Eskici M, Mete E. GC/MS evaluation and *in vitro* antioxidant activity of essential oil and solvent extracts of an endemic plant used as folk remedy in Turkey: *Phlomis bourgaei* Boiss. Evid Based Complement Alternat Med 2013;2013:293080.
30. Dantas MG, Reis SA, Damasceno CM, Rolim LA, Rolim-Neto PJ, Carvalho FO, *et al.* Development and evaluation of stability of a gel formulation containing the monoterpene borneol. ScientificWorldJournal 2016;2016:7394685.
31. Alam MS, Algahtani MS, Ahmad J, Kohli K, Shafiq-Un-Nabi S, Warsi MH, *et al*. Formulation design and evaluation of aceclofenac nanogel for topical application. Ther Deliv 2020;11:767-78.
32. Soliman WE, Shehata TM, Mohamed ME, Younis NS, Elsewedy HS. Enhancement of curcumin anti-inflammatory effect via formulation into myrrh oil-based nanoemulgel. Polymers (Basel) 2021;13:577.
33. Kakade P, Patravale V, Patil A, Disouza J. Formulation development of nanostructured lipid carrier-based nanogels encapsulating tacrolimus for sustained therapy of psoriasis. Int J Pharm 2014;660:124172.
34. Jaafer H, Al-Kinani KK. Formulation and evaluation of idebenone microemulsion as a potential approach for the transmucosal drug delivery systems. Iraqi J Pharm Sci 2024;33:79-88.
35. Khullar R, Kumar D, Seth N, Saini S. Formulation and evaluation of mefenamic acid emulgel for topical delivery. Saudi Pharm J 2012;20:63-7.
36. Said Dos Santos R, Bassi da Silva J, Rosseto HC, Vecchi CF, Campanholi KD, Caetano W, *et al.* Emulgels containing propolis and curcumin: The effect of type of vegetable oil, poly (acrylic acid) and bioactive agent on physicochemical stability, mechanical and rheological properties. Gels 2021;7:120.
37. Arora R, Aggarwal G, Harikumar SL, Kaur K. Nanoemulsion based hydrogel for enhanced transdermal delivery of ketoprofen. Adv Pharm 2014;2014:468456.
38. Burki IK, Khan MK, Khan BA, Uzair B, Braga VA, Jamil QA. Formulation development, characterization, and evaluation of a novel dexibuprofen-capsaicin skin emulgel with improved *in vivo* anti-inflammatory and analgesic effects. AAPS PharmSciTech 2020;21:211.
39. Mittal S, Ali J, Baboota S. Enhanced anti-psoriatic activity of tacrolimus loaded nanoemulsion gel via omega 3-Fatty acid (EPA and DHA) rich oils-fish oil and linseed oil. J Drug Deliv Sci Technol 2021;63:102458.
40. Agrawal M, Saraf S, Pradhan M, Patel RJ, Singhvi G, Ajazuddin, *et al.* Design and optimization of curcumin loaded nano lipid carrier system using Box-Behnken design. Biomed Pharmacother 2021;141:111919.
41. Abdallah MH, Elghamry HA, Khalifa NE, Khojali WM, Khafagy ES, Shawky S, *et al*. Development and optimization of erythromycin loaded transethosomes cinnamon oil based emulgel for antimicrobial efficiency. Gels 2023;9:137.
42. Alam MS, Ali MS, Alam MI, Anwer T, Safhi MM. Stability testing of beclomethasone dipropionate nanoemulsion. Trop J Pharm Res 2015;14:15.
43. Singh S, Aldawsari HM, Alam A, Alqarni MH, Ranjan S, Kesharwani P. Synthesis and antimicrobial activity of vancomycin-conjugated zinc coordination polymer nanoparticles against methicillin-resistant *Staphylococcus aureus*. J Drug Deliv Sci Technol 2022;70:103255.
44. Kadam SV, Magdum CS, Kane SR, Bhutkar MA, Randive DS, Bhinge SD, *et al*. Investigation of therapeutic potential of biosynthesized silver and gold nanoparticles using extract of *Wrightia tinctoria*. Nanosci Nanotechnol Asia 2024;14:56-68.
45. Iriventi P, Gupta NV. Development and evaluation of nanosponge loaded topical herbal gel of *Wrightia tinctoria*. Int J Appl Pharm 2020;15:89-95.
46. Mulye SP, Wadkar KA, Kondawar MS. Formulation development and evaluation of indomethacin emulgel. Der Pharm Sin 2013;4:31-45.
47. Khan N, Ali A, Qadir A, Ali A, Warsi MH, Tahir A, *et al*. GC-MS analysis and antioxidant activity of *Wrightia tinctoria* R.Br. Leaf extract. J AOAC Int 2021;104:1415-9.

Source of Support: Nil. **Conflicts of Interest:** None declared.