e-ISSN: 2249 – 7781
Print ISSN: 2249 – 779X

International Journal of Pharmaceutical Research & Analysis
www.ijpra.com

Research Article

FORMULATION AND EVALUATION OF A TRANSDERMAL FILM-FORMING GEL LOADED WITH TERBINAFINE

Alike. Naga Sri[1]*, Asha Jyothi P[2]

KLR Pharmacy College, Paloncha, Bhadradri Kothagudem, Telangana-507511, India.

ABSTRACT

The development and testing of a transdermal film-forming gel (TFFG) impregnated with terbinafine to treat superficial fungal infections including athlete foot, ringworm and onychomycosis. Terbinafine is an antifungal agent made synthetically, which is known to inhibit fungal growth, although, when administered orally, it usually results in other side effects such as liver toxicity and gastrointestinal disturbances. To address such concerns, a formulation of TFFG was designed with the purpose of delivering the drug to the site of infection and reducing systemic absorption and side effects. Hydroxypropyl methylcellulose (HPMC) and Eudragit polymers were used to prepare the gel in the presence of ethanol, as a penetration enhancer to ensure the absorption of the drug through the skin. Some of the properties that were considered in the development of the formulation include pH, viscosity, spreadability, drug content, drying time, film thickness and antifungal activity. The findings revealed that the gel had good uniformity in drug content (88.08% 97.14%), satisfactory spreadability (4.15 cm 5.78 cm) and controlled rate of release. Formulation F10 containing 15 percent Eudragit RS100 showed the most favorable sustained release and antifungal release, thus a potential contender in the treatment of chronic fungal infections. This is a safe and effective patient-friendly alternative to oral therapies.

Keywords: Transdermal drug delivery, terbinafine, film-forming gel, antifungal activity.

INTRODUCTION

Transdermal drug delivery systems (TDDS) are among the most topical innovations in pharmacological therapy since they provide active pharmaceutical ingredients (APIs) whose sequential and slow release into the blood overcomes the gastrointestinal tracts [1]. TDDS circumvents the gastrointestinal (GI) tract and first-pass hepatic metabolism of the older route of administration, through the gastrointestinal (GI) tract or by intravenous injection, eliminating the lower bioavailability of the active ingredient as well as the side effects of the latter. This allows the delivery of drugs with greater reliability in the long term, making patients more compliant and effectively treated, especially in chronic diseases. They are also called localized conditions, and they are especially helpful when the drug is used via TDDS since it is delivered at the location of the disease thus minimizing interaction with the entire organism and other undesirable side effects.

One such commonly used synthetic antifungal agent is terbinafine and could be effective in the treatment of superficial fungus infection like athlete foot, ringworm and onychomycosis [2]. It acts by inhibiting the fungus squalene epoxidase which is the key component in the production of the ergosterol that is one of the main components of the fungus cell membrane [3]. However, despite its usefulness, oral terbinafine may cause liver poisoning, gastrointestinal and taste alterations, especially during a course of more than several months. One potential resolution to this type of side effect is to use transdermal delivery of the drug; local therapy of the area of infection is administered and there is minimal absorption of drug in the system.

Corresponding Author

Alike. Naga Sri

Email: nagasrialike@gmail.com

Transdermal Film-Forming Gel (TFFG) for Terbinafine

One of the greatest advancements in drug delivery is the use of transdermal film-forming gels (TDFGs) which contain terbinafine [4]. Unlike other traditional creams or gels, TFFGs form a thin, flexible film on the skin that adheses well, and degrades the drug in a regulated and slow manner. This system makes it possible to treat them locally, though regular reapplications are not necessary to make patients more compliant. TFFGs are indicated for the treatment of superficial fungi because they release the drug slowly over time and minimize side effects associated with oral administration.

The lipophilic property of terbinafine presents a problem when formulation in transdermal systems is required; terbinafine is not dissolvable in water and readily penetrates the deepest layer of the skin, the stratum corneum. To counter this, ethanol or fatty acids are added to the formula to destabilize temporarily the skin barrier in order to increase the drug uptake. The gel matrix must also be optimized to ensure that the release of the drug is slow to prevent depletion of therapeutic levels in the site of infection over an extended period [5].

METHODOLOGY

Preformulation Studies

Determination of Solubility of Terbinafine

Solubility of the Terbinafine λ max was tested in various solvents according to the standard procedure.

Determination of λ max Terbinafine

Terbinafine can be successfully investigated spectroscopically by UV-Vis absorption and the wavelength of maximum absorbance (282 nm) is usually obtained. This is subject to slight variation due to the formulation or the media in which it is carried out; though perhaps 282 nm is considered to be the reputed standard wavelength maximum of the terbinafine absorbance in a UV spectrum. This 1 amber max plays an important role in attaining the concentration of terbinafine in the solution in the administration of a variety of steps involving analysis where such a 1 amber max is essential in the formation of the calibration curve in measuring the drug content.

Standard curve of Terbinafine

The above stock solution was taken in aliquots and diluted using phosphate buffer (pH 7.4) to get the concentrations of 2, 4, 6, 8, 10, 12, 14, 16, and 18 2. Absorbance of the solutions was taken at 282-nm and a graph was constructed on which concentration is placed at X-axis and at Y- axis absorbance.

Formulation of film forming gel

A high-speed homogenizer at 1500 rpm was used in the preparation of the gel. The dispersion of HPMC K100M was done in water in a beaker and allowed to settle undisturbed after one hour. Approximately 3 mL of ethanol was added and then terbinafine was dissolved at normal agitation and mixed completely with the HPMC dispersion. The film-forming polymer was subsequently dissolved in a sufficient quantity of ethanol which had been combined with the Polyethylene glycol previously and was put into the HPMC and the terbinafine dispersion. This mixture was slowly stirred until a homogenous mixture had been obtained. Propylene glycol was added to the dispersion of menthol and camphor (1:1 ratio mixed by dissolving in propylene glycol) by diluting it and mixing it well during two hours. The gel prepared was subsequently filled into a collapsible tube [6]. The table 1 contains the concentrations of the various batches of film forming gels.

Evaluation of Film Forming Gel

Properties of Gel

pH

The existing pH of the gel was determined utilizing an automated pH meter that was standardized by using a buffer solution (pH 7) prior to use. The value of pH of every formulation was determined in triplicates, and averages were calculated [7].

Viscosity

The formulated batches were assessed concerning their viscosity with Brookfield Viscometer and spindle 04. The test formulation was placed in a beaker and left to settle, in the measurement temperature of 25° ± 1°C over a 30 minutes period. The spindle was then pushed vertically into the middle of the gel making sure it does not touch the bottom of the beaker. The rate of spinning was set at 30 rpm and rotated 10 minutes. The reading of viscosity was taken and the mean of the three readings made during the 10 mins period was noted as the viscosity of the gel [8].

Spreadability

A sample of 100 mg was employed in a centre of a glass slide. A slide was then placed on top of the slide and when the two slides were placed in between the fingers a further expansion of the circle created by the gel between the two slides was not noticed. The size of the circle in circumference was measured using centimeters.

Drying time

In an evaluation of the drying time the formulation was placed on the glass slide. Then in 2 minutes time another slide of glass was put on top of the film with no pressure. In case there were no remains of a

liquid on the glass slide after the removal, the film was considered dry. In case any liquid stains could be seen through the glass slide the experiment was repeated until it was determined that the film was dry.

Drug content

A 100 ml volumetric flask was filled with 10 ml methanol and 10 mg equivalent of a gel was added into the flask and the volume was brought to the mark with methanol to get a concentration of 100 µg/ml. 0.5 ml was pipetted into a 10 ml volumetric flask and the vol. brought to 10 to 5 in methanol. Absorbance of the prepared solution was determined at 0 that is, 0 max with the help of UV visible spectro photometer.

Properties of film

To determine the film properties, the films were prepared by using the solvent evaporation method by pouring 1 ml of the preparations in a stainless-steel mould (with Teflon lining; 6 cm x 10 cm).

Drying of the films was done at room temperature (72 hours) (three hours under the open air to evaporate the ethanol) [9].

Bio adhesion test

It was acrylized by uniform film on the plate of the glass at room temperature within 24hr. Slicing of the film was done in parallel direction and also in perpendicular direction with scalpel (0.37mm thickness waver blade) in equal division of 1mm. Then, cellophane tape having a pressure-sensitive adhesive was pasted onto the film and finger was used as a smoothing device whilst leaving a strip of tape aside unadhered (free piece). In a few minutes, at 600 C angle, the gel film was pulled manually with holding the unadhered tape free end.

The number of squares on the film to adhere on to the tape was calculated and the percentage by which peel off is calculated by the formula.

$$Percentage\ peel\ of\ film = \frac{Initial\ squares\ of\ film - Final\ squares\ of\ film}{Initial\ squares\ of\ film} \times 100$$

Film thickness

Using a digital vernier caliper, the size of the films of the films cut into size of 10 x 40 mm and the thickness of the film was measured.

They were each measured out at five points (four corners and the center) and the average thickness was determined.

Film stickness

The dry film is pressed using low pressure cotton wool in order to know the stickiness of the same. The stickiness is also rated on basis of the extent of the cotton fiber captured by the film. The stickiness will be rated as a high score when there is thick layer of fibers on the film, medium when there is a thin layer of fibers on the film and poor when the adherence of the fibers on the film never or seldom happens. This is a key parameter of evaluation, because the devised cruelty is not supposed to be sticky to avoid sticking into the clothes of the patients.

Folding endurance

The prepared films were measured manually on the basis of folding endurance. A film (10 x 40 mm) was taken, and folded at the same point repeatedly, till it fractured. The position where the film was repeated to be folded a number of times before it breaks/cracks determined the value of folding endurance.

Weight Variation test

Each formulation used three film samples (10 x 40 mm) per film. The weight of each sample of films was determined and an average obtained.

Drug content of film

To obtain homogeneous solution, film was added to phosphate buffer solution (pH 5.8), 100 ml phosphate buffer solution and stirred well after 2 hours. In a period of 15 minutes, the whole solution was sonicated. The above solution was filtrated and spectrophotometrical drug was estimated at λ max.

Water vapour permeability

A technique based on that of British Pharmacopoeia was useful in determining the water vapor permeability (WVP). The movies were prepared by the process of solvent evaporation as discussed above. Scalpel was used to cut pieces of dry film sheets in circular shapes with a 2 cm diameter. The sample preparation took place with the use of 10-mL glass vials, the opening of which had outside diameter of 1.2 cm (A = 1.13 cm2), into which a quantity of approximately 3-mL of distilled water was placed and covered with the circular specimen of the films. The top of a vial was removed, and the weight of the vial was measured by using the analytical scale to begin the experiment. Each formulation was replicated into three and the vials were placed into desiccator containing desiccant so as to make low relative humidity environment (approximately 0 %). The vials were kept under uniform temperature at 37C and weighed after every 72 hours. The measure of the value of the water vapor permeability (WVP) as the value of the weight loss (W, in grams) of the vials identified the quantity of the water that passed through the film. It was related to the area (A, in cm 2) of the film and to the period (t, in hours) as the next formula:

WVP= W/ (A*t) (g cm^{-2} 24 hrs)

***In vitro* drug diffusion study**

The release profile of the drug through the film-forming gel was ascertained in a laboratory generated structure which looks like Franz diffusion cell. The

apparatus was created by two chambers that are donor and receptor compartments divided by diffusion membrane (egg membrane). The inner diameter of the donor compartment was 24 mm and it was mountaintained open at one end such that it was exposed to the atmosphere but the receptor compartment was in a form that permitted sampling.

The buffering agent was the phosphate buffer solution. The sample of the film-forming gel that contained the drug was 1 mL and it was placed in the donor chamber that was cut with the aid of the egg membrane and the receptor chamber. Phosphate buffer solution was pre-saturated with the egg membrane of 24 hour. A clamp was screwed to connect the receptor and the donor compartments. The donor box was cut such that the membrane around the egg got into contact with diffusion medium. All the cocktail was put into a magnetic stirrer. Next, 100 mL of phosphate buffer was left in the receptor compartment on a stirring temperature-controlled magnetic stirrer under constant temperature of 37 0.5 Celsius degrees and constant stirring of 50 rpm. Samples (1 mL) of solutions in the receptor compartment were taken at fixed time intervals and their drug contents remarked with UV spectrophotometer at λ max after placing in blocks. The amount of fresh phosphate buffer that was added to the receptor phase after any sample tap was taken was the same.

Anti- fungal activity

Agar diffusion was used when assessing the antifungal activity of the formulations. Medium was added to standard Petri dishes (7.5 cm) until level 0.5 cm. The plenty of the lots was verified prior to use. The inoculum was done by inoculating 1-2 colony of Candida albicans (NCIM no. 3102) on 24-hour cultures in Sabouraud broth into tubes with 10 mL sterile saline and diluted in saline. One-half milliliter of the inoculum was poured onto the surface of the agar and mixed uniformly. Formulation was put on the plates after drying at 35°C in 15 minutes. Agar bores of 0.5 cm diameter were punched into the agar and 20 µL of the formulation (1 per cent w/v) were added to each bore. Following a 2 days incubation period in 35°C, the plate was measured at the bore of inhibition.

RESULTS AND DISCUSSION

RESULTS

Preformulation study

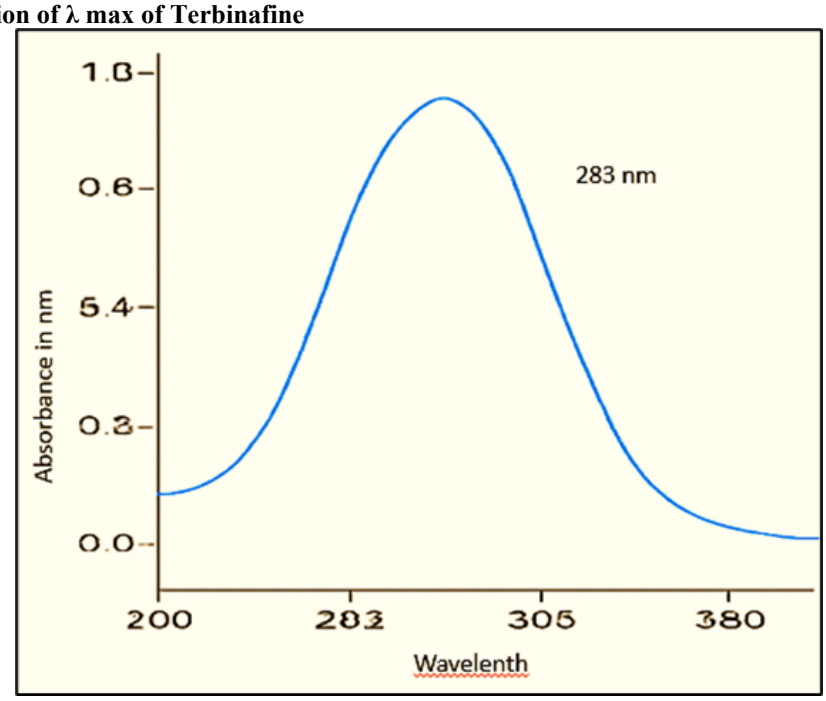
Solubility studies

The Terbinafine solubility was considered in different solvents and it was noted that a drug showed superior solubility in methanol than other solvents.

Determination of wavelength

The absorbance of Terbinafine was obtained at UV spectrophotometer at dilutions of the drug (10 2g/ml) in phosphate buffer pH 7.4, in the range of 200 nm-400 nm. The absorption maximum was determined at 282 nm when maximum absorbance was attained thus establishing the absorption maximum of the drug. Figure 1 demonstrates the activity.

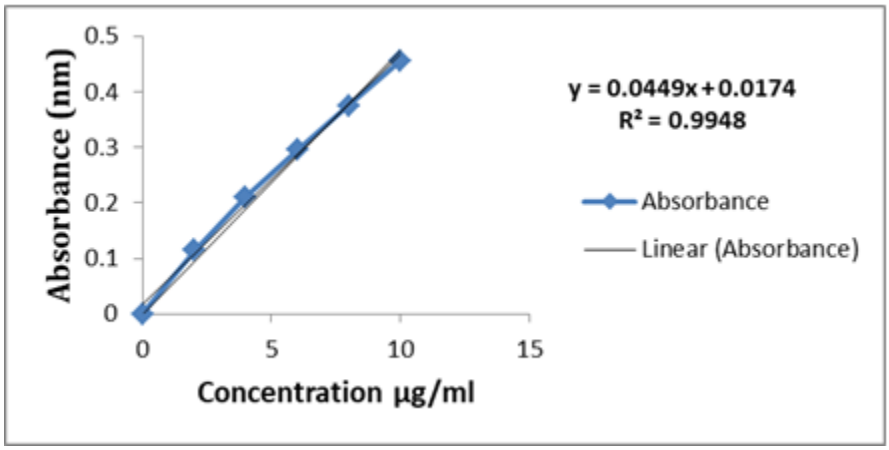
Figure 1: Determination of λ max of Terbinafine



Preparation of calibration curve

Calibration of the Terbinafine was done by weighing 100 mg of the pure drug accurately then dissolved in methanol to make an up of 100 mLs, labeled Stock-A. Stock-A was diluted 10 mL to 100 mL phosphate buffer (pH 7.4) to give Stock-B. A number of dilutions were then made with Stock-B, which included; 2, 4, 6, 8 and 10 6g/mL. The regression came out to be 0.9998. Figure 2 shows the calibration curve.

Figure 2: Calibration curve of Terbinafine



Formulation of Terbinafine Film Forming GEL

The formulation was considered to be a film-forming gel where HPMC 100M was considered to be the gelling agent, whereas Eudragit RS100 and Eudragit RL100 were used as the polymers of film formation. They fabricated the gels in ethanol employing the dispersion technique. To have different concentrations of the film-forming polymer, ten various batches of the gels were made. Figure 3 represents prepared gel. The characterization of all the formulations was carried out in terms of gel and film characterization, drug diffusion in vitro analysis to ascertain the best formulation.

Figure 3: Terbinafine film forming gel

Evaluation of film forming gel

pH, Spreadability, Drying time

Table 1 shows pH value of the film-forming gel formulations. pH was analyzed to be 5.3- 6.1. The formulation is also safe to apply as this pH is near normal pH of skin, hence, it does not result in tissues irritation.

Spreadability test indicated that the gels spread out to a distance of between 4.15cm and 5.78 cm, depending on the spreadability of the gel.

Drying time or time to form film is indicated in table 8.4. As a means of reducing pain on the patients, film forming gel ought to dry fast on the skin leaving a thin film. All the formulations produced a satisfactory range of results.

Table 1: pH, Spreadability, Drying time

S.no	Formulation code	pH	Spreadability diameter (cm)	Drying time
1	F1	5.7±0.019	5.15±0.05	5mins 28secs±12secs
2	F2	5.5±0.10	4.15±0.05	5mins 45 secs±41secs
3	F3	5.3±0.009	4.64±0.04	6mins 05 secs±45secs
4	F4	5.9±0.012	4.75±0.25	4mins 15 secs±14secs
5	F5	5.6±0.10	5.54±0.21	4mins 49 secs±41secs
6	F6	5.73±0.009	5.65±0.05	5mins 15 secs±14secs
7	F7	5.21±0.09	5.23±0.25	5mins 51 secs±40secs
8	F8	5.5±0.06	4.88±0.25	6mins 25 secs±41secs
9	F9	5.9±0.1	4.96±0.15	4mins 21 secs±40secs
10	F10	6.1±0.05	5.78±0.25	4mins 15 secs±22secs

Drug content of gel, Viscosity

As per table 2, the drug content in the formulation of the film forming gel is between 88.08% to 97.14% which implies that there is consistent spread of the drug in the gel formulation.

Brookfield viscometers were applied so as to test the viscosity of formulated solutions. Viscosity of the formulas F1 to F10 is represented in the table.

Table 2: Drug content of gel, Viscosity

S.no	Formulation code	Drug content	Viscosity
1	F1	90.14%	11500
2	F2	93.48%	11650
3	F3	95.25%	11800
4	F4	92.63%	11960
5	F5	96.10%	12200
6	F6	96.34%	11700
7	F7	89.38%	11940
8	F8	95.47%	12300
9	F9	88.08%	12600
10	F10	97.14%	12900

Evaluation of film properties

Weight variation test, Film thickness, Film stickness

On the films, a weight variation test was carried out. The results have been summarized in Table 3. The difference of weight between the films was between 0.0301g and 0.052g. The weight of the film also increased with increasing proportion of polymer concentration.

The formulations were able to create a spectrum of formulations up to 0.023mm thick or up to 0.061mm. As the concentration of polymer increased, the film thickness rose because of using increased amount of polymer.

All formulations are shown in table for their outward stickiness, which is a measure of the overall stickiness.

Table 3: Weight variation test, Film thickness, Film stickness

S.no	Formulation code	Weight variation (g)	Film Thickness (mm)	Film stickness
1	F1	0.0418±0.03	0.022±0.01	Fair
2	F2	0.0432±0.03	0.038±0.02	Good
3	F3	0.0437±0.04	0.042±0.01	Fair
4	F4	0.0481±0.01	0.053±0.01	Good
5	F5	0.0512±0.03	0.065±0.01	Good
6	F6	0.0471±0.03	0.028±0.01	Good
7	F7	0.0345±0.03	0.037±0.01	Good
8	F8	0.0394±0.03	0.046±0.01	Fair
9	F9	0.0435±0.03	0.059±0.01	Good

10	F10	0.0301±0.03	0.061±0.01	Good

Drug content of film, Folding endurance

The contents of all formulations were tested in a uniform manner and the particulars of the same are presented in the Table. 8.10. Each formulation was analyzed by spectrophotometry to get its drug content. The film contained terbinafine with an amount between 87.76 to 95.81%.

The propensity to resist rupture is gauged in terms of folding endurance which the film is able to resist. A film that has greater folding endurance is not likely to burst. Endurance values on the range of folding were between 10 -20.

Table 4: Drug content of film, Folding endurance

S.no	Formulation code	Drug content	Folding endurance
1	F1	89.74%	13
2	F2	92.75%	10
3	F3	95.02%	14
4	F4	91.54%	16
5	F5	95.65%	19
6	F6	93.73%	18
7	F7	88.67%	16
8	F8	95.13%	18
9	F9	87.76%	14
10	F10	95.81%	20

Bioadhesion test, Water permeability

Bioadhesion of the film deposited during drying must be adequate to allow the film to stick on the skin throughout 24 hours. Results of the bioadhesion test are shown in Table 5.

The outcome of the permeability tests of the film to water vapour. Range of water vapour permeability was also recorded to be 0.015 g to 0.036 cm/h. Films with water vapour permeability of more than 0.05 g/cm/h may be deemed as non-occlusive because the water vapour can permeate through the films.

Table 5: Bioadhesion test, Water permeability

S.no	Formulation code	%Peel off	Water vapour permeability (g/cm/h)
1	F1	4	0.031
2	F2	4	0.036
3	F3	7	0.025
4	F4	9	0.019
5	F5	9	0.016
6	F6	4	0.035
7	F7	4	0.015
8	F8	9	0.033
9	F9	0	0.028
10	F10	0	0.015

***In vitro* drug – diffusion study**

In the studies, we discovered that the Film Forming gel drugs will be released within 12 hours. *In vitro* drug diffusion test carried on a topical gel prepared. The figures 4 and 5 show the graphical representation of in vitro diffusion study of drug topical gel. With the formulations F1 to F5, Eudragit RL100 raises the percentage of drug release as the polymer concentration is also raised. Films that involve Eudragit RS 100 on the other hand have lower percentages of the release of the drug and the higher level of the polymer and have a prolonged release into the medium. Formulation F10 with a proportion of 15 percent of Eudragit RS100 was selected as the most suitable formulation in the determination of long term drug delivery.

Figure 4: *In vitro* drug diffusion study (F1-F5)

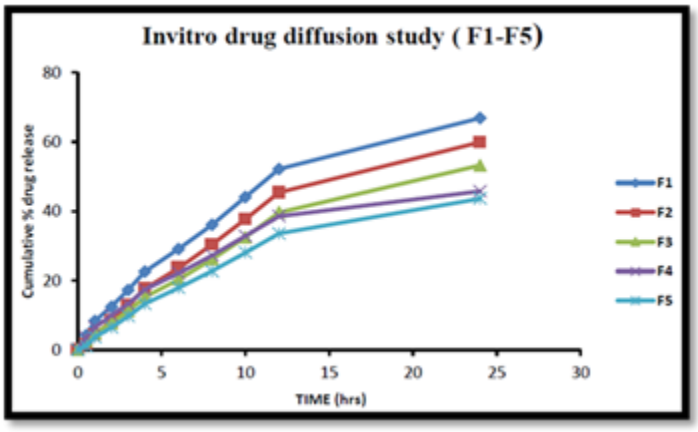
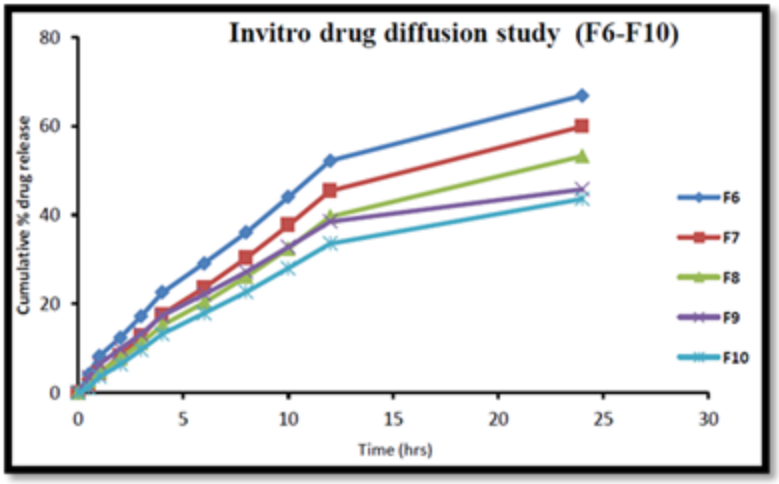


Figure 5: *In vitro* drug diffusion study (F6-F10)



Anti-fungal activity

Terbinafine was demonstrated to maintain antifungal action in its forms as a film-forming dermal gel and as active against some strain of a microorganism. During a study carried out on Terbinafine in treating Aspergillus spp. the Inhibition Zone obtained was 21mm in diameter standard. It was discovered that the zone of inhibition of F10 formulation was 19.46 mm and 98.34% of the same. To compare, the intrinsic antifungal activity of ethanol was also calculated by finding out its zone of inhibition.

DISCUSSION

The results of the solubility experiments showed that Terbinafine exhibited better methanol solubility than in other solvents, which is a significant component to obtain an effective drug formulation and release. This observation conforms to the fact that the drug must be in a dissolved form to increase bioavailability and skin penetration. UV spectrophotometry was used in the determination of the 282 nm (282 nm) of the λ max; this is necessary in defining the drug absorption characters. The calibration curve made at this wavelength produced a high value regression of 0.9998 confirming that the absorbances were linear with concentration. This guarantees that the concentration of the drug in gel formulation is discernible. In terms of the development of Terbinafin film-forming gel, HPMC 100M was chosen as a gelling agent, and there was also Eudragit RS100 and RL100, as the film polymer. Applications of such polymers enable the gel to create a stable and flexible film, which is able to transfer the drug effectively [10-12]. Formulated gels had pH ranges of 5.3-6.1, which was near skin natural pH so as to ascertain that, the gel was not to be irritating once applied on skin. This will play a significant role in patient compliance whereby the formulation will have to be non-irritating to enhance long term use. Spreadability tests showed that the gel formulations were well affected in terms of spreading behavior and gave a spreadability range of 4.15 cm to 5.78 cm. This is needed in order to make sure that when the gel will be applied to the skin, it will be able to cover more of the surface and thus it will have a stronger therapeutic

effect. The tests carried out on the drying time indicated that the films took up to a time span of 4 to 6 minutes, which is good so far as ease of application is concerned. The quick drying mechanism makes it possible where the gel sits form a thin layer on the skin without any discomfort to allow long contact and increase drug absorption. The gels had a drug content of 88.08 percent to 97.14 which was found to be consistent and uniform distribution of Terbinafine in the gel formulation. This consistency in drug content is the key to keeping the treatment at high rates. Viscosity tests showed that the gel formulations were suitably thick to be applied topically so that neither the runny nor the sticky gel would have an effect on patient adherence and effectiveness [13]. These viscosities were between 11,500cP and 12,900cP, appropriate to a topical gel. In vitro experiment involving drug diffusion revealed that the film forming gel enabled a controlled release of the drug, formulations with Eudragit RL100 liberating the drug at a higher rate than formulations of Eudragit RS100. The 15 % Eudragit RS100 formulation F10 was identified to impart the greatest extent of sustained release, which qualifies it to be used in long-lasting therapeutic activity. The release levels were very high after 12 hours and formulation F10 had the fastest rate of release at 42.59%. This is suggestive of the long-acting potential of the administration of the formulation which is a key benefit in the management of chronic fungal infections. In the antifungal characteristic, the efficacy of the gel formulations against Aspergillus spp. was determined where the zone of inhibition was the prime element of efficacy. The standard formulation generated a zone of inhibition of 21 mm, formulation F10 generated a zone of 19.46 mm with 98.34% efficacy indicating that the gel formulation does not wash away the antifungal activity of Terbinafine. The control (ethanol activity) was much reduced, with a zone of inhibition of 1.25 mm, therefore proving that the gel-formulation of the study had a tremendous antifungal impact [14].

CONCLUSION

Finally, the work was able to create terbinafine-loaded film-forming gels with an acceptable level of antifungal properties and represents a new and effective approach to topical therapy. Formulation F10, with its enhanced drug release profile and potent antifungal activity, has a lot of potential in the treatment of fungal infections in areas where sustained release and enhanced compliance rates are required. This study has revealed the potential of terbinafine film-forming gels as a promising product by bypassing certain shortcomings of conventional dosage forms by way of delivery via skin.

REFERENCES

1. Bala, P., Jathar, S., Kale, S., & Pal, K., et al. Transdermal drug delivery system (TDDS) - A multifaceted approach for drug delivery. *Journal of Pharmaceutical Research*, 8(12), 2014, 1805-1835.
2. Ptak, A., & Szyc, M. Athlete's foot: A common fungal infection in athletes and beyond. The use of terbinafine in treating tinea pedis and onychomycosis. *Quality in Sport*, 34, 2024, 56195.
3. Ryder, N. S. Terbinafine: Mode of action and properties of the squalene epoxidase inhibition. *British Journal of Dermatology*, 126, 1992, 2-7.
4. Mustaffa, M. F., Ramasamy, K. A., Jaafar, N. A., Hasan, M. H., Ramli, N. A., Suratman, S. U., & Adam, A., et al. In-situ film-forming solution for topical application of terbinafine HCl: Biopharmaceutical evaluation and in vivo antifungal performance using animal model. *International Journal of Applied Pharmaceutics*, 13(6), 2021, 98-105.
5. Wu, P., & Grainger, D. W. Drug/device combinations for local drug therapies and infection prophylaxis. *Biomaterials*, 27(11), 2006, 2450-2467.
6. Srivatsava, S., Verma, U., Kumar, R., & Bhatt, N., et al. Preparation and evaluation of econazole nitrate containing film forming gel. *European Journal of Molecular & Clinical Medicine*, 8(3), 2021, 2881-2895.
7. Wu, S., et al. Controlled release of triamcinolone from an episcleral microfilm delivery system for open-globe eye injuries and proliferative vitreo retinopathy. *Journal of Controlled Release*, 333, 2021, 76-90.
8. Oh, D. W., et al. Formulation and in vitro/in vivo evaluation of chitosan-based film-forming gel containing ketoprofen. *Drug Delivery*, 24(1), 2017, 1056-1066.
9. Bhatt, J., Patel, A., Sinha, P., Suthar, B., & Narkhede, S., et al. Formulation and evaluation of film-forming gel of bifonazole for local delivery. *Pharmaceutical Sciences Monitor*, 8(3), 2017, 173-189.
10. Jagur-Grodzinski, J. Polymeric gels and hydrogels for biomedical and pharmaceutical applications. *Polymers for Advanced Technologies*, 21(1), 2010, 27-47.
11. Zhao, F., Shi, Y., Pan, L., & Yu, G., et al. Multifunctional nanostructured conductive polymer gels: Synthesis, properties, and applications. *Accounts of Chemical Research*, 50(7), 2017, 1734-1743.
12. Gandhi, K. J., Deshmane, S. V., & Biyani, K. R., et al. Polymers in pharmaceutical drug delivery systems: A review. *International Journal of Pharmaceutical Sciences Review and Research*, 14(2), 2012, 57-66.
13. Kelly, H. M., Deasy, P. B., Busquet, M., & Torrance, A. A., et al. Bioadhesive, rheological, lubricant and other aspects of an oral gel formulation intended for the treatment of xerostomia. *International Journal of Pharmaceutics*, 278(2), 2004, 391-406.

14. Kumar, K. J., Muralidharan, S., & Dhanaraj, S. A., et al. Anti-fungal activity of microemulsion-based fluconazole gel for onychomycosis against *Aspergillus niger*. *International Journal of Pharmacy and Pharmaceutical Sciences*, 5(1), 2012, 96-102.

Cite this article:
Alike. Naga Sri, Asha Jyothi P. Formulation and Evaluation of a Transdermal Film-Forming Gel Loaded with Terbinafine. *International Journal of Pharmaceutical Research & Analysis,* 15(2), 2025, 45-54.

Attribution-Non Commercial-NoDerivatives 4.0 International