AMERICAN JOURNAL OF PHARMTECH RESEARCH
Journal home page: http://www.ajptr.com/

From Seeds to Sheild: Design and Evaluation of Herbal Nail Lacquer- A Natural Antifungal Approach Against Onychomycosis

Smt. Aishwarya Hiremath[1]*, Samarth AV[1], Atiya[2], Shrushti S[1], Manikantha P Garlpet[1], Muhammed Mussamil A[1]

1. Department of Pharmaceutics, Bapuji Pharmacy College, SS Layout, Shamanur road, Davanagere, India. Affiliated to Rajiv Gandhi University of Health Sciences, Bengaluru, Karnataka.

ABSTRACT

Onychomycosis also referred to as dermatophytic onychomycosis or Tinea unguium, is a fungal nail infection primarily caused by dermatophytes (like Trichophyton rubrum), yeasts (like Candida albicans), and non-dermatophytic moulds. In this study, an effort was made to develop a herbal medicated antifungal nail lacquer using Caesalpinia bonducella seeds. The objective was to enhance clinical efficacy while improving patient compliance. Authenticated C. bonducella seeds were extracted and formulated into nail lacquers using suitable excipients, including film-forming agents, plasticizers, solvents, penetration enhancers, and resins. The prepared formulations were evaluated for various physicochemical and biological parameters such as smoothness, glossiness, non-volatile content, drug content, adhesion, diffusion, and antifungal activity (zone of inhibition). FTIR analysis confirmed drug–excipient compatibility by retaining characteristic peaks. Among the formulations, F5 was identified as the optimized batch and subjected to accelerated stability testing under ICH guidelines at 37 ± 2 ℃ for one month. The results showed no significant changes in its initial characteristics, while the formulation maintained excellent antifungal activity. Overall, the developed antifungal nail lacquer demonstrated safety, stability, and effectiveness, suggesting its potential as a novel dosage form for the treatment of dermatophytic nail infections such as onychomycosis. Its use may significantly improve therapeutic outcomes and patient adherence compared to conventional therapies.

Keywords: Onychomycosis, Antifungal nail lacquer, Caesalpinia bonducella, Dermatophytes, Diffusion studies, FTIR

*Corresponding Author Email: aishwaryashiremath1990@gmail.com
Received 28 November 2025, Accepted 08 December 2025

Please cite this article as: Hiremath A *et al*., From Seeds to Sheild: Design and Evaluation of Herbal Nail Lacquer- A Natural Antifungal Approach Against Onychomycosis. American Journal of PharmTech Research 2025.

INTRODUCTION

Onychomycosis is a fungal infection of the nail unit caused by dermatophytes, non-dermatophyte moulds, or yeasts. It affects both toenails and fingernails, although toenails are more commonly involved due to repeated trauma and slower growth. The term is derived from the Greek word "onyx" meaning nail and "mykes" meaning fungus. [1] Dermatophytes such as *Trichophyton rubrum* are the most common causative agents, though yeasts like *Candida albicans* and Non dermatophytes like *Fusarium* and *Aspergillus* also contribute significantly, especially in immunocompromised individuals. [2]

Globally, onychomycosis accounts for about 30% of all fungal skin infections and 20–40% of nail disorders, affecting nearly 5.5% of the population. The prevalence is highly variable and is influenced by factors such as age, immune status, comorbidities like diabetes, geographic location, personal hygiene and occupation.[3] Reports from Western countries estimate prevalence rates ranging from 2–13%, while Asian studies suggest lower rates in tropical climates (3.8%) and higher in temperate zones (18%). In India, estimates range between 0.5% and 5% depending on the region, with some urban studies reporting even higher rates. The condition is more prevalent among the elderly, diabetics, immunocompromised patients, and individuals frequently exposed to communal bathing areas or occlusive footwear. [4]

Several forms of onychomycosis are distinguished by their morphologic patterns and the way in which the nail invades. Classification aids in characteristic prediction and offers a framework for diagnosis and expected response to treatment. These include proximal subungual onychomycosis, superficial onychomycosis, complete dystrophic onychomycosis, distal and lateral subungual onychomycosis, and endonyx subungual onychomycosis, which is uncommon. Some nails combine characteristics from different classifications. [5]

Although conventional antifungal agents remain the mainstay of onychomycosis therapy, their limited nail penetration, systemic side effects, and growing resistance highlight the need for safer substitute.[6] Herbal remedies, with their broad antifungal activity and favourable safety profile, present a promising alternative. Among these, *Caesalpinia bonducella* has demonstrated significant antifungal potential in vitro,[7] yet there is no documented evidence of its incorporation into a nail lacquer system. This gap forms the basis of the present study, which aims to develop and evaluate a single drug herbal nail lacquer using *C. bonducella* seed extract for the treatment of onychomycosis.

MATERIALS AND METHOD

Plant material preparation:

The collected seeds were first washed with tap water to remove any adhering debris, then dried in a hot air oven at 40 °C until a constant weight was achieved. After complete drying, the seeds were ground using a mechanical mill to obtain coarse powder.

Preparation of the extract:

The seed extract was prepared using the Soxhlet extraction method. In brief, 100 g of ***C. bonducella*** seed powder was extracted with 500 ml of 95% ethanol in a Soxhlet apparatus for 16 h. The obtained crude extract was filtered through Whatman filter paper, and the filtrate was concentrated to dryness on a water bath.[8] The percentage yield of the extract was then calculated. The resulting ***C. bonducella*** seed extract (CBSE) was stored in a sterile glass container until further use.

Chemical test:

Chemical tests were performed for the screening and identification of phytochemical constituents present in the extract of C. bonducella.

Test for Alkaloids:

Dragendorff's test: The extract and Dragendorff's reagent along the side of the test tube orange reddish brown precipitate.

Wagner's reagent: The extract and add few drops wagner's reagent. The formation of reddish-brown precipitate indicated the presence of alkaloids.[8]

Test for carbohydrates

Fehling's Test Equal volumes of Fehling's solution A and B were mixed and heated for 1 minute, followed by the addition of an equal volume of extract. The mixture was boiled for 10 minutes, and the appearance of a yellow to brick-red precipitate will confirm the reducing sugars. [9]

Benedict's Test Equal volumes of extract and Benedict's reagent were mixed and heated for 5 minutes. The formation of green, yellow, or brick-red colour depending on concentration will confirm the presence of reducing sugars. [10]

Test for cardiac glycosides *Keller–Kiliani Test* 1 ml of extract was combined with 1 ml of 5% $FeCl_3$ and 1 ml of glacial acetic acid. After standing for 1 minute, 0.1 ml concentrated sulphuric acid was carefully added. A greenish-blue colour indicated the presence of cardiac glycosides. [11]

Test for Flavonoids 0.5 ml of extract was mixed with few drops of sodium hydroxide. The appearance of a bright yellow colour that disappears upon adding dilute acid indicated the presence of flavonoids. [12]

Test for Phenols 0.5 ml of extract was treated with 1 drop of 10% ferric chloride solution. A blue, green, red or purple colour confirmed the presence of phenols. [13]

Test for Saponins The extract and water was shaken vigorously in a test tube. The formation of a stable foam indicated the presence of saponins.[14]

Test for Tannins: 0.5ml of extract was treated with 5% of ferric chloride solution. A bluish-black colour confirmed the presence of tannins. [15]

Formulation development of nail lacquer:

Nail lacquer formulation was developed by taking into various polymers (Cellulose acetate and Ethyl acetate) in 10% concentration along with various plasticizers (Di-ethyl phthalate and di-butyl phthalate). Optimization of formulation was done by preparing 5 different formulations.

The aim was to optimize which polymer on which concentration suitable for *C. bonducella* nail lacquer based on the drug permeability studies and also optimize the effect of plasticizer on film properties such as gloss and adhesive property.

The aim was to optimized which polymer and its concentration is suitable for the

Film forming agent (polymer): Cellulose acetate, Ethyl acetate

Plasticizer: Di-ethyl phthalate, Di-butyl phthalate

Solvent: Acetone, Ethanol, Ethyl acetate

Penetration enhancer: Salicylic acid, Chitosan, Hydroxy β cyclodextrin, PEG, Thioglycolic acid, Lactic acid

Resin: Shellac, Agar, Acaica, Tragacanth

Here an attempt was made to prepare the nail lacquer by using the different solvents like ethanol, acetone and ethyl acetate. But in ethanol and acetone, Ethyl cellulose a film forming agent was not properly get dissolved. So the further dosage form was developed by using ethyl acetate as a solvent. Next to the selection of solvent all the remaining excipients were selected based on the availability. The list of excipients used are as given below.

The required amount of ethyl cellulose was dissolved in sufficient quantity of ethyl acetate to get a clear solution. Thioglycolic acid, Shellac and Di-butyl phthalate was added. Then extract of Caesalpinia bounducella was added with continuous stirring at 100 rpm on magnetic stirrer to get proper consistency of nail lacquer. The formulations were coded as F1 to F5. The prepared nail lacquer was transferred into a narrow mouthed, plastic screw capped glass bottle. [16]

Different Excipients	Uses
Ethyl Cellulose	Film forming agent
Ethyl Acetate	Solvent
Thioglycolic Acid	Penetration Enhancer
Shellac	Resin
Di-butyl phthlate	Plasticizer

Table 1: **List of ingredients used for the formulation of nail lacquer (F1, F2, F3, F4, F5)**

Ingredients (%)	F1	F2	F3	F4	F5
Ethyl cellulose	10	10	10	10	10
Di-butyl phthalate	1.3	1.3	1.3	1.3	1.3
Shellac	10	10	10	10	10
Thioglycolic acid	-	-	-	-	5
Lactic acid	-	-	-	5	-
Polyethylene glycol	-	-	5	-	-
Chitosan	0.2	0.4	-	-	-
2-hydroxypropyl-β-cyclodextrin	0.25	0.5	-	-	-
Polyvinyl phosphate	0.5	0.5	-	-	-
Salicylic acid	0.1	0.2	-	-	-
Acetone	10	-	-	-	-
Ethanol	-	10	-	-	-
Ethyl acetate	-	-	q.s	q.s	q.s

Evaluation of Nail Lacquer:

Drying Time

A thin film of the prepared nail lacquer was applied on a Petri dish using a brush, and a stopwatch was used to record the time required for the film to dry. The formulation was considered dry when no residue adhered to the finger upon gentle touch. [17]

Smoothness of flow

The sample was poured from a height of 1.5 inches onto a glass plate and allowed to spread. The plate was then raised vertically, and the flow was visually assessed for smoothness. [18]

Glossiness

Glossiness of the film was evaluated by visual inspection under normal light. [19]

Non-Volatile content

An empty Petri plate was weighed (M1), and 1 g of the formulation (M) was evenly spread on it. The plate was reweighed, kept in a hot air oven at 105 ± 2 °C for 1 h, cooled and weighed again (M2) [19]. The non-volatile content (%) was calculated as

$$\% \text{ Non-volatile content} = \frac{M2 - M1}{M} \times 100$$

where M = mass of sample, M1 = mass of empty Petri plate, M2 = mass of Petri plate with dried sample.

Water Resistance

A dried film of lacquer on a glass plate was weighed and immersed in distilled water for 24 h. After drying with filter paper, the plate was reweighed, and water resistance was expressed as percentage weight loss.[20]

Viscosity

Viscosity was measured at room temperature using a Brookfield Viscometer (Model LVF) with spindle no.4 at different rotational speeds (rpm). [21]

Adhesion Test

A 1 × 25 cm^2 film of lacquer was prepared on a glass slide (cleaned with toluene/xylene) and allowed to dry for 24 h at room temperature. A pressure-sensitive adhesive tape was pressed over the film and peeled off. The formulation was considered satisfactory if less than 10% of the film was removed. [22]

Blush Test

A uniform film of lacquer was prepared on a Petri dish and allowed to dry for 24 h. The dish was half-immersed in tap water for 4 h, dried, and re-observed after 4 h at ambient conditions. Films showing no blistering or peeling and minimal or no whitishness were considered to have passed. [23]

Drug Content Estimation

An amount of lacquer equivalent to 1 mg drug was dissolved in 50 ml of phosphate buffer (pH 7.4), sonicated for 15 min, filtered, and diluted to 100 ml**.** [24] The drug content was determined spectrophotometrically at 235 nm using the following equation:

$$\left(\frac{y - c/m \times 50}{1000}\right) \times 100$$

Stability Studies:

The optimized formulation was stored at 40 °C and 37 ± 2 °C for 1 month. Samples were evaluated for drying time, non-volatile content, adhesion, water resistance, and drug content to assess stability. [25]

In-vitro drug release studies:

Transport studies were performed using *C. bonducella* extract (1 mg/ml) in a custom-made transport cell (10.4 cm length, 2.3 cm internal diameter). One end of the cell was fitted with a dialysis membrane prehydrated overnight. The cell (donor compartment) containing 2 ml of drug solution was immersed in a beaker (receptor compartment) with 50 ml phosphate buffer (pH 7.4) maintained at 37 °C on a magnetic stirrer. Care was taken to equalize fluid levels inside and outside the cell to avoid hydrostatic pressure effects. Stirring was kept at a constant low speed to minimize viscosity effects and ensure uniform mixing. During transport studies, 5 ml samples were withdrawn from the receptor compartment at predetermined intervals up to 6 h, and an equal volume of fresh phosphate buffer (pH 7.4) was added to maintain constant volume. The drug content of each sample was determined using the analytical methods described earlier. [26]

FTIR:

About 3 mg of the sample was mixed with 300 mg of FTIR-grade potassium bromide (KBr) and finely ground in a mortar and pestle. The mixture was compressed into a pellet under ~8 tons of pressure using a hydraulic press for 2–3 min. The pellet was then placed in the holder and scanned using an FTIR spectrophotometer (Model 8400S, Shimadzu) with IR Solution software to obtain the spectra. [27]

Drug–Excipients Compatibility Studies:

In the preparation of tablet formulations, drug and excipients may interact as they are in close contact with each other, which could lead to the instability of drug. Pre-formulation studies regarding the drug-excipient interactions are therefore very critical in selecting appropriate excipients. FT- IR spectroscopy was employed to ascertain the compatibility between CBSE and the selected excipients.

The pure drug and drug-excipients combinations were subjected to FT- IR studies. Potassium bromide, pure drug, and the excipients were heated to 105 °C for one hour to remove the moisture content if present in a hot air oven. Then in presence of IR lamp, potassium bromide was mixed with drug and/or excipient. Grinding in smooth mortar can effect mixing. The mixtures were then placed in the sample holder of the instrument and the spectra were taken. The spectra were run from 4000 cm-1 to 400 cm-1 wave number. FT-IR spectrum of CBSE was compared with FT-IR spectrum of CBSE with excipient. The pure drug and drug with excipients were scanned separately. Disappearance of CBSE peaks or shifting of peak in any of the spectra was studied.

Anti-fungal activity:

Fungal strains were maintained on SDA agar. Antifungal susceptibility was assessed by the agar well diffusion method (Kirby-Bauer). Fungal strains were evenly swabbed onto SDA plates, and wells (6 mm diameter, ~2 cm apart) were prepared using a sterile cork borer. Each well was filled with 100 µl of test sample (1 mg/ml). Plates were incubated at 37 °C for 48 h, after which zones of inhibition were measured in millimetres using a transparent ruler.[28, 29]

RESULTS AND DISCUSSION

Soxhlet Extraction of *Caesalpinia bonducella* Seeds

Soxhlet extraction of *Caesalpinia bonducella* seeds with 95% ethanol yielded a dark brown, semi-solid crude extract with a percentage yield of 5.52% w/w. The appearance and consistency of the extract confirmed successful recovery of ethanol-soluble phytoconstituents. Ethanol's polarity allows efficient extraction of alkaloids, flavonoids, tannins, glycosides, and phenolic compounds, explaining the relatively good yield obtained. These findings align with previous reports on the

effectiveness of ethanol for isolating pharmacologically active metabolites from *C. bonducella* and provide a benchmark for reproducibility and solvent comparison in future studies.

Preliminary Phytochemical Screening

Phytochemical screening of the ethanol extract of *Caesalpinia bonducella* seeds (CBSE) revealed the presence of a diverse range of secondary metabolites, as summarized below.

Alkaloids were confirmed by both Dragendorff's and Wagner's tests, which produced characteristic orange to reddish-brown and reddish-brown precipitates, respectively. The presence of alkaloids is pharmacologically significant, as these compounds are known to exhibit a broad spectrum of biological activities including antifungal, antibacterial, and analgesic effects, potentially contributing to the therapeutic profile of CBSE.

Cardiac glycosides were identified through the Keller–Kiliani test, which produced a brown ring at the interface, occasionally accompanied by a violet ring and a greenish upper layer. These findings indicate the presence of deoxy sugars typical of cardiac glycosides. Given their well-documented cardiotonic effects, this result supports the traditional use of *C. bonducella* in managing cardiovascular disorders.

Carbohydrates were confirmed by Fehling's and Benedict's tests, producing brick-red and reddish-brown precipitates, respectively. Reducing sugars not only serve as primary energy sources but may also act as precursors for the synthesis of bioactive secondary metabolites, further enhancing the medicinal potential of the plant extract.

Flavonoids The Shinoda test produced a yellow coloration, confirming the presence of flavonoids. These compounds are widely recognized for their antioxidant, antifungal, antibacterial and anti-inflammatory activities. Their presence in CBSE suggests that flavonoids may contribute significantly to the plant's pharmacological and protective effects.

Saponins were detected through the foam test, which showed persistent froth formation. Saponins are associated with immunomodulatory, hypocholesterolemic, and antifungal activities, suggesting a potential role of CBSE in immune regulation and fungal infection management.

Phenolic compounds were confirmed by the ferric chloride test, producing a bluish-green to purple coloration. Phenolics are well known for their antioxidant properties, which may help mitigate oxidative stress-related disorders.

Proteinaceous compounds and free amino acids were confirmed by Millon's and Ninhydrin tests, which yielded red and violet colorations, respectively. The presence of amino acids suggests that CBSE contains nutritionally relevant constituents that may play a role in metabolic and therapeutic functions.

Tannins were confirmed by the ferric chloride test, which produced a dark bluish-black coloration. Tannins possess astringent, antioxidant, antifungal, and antibacterial activities, which may enhance the therapeutic applications of CBSE. Overall, the presence of multiple bioactive constituents such as flavonoids, saponins, and tannins known for their antifungal activity suggests that CBSE holds potential as a natural antifungal agent. These findings justify the traditional use of *C. bonducella* seeds and provide a strong basis for further pharmacological evaluation.

Standard curve for CBSE extract:

Standard solutions of CBSE in different concentrations were prepared using PBS pH 7.4 and their absorption was measured at 235nm. Drug concentration Vs. Absorbance was plotted.

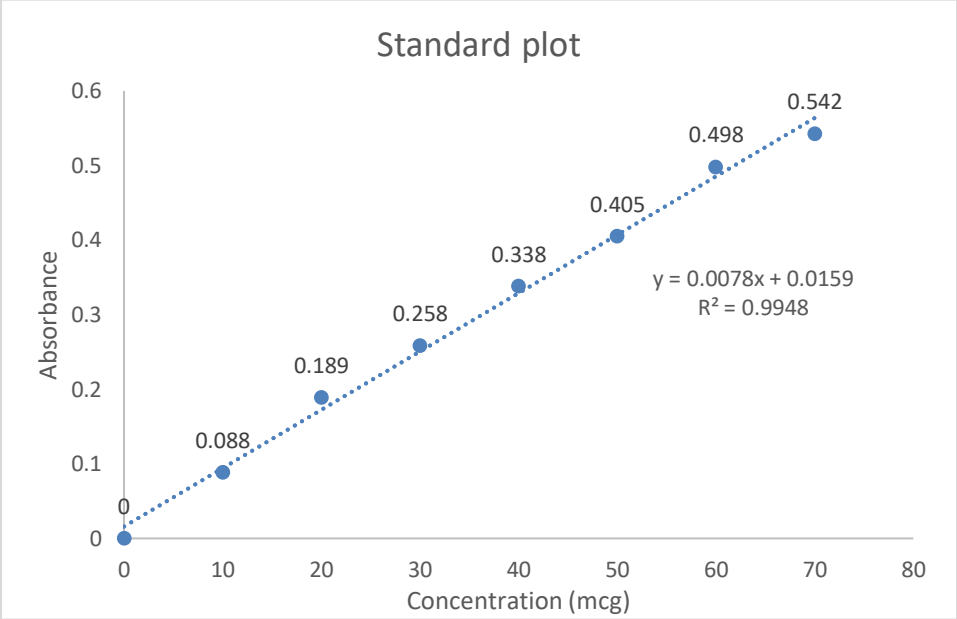

***Figure 1*: Calibration curve of CBSE in phosphate buffer solution pH 7.4**

EVALUATION OF NAIL LACQUER

Drying Time

The drying time of formulations F3–F5 ranged from 35 to 120 seconds, well below the IS 9245:1994 standard of six minutes, indicating rapid film formation. Higher polymer concentrations slightly increased drying time due to elevated viscosity, which slows solvent evaporation.

Smoothness of Flow

Formulations F4 and F5 exhibited higher viscosity due to increased ethyl cellulose concentration, resulting in controlled flow and uniform film formation. The improved flow prevents streaking and ensures a smooth, glossy finish (Table 02).

Glossiness

Formulation F3 showed superior gloss due to an optimal polymer-to-plasticizer ratio, while F4 and F5 exhibited satisfactory gloss influenced by PEG 400 and dibutyl phthalate. All formulations maintained acceptable gloss levels for aesthetic appeal (Table 02).

Non-Volatile Content

Formulations F4 and F5 showed non-volatile content above 20%, increasing with higher ethyl cellulose concentration. This ensures uniform, durable film formation and effective drug retention on the nail plate (Table 02).

Water Resistance

All formulations (F3–F5) showed weight loss below 10%, complying with IS 9245:1994. Increased polymer concentration improved water resistance by forming a denser, less permeable film, enhancing drug retention on the nail plate (Table 02).

Viscosity

The formulations exhibited viscosities of 105–330 cps, within the optimal range of 105–350 cps. This ensured good adhesion, uniform film formation, and satisfactory gloss, while preventing cloudiness and poor aesthetic appeal (Table 02).

Adhesion

Formulation F3, containing thioglycolic acid, showed superior adhesion with peel-off values below 10% (IS 9245:1994), while F4 and F5 exhibited lower adhesion due to the use of PEG 400, lactic acid, and dibutyl phthalate. Adequate adhesion ensures prolonged drug contact and effective treatment (Table 02).

***Table 2*: Evaluation of Nail Lacquer**

Parameters	Formulations			
	F3	F4	F5	Ciclopirox olamine
Drying time [sec]	205	122	82	75
Smoothness to flow	Good	Good	Poor	Good
Glossiness	+	++	+++	+++
%Non-volatile content	24	15	17	5
Water resistance test	Peel off	Peel off	Didn't peel off	Didn't peel off
Blush test	More blister	More blister	Slight whitishness	No whitishness
Viscosity	201	157	236	249
Adhesion	More than 10% Peel off	More than 10% Peel off	Less than 10% Peel off	Less than 10%peel off

ANTI FUNGAL ACTIVITY:

In this study, given test compounds viz., DF1, DF2, DF3 caused the anti-fungal effect on concentration dependent fashion whereas Placebo and CBSE caused moderate low effect against the *C. albicans* which was assessed by Agar well diffusion method. In this study, given test

compounds viz., DF1, DF2, DF3 caused the significant anti-fungal effect on concentration dependent fashion whereas Placebo and CBSE caused moderate low effect against the *T. rubrum* which was assessed by Agar well diffusion method. The observed results showed satisfactory anti-fungal effect of the molecules against the microbes tested, *C. albicans and T. rubrum* in comparison to the std control used for the study. Fluconazole with 150ug/ml concentration was used as a reference std control for the current study.

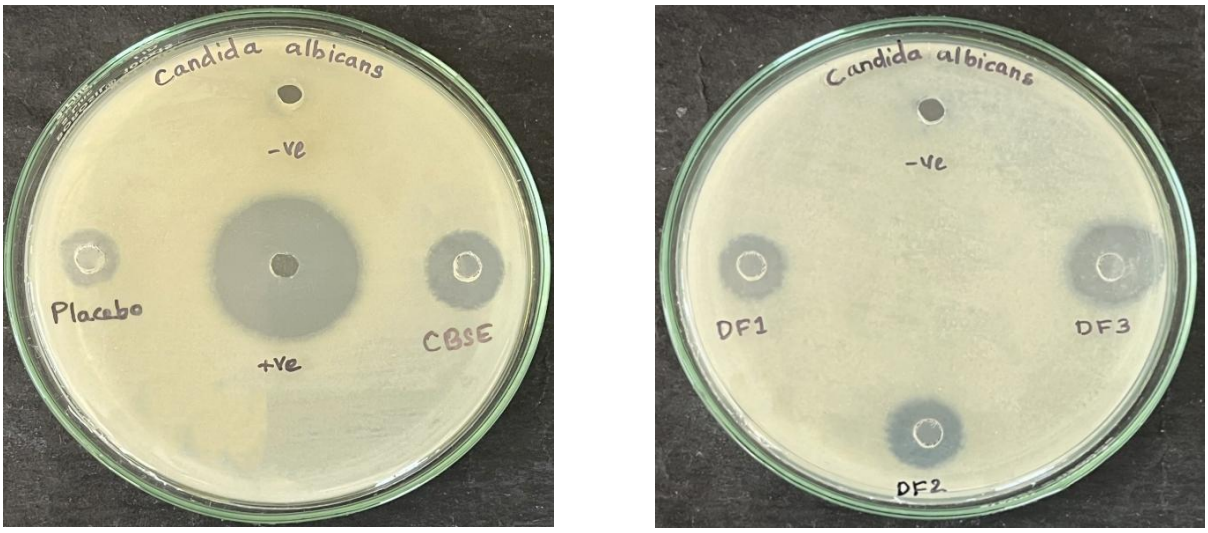

***Figure 2*: Anti-fungal activity of given formulations against the *C.albicans* in comparison to Positive control (Fluconazole-150ug/ml) and Negative control (Distilled water).**

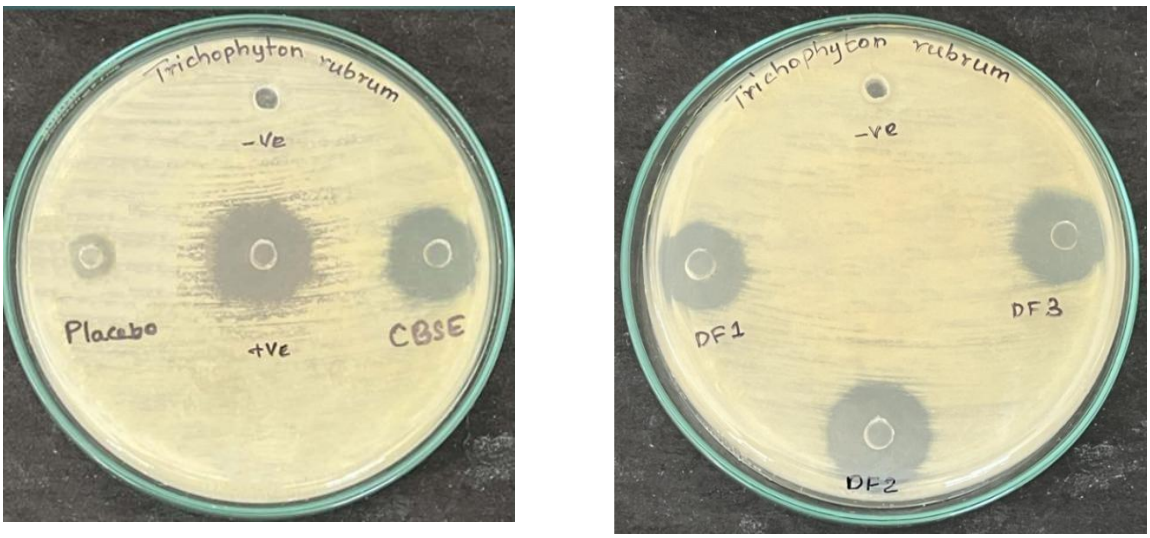

***Figure 3*: Anti-fungal activity of given formulations against the *T.rubrum* incomparison to Positive control (Fluconazole-150ug/ml) and Negative control (Distilled water).**

***Table 3*: Zone of inhibition (mm) values of given samples against the *C. albicans* and *T. rubrum* after the 48hours of incubation period.**

Sample code	*C. albicans*	*T. rubrum*
Negative control	0	0
Fluconazole-150ug	26	19
DF1(0.25mg/ml)	12	16
DF2(0.5mg/ml)	13	18
DF3(1mg/ml)	18	19
Placebo	12	12
CBSE	16	16

FTIR

After spectral comparison it was confirmed that compatibility reaction took place between drug and additives, as all main properties IR peaks of C bonducella are present in the physical mixture with individual additives and also in the final optimized formulation, F5. All the additives peaks were obtained to be entire indicating satisfactory compatibility.

***Table 4:* Table showing FTIR peaks of standard drug and F3 formulation**

Functional groups	Principal Peaks (cm-1)	
	Crude extract	F3 Formulation
O-H stretch	3398	3444
-C-H aliphatic	2892	2982
=C-H aromatic	3000	2982
C=O stretch	1745	1770
C=C stretch	1615	1637
C-O stretch	1240	1244
CO stretch	2360	2362
C-N stretch	1055	1055

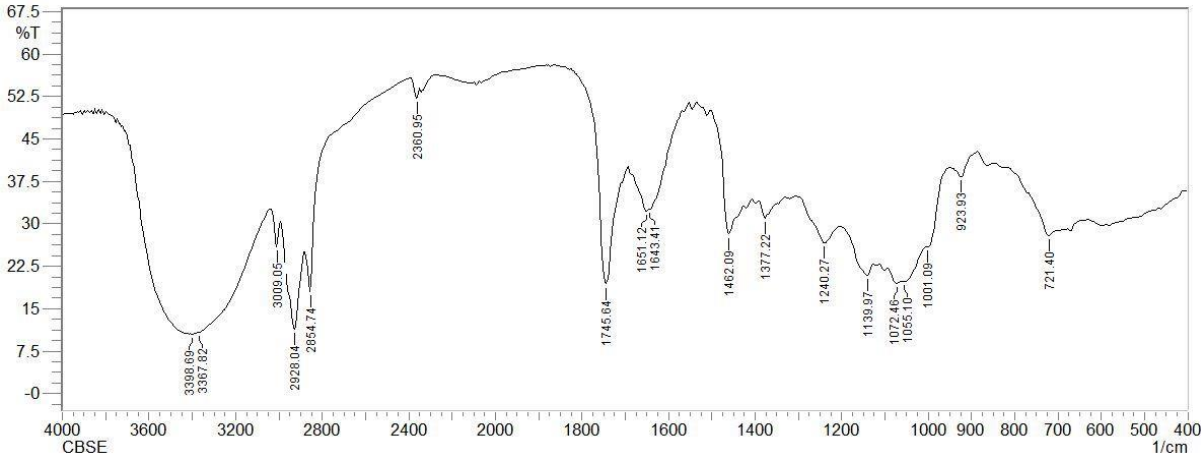

***Figure 4*: IR spectra of *C. bonducella* seed extract**

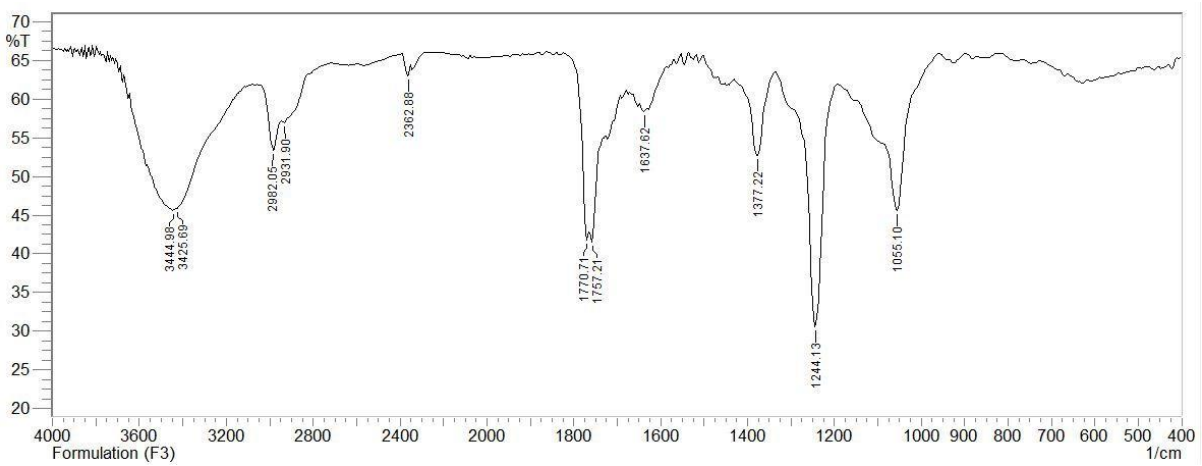

***Figure 5*: IR spectra of F5 formulation.**

PERCENTAGE OF DRUG RELEASE THROUGH DIFFUSION FOR F3 FORMULATION

***Table 5*: Percentage of drug release through diffusion for F5 formulation**

Time	m	c	y(absor)	x(conc)	Amount present in 5 ml(mg)	amount present in 50 ml (mg)	CDR	PDR
1 hr	0.0078	0.0159	0.083	8.602564	0.043012821	0.430128205	0.366447368	18.32237
2 hr	0.0078	0.0159	0.105	11.42308	0.057115385	0.571153846	0.614166667	30.70833
3 hr	0.0078	0.0159	0.118	13.08974	0.065448718	0.654487179	0.754615385	37.73077
4 hr	0.0078	0.0159	0.143	16.29487	0.081474359	0.81474359	0.980320513	49.01603
5 hr	0.0078	0.0159	0.157	18.08974	0.090448718	0.904487179	1.151538462	57.57692
6 hr	0.0078	0.0159	0.181	21.16667	0.105833333	1.058333333	1.395833333	69.79167
7 hr	0.0078	0.0159	0.233	27.83333	0.139166667	1.391666667	1.835	91.75

The results demonstrated time-dependent diffusion of the drug across the dialysis membrane. Variations in the vehicle composition significantly influenced the extent and rate of drug transport. The data indicated that transport was not driven by hydrostatic pressure but was dependent on the diffusional characteristics of the vehicle system. The diffusion study was done over the F3, F4 and F5. Out of them formulation F5 was showing very much desirable drug release in the diffusion study as shown below, hence the formula F5 was decided as the final formula.

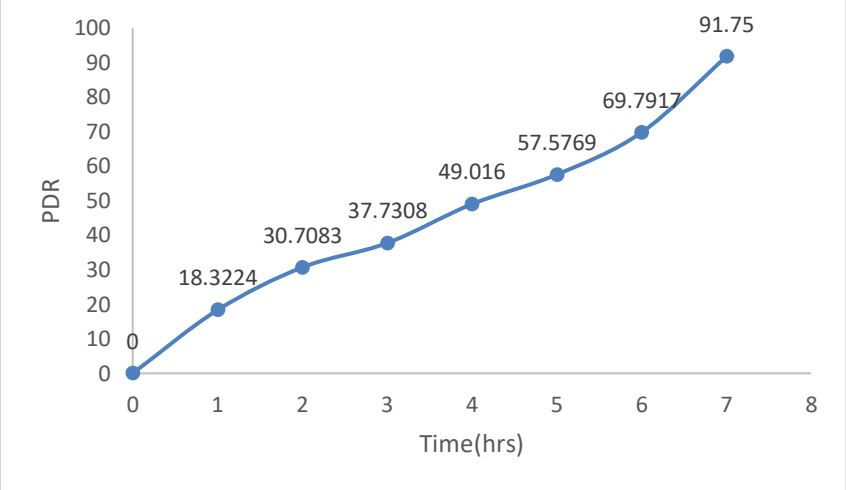

Figure 6: **Percentage of drug release for F5 formulation**

Estimation of % Drug Content

The absorbance of this solution was measured spectrophotometrically at 235 nm, which corresponds to the λmax of the drug. % Drug Content= 79.39% The results revealed that the percentage drug content of the formulation was found to be within the acceptable limits, indicating uniform drug distribution throughout the formulation. This confirms the accuracy of the formulation process and the reproducibility of drug incorporation in the nail lacquer matrix. The findings also demonstrate that the analytical method employed was suitable for reliable quantification of the active pharmaceutical ingredient.

Stability studies

After conducting stability studies, the formulations showed no noticeable variation in drying time, smoothness to flow, glossiness, non-volatile content, water resistant test, blush test or adhesion when compared to the initial results. This indicates that the formulations met the stability criteria outlined in the ICH guidelines.

Tables 6: **Stability studies of F5 formulations**

	50°C	**60°C**	**70°C**	**80°C**
Drying time	2min 20sec	2min7sec	1min24sec	4min19sec
Smoothness to flow	Good	Good	Good	Good
Glossiness	+++	+++	+++	+++
Non-volatile content (%)	17	16	18	19
Water resistance test	Didn't peel off	Didn't peel off	Didn't peel off	Didn't peel off
Blush test	Slight whitishness	Slight whitishness	No whitishness	No whitishness
Adhesion	Less than 10% peel off	Less than 10% peel off	Less than 10% peel off	Less than 10% peel off

CONCLUSION

The present study focused on developing and evaluating a *C. bonducella* seed extract– based antifungal nail lacquer for the treatment of onychomycosis. The series of formulations were developed using different penetration enhancers like Thioglycolic acid, Lactic acid and PEG, and the formulations were assessed for their physicochemical and biological properties. FTIR analysis confirmed compatibility between the drug and excipients. Among the different formulations, F5 stood out with excellent film-forming ability, fast drying, smooth texture, glossy appearance, and desirable viscosity. It shown a non-volatile content of 17% and produced a clear, uniform film with strong adhesion. The formulated nail lacquer exhibited comparable results to the marketed formulation across all evaluated parameters, indicating similar performance and quality. The drug content of 79.39% indicated sufficient therapeutic potential. Microbial testing confirmed antifungal activity against Candida albicans and Trichophyton rubrum, while accelerated stability studies conducted at 37 °C for one month revealed no significant changes, meeting ICH stability standards. Overall, F5 proved to be a stable and effective formulation, demonstrating promising antifungal potential for managing onychomycosis.

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