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Research

Ethanolic Extract of *Peltophorum pterocarpum* [Pod] Against Candidiasis: *In- Vitro* Studies

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Abstract:

Background: Fungal infections, particularly candidiasis, continue to pose a significant global health challenge due to increasing incidence and the emergence of antifungal resistance. The limited availability of new antifungal agents has encouraged the exploration of medicinal plants as alternative therapeutic sources. *Peltophorum pterocarpum* is a traditionally used medicinal plant reported to possess various biological activities. **Aim:** To perform phytochemical screening and evaluate the in vitro antifungal activity of the ethanolic pod extract of *P. pterocarpum* against *Candida tropicalis*. **Methodology:** Shade-dried pods of *P. pterocarpum* were extracted with ethanol using a Soxhlet apparatus. The concentrated extract was subjected to preliminary phytochemical screening using standard qualitative methods. Antifungal activity against *Candida tropicalis* was evaluated by agar well diffusion assay, and the minimum inhibitory concentration (MIC) was determined using the broth microdilution method. **Results**: Soxhlet extraction yielded 2.01% w/w of ethanolic extract. Phytochemical analysis revealed the presence of flavonoids, tannins, and alkaloids. The extract exhibited concentration-dependent antifungal activity, producing a maximum zone of inhibition of 14 mm at the highest tested concentration. The MIC value against *Candida tropicalis* was determined to be 2 mg/mL. **Conclusion**: The ethanolic pod extract of *P. pterocarpum* demonstrated promising in vitro antifungal activity against *Candida tropicalis*. The observed activity may be attributed to the presence of bioactive phytochemicals, indicating its potential as a natural source for the development of herbal antifungal formulations.

Keywords: *Peltophorum pterocarpum, Candida tropicalis*, Candidiasis, Phytochemical screening, Antifungal.

INTRODUCTION

Over 1.6 million people die each year from fungal diseases, often known as mycoses, which are a serious hazard to all living things. Plants, animals, and people are all susceptible to these illnesses. Mycoses, or skin conditions, are the main symptoms of fungal infections. The fungi that cause these infections can spread to tissues, bones, organs, and, in extreme situations, the entire body. [Kumar Y, et al.,2024]. Candidiasis is a yeast infection that is caused by a fungal pathogen, most typically the fungus C. albicans, C. tropicalis. Thrush, another name for candidiasis, can result in yeast infections in various body parts. These frequently include the digestive tract

(gastroenteritis), the mouth (oral thrush), and the vagina (vaginal yeast infection, vaginal thrush) [Assob JC, et al., 2017]. One of the many mycotic infections brought on by opportunistic fungi is candidiasis, which is caused by Candida. Candida is one of the deadliest illnesses due to its severity and widespread frequency. Apart from candidiasis, additional fungal infections that pose a threat to life include invasive aspergillosis and cryptococcal meningitis. Many antifungal medications have adverse effects that might cause allergic reactions in humans, such as liver damage or changes in estrogen levels. For example, anaphylaxis now that the bulk of antifungal drugs are azole group of synthetics can be caused a risky allergic reaction that can lead to death, 18 out of 23 antifungal drugs licensed from 1980 to 2002 are synthetic. . In this regard, amphotericin B and the lipopeptide caspofungin are among the most authorized antifungal medications in the last two decade [Khan H, *et al.,*2018]. On the other hand, fungal illnesses are treated with medications made from natural sources. Only 3% of antifungals have been licensed in the past 40 years, and only two synthetic agents—Isavuconazonium sulfate and fosravuconazole—are now being used for medical purposes, according to Newman and Cragg (2020). Triazole derivatives are widely employed and have a wide range of uses, however they have only been utilized in medicine. [Silva-beltranet NP, *et al.,*2023].

Peltophorum pterocarpum (Copper pod), Golden Flamboyant, Yellow Flamboyant, Yellow Flame Tree, Yellow Poinciana and Radhachura in Bangla; Synonyms: (*Peltophorum inermis* and *Peltophorum ferrugineum)* is a family of Fabaceae and a popularly ornamental tree grown around the world. The plant is native to tropical southeastern Asia and northern Australasia, in Sri Lanka, Thailand, Vietnam, Indonesia, Malaysia, Papua New Guinea, Philippines and the islands of the coast of Northern Territory, Australia. The plant is also found in different regions of India including Birbhum District, West Bengal. Its flowers are used for slowing intestinal diseases and childbirth pain, treating muscle sprains, bruises, swelling, and pain. Roots and barks are also used to cure abdominal colic, joint and backpain, and ascites. Reports on Peltophorum species have described antibacterial, antifungal, antivirus, antioxidant, antitumor, deworming, hypoglycaemic, cardiotonic, hepatoprotective and leucoagglutination bioactivities [Jash SK, *et al.,* 2014].

MATERIALS AND METHODOLOGY

SOLVENTS AND CHEMICALS

Ethanol was purchased from **Great Scientific Industries,** Tiruvannamalai 606 601. The pod of *Peltophorum pterocarpum* was collected from ACP Medicinal Garden, Tiruvannamalai. The herbarium was prepared and authenticated by Dr. J. Suresh Kumar., M.Sc., M.Phil., Ph.D., PGDCA., Dept of Botany, Kalaignar Karunanidhi Government Arts College, Tiruvannamalai.

METHODOLOGY

EXTRACTION

Soxhlet extraction was performed using ethanol as the solvent for extracting phytoconstituents from the pods of *Peltophorum pterocarpum*. About 180 g of shade-dried, finely powdered pod material was packed into a cellulose thimble and placed into the Soxhlet extractor. The extractor was equipped with a reflux condenser and attached to an ethanol-filled round-bottom flask. To enable the ethanol to boil, evaporate, and condense via the condenser, the apparatus was heated. This cycle of reflux, percolation, and siphoning was permitted to continue for several hours to Until the solvent in the siphon tube became practically colorless, indicating rigorous extraction assure full extraction. Once finished, the extract was concentrated by allowing it to evaporate on a heated plate. After being weighed, the residue was refrigerated.

PHYTOCHEMICAL SCREENING

Using standard laboratory methods, the ethanolic extract of pods of *Peltophorum pterocarpum* was examined to determine the presence or absence of secondary metabolites such as phenols, saponins, reducing sugars, carotenes, coumarins, phytosterols, anthracenes, tannins, alkaloids, flavonoids, and glycosides [Yadav RN *et al.,* 2019]

ANTIFUNGAL ASSAY METHODS

Agar well diffusion (zone of inhibition)

The antifungal activity was determined by the well-diffusion method. About 25 ml of potato dextrose agar was poured into a sterile Petridish plate (HI media, Mumbai, India). The plates were allowed to solidify, after which 18 h old yeast strain OD adjusted with Colony forming units (105 cfu/ml) was swabbed using a sterile cotton swab on the agar plate and wells were

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made. Extraction yield (%) = (Weight of crude extract / Weight of sample) × 100. The test samples were loaded into wells with different concentrations (0.5 to 2 mg/well). Clotrimazole and solvent served as positive and negative controls, respectively. All the drug loaded plates were kept for 48 h. The antifungal activity was determined by measuring the diameter of the zone of inhibition around the well using the antibiotic zone scale (Hi media, Mumbai, India) [Magaldi S *et al.,* 2004].

Determination of Minimum Inhibitory Concentration (MIC)

The minimum inhibitory concentration (MIC) of the sample was determined using the broth micro dilution method according to the guidelines of the Clinical and Laboratory Standards Institute with slight modifications. For the antifungal assay, different concentrations of the test sample ranging from 0.02 to 8 mg/ml were prepared in potato dextrose broth (PDB) using twofold serial dilutions in sterile 96-well microtiter plates. Briefly, 200 µl of the highest concentration of the sample prepared in broth was added to the first well of rows C–E (column 1). Wells in columns 2–11 of rows C–E contained 100 µl of sterile broth, while column 12 containing 200 µl broth served as the sterility control. Two-fold serial dilutions were performed by transferring 100 µl from column 1 to column 2, mixing thoroughly, and continuing the dilution sequentially up to column 10. After mixing in column 10, 100 µl was discarded to maintain equal volumes in all wells. An equal volume (100 µl) of fungal inoculum adjusted to 1 × 10^6 CFU/ml of Candida tropicalis (MTCC 184) was added to each well except those in column 12, resulting in a final inoculum concentration of 5 × 10^5 CFU/ml per well. Column 11 served as the growth control (broth + inoculum without sample). The microtiter plates were incubated at 37 °C for 48 h. The MIC was defined as the lowest concentration of the sample showing no visible fungal growth when compared with the growth control [De-Souza-Silva CM *et al.,* 2007].

Optical Density Measurement and Percentage Inhibition

After incubation, fungal growth was quantified by measuring the optical density (OD) at 600 nm using a microplate reader.

The percentage inhibition of fungal growth was calculated using the following formula:

$$\text{Percentage inhibition (\%)} = \frac{\text{OD control} - \text{OD sample}}{\text{OD control}} \times 100$$

Where:

OD control = optical density of growth control (fungus without sample)

OD sample = optical density of wells containing test sample

The concentration showing ≥90% inhibition of fungal growth compared to the control was considered as the MIC value.

RESULT AND DISCUSSION

The *Peltophorum pterocarpum* plant's pod was collected and dried in shade for 2days and powdered. Then extracted with ethanol by using Soxhlet apparatus and concentrated on the hot plate shown in Figure 1&2. The Percentage yield was calculated.

Figure 1; Ethanolic extraction

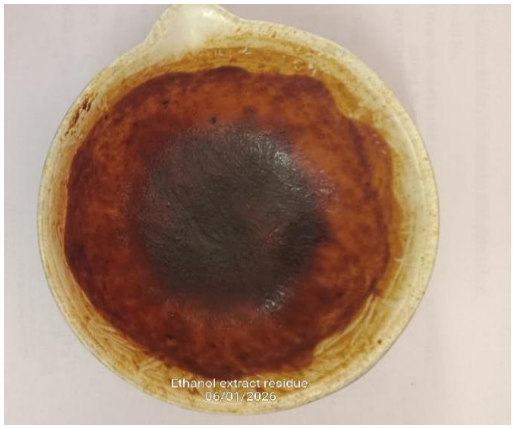

Figure 2; Extract residue

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Table :1 Percentage yield of pod ethanolic extract

Name of the plant	Percentage yield (%)
Peltophorum pterocarpum (pod)	**2.01%w/w**

PHYTOCHEMICAL SCREENING

The preliminary phytochemical screening of the plant extract demonstrated the presence of a wide range of primary and secondary metabolites (Table 2). All the qualitative chemical tests performed showed positive (+) results, indicating the abundance of biologically active phytoconstituents. Alkaloids were confirmed by positive responses to Dragendorff's, Hager's, Mayer's, and Wagner's tests. Carbohydrates were detected through positive Barfoed's, Molisch, Seliwanoff's, Resorcinol, and starch tests, while reducing sugars were confirmed by Benedict's and Fehling's tests. Cardiac glycosides were identified by positive Keller–Killiani and cardenolide tests. Phenolic compounds were detected by iodine, ferric chloride ($FeCl_3$), gelatin, lead acetate, and ellagic acid tests. The presence of saponins was confirmed by foam and sodium bicarbonate tests, whereas resins showed a positive reaction in the acetic anhydride test. Tannins were identified through positive gelatin, Braymer's, sodium hydroxide, bromine water, and lead sub-acetate tests. Phytosterols were confirmed by positive Salkowski's, Hesse's, and sulphur tests. Quinones were detected using alcoholic potassium hydroxide, concentrated hydrochloric acid, and sulphuric acid tests. Flavonoids showed positive reactions in alkaline reagent, lead acetate, and concentrated sulphuric acid tests. Gums and mucilage were confirmed by the alcohol test, while coumarins exhibited positive reactions in the sodium hydroxide paper test and sodium hydroxide test. Overall, the qualitative phytochemical analysis confirmed the presence of alkaloids, carbohydrates, reducing sugars, cardiac glycosides, phenolic compounds, tannins, saponins, resins, phytosterols, quinones, flavonoids, gums and mucilage, and coumarins in the investigated plant extract.

Absence of Phytoconstituents

The qualitative phytochemical screening also demonstrated the absence of several phytoconstituents in the plant extract (Table 3). Proteins and amino acids were not detected, as evidenced by negative results in the Biuret, Millon's, and Ninhydrin tests. Similarly, cholesterol was absent, showing a negative response in the cholesterol detection test.

The extract also tested negative for terpenoids and triterpenoids, as confirmed by the detection test for terpenoids and Salkowski's test, respectively. Carboxylic acids were not detected by the effervescence test. Furthermore, anthraquinones were absent, as indicated by negative Borntrager's and ammonium hydroxide tests. Anthocyanins were not detected in the hydrochloric acid test, and emodin was absent according to the emodin detection test.

The absence of these phytoconstituents suggests that the phytochemical profile of the extract is predominantly composed of other classes of bioactive metabolites, such as alkaloids, flavonoids, phenolics, tannins, saponins, phytosterols, quinones, cardiac glycosides, gums and mucilage, and coumarins, which were detected during qualitative analysis.

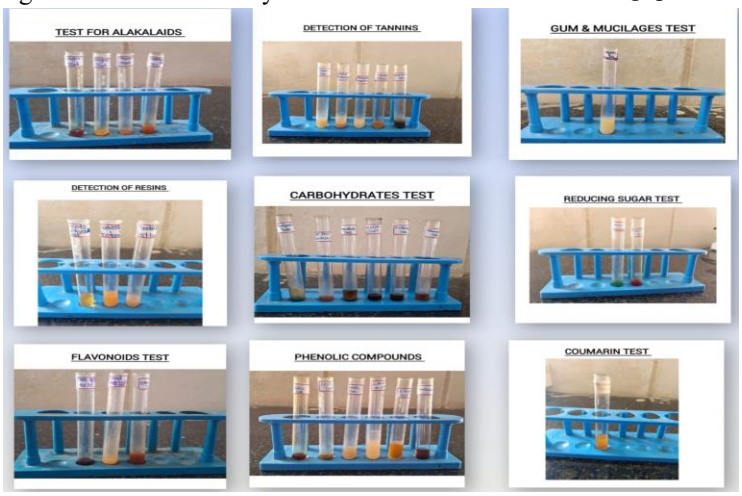

Figure 3: presence of phytochemical screening of the residue

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Figure 4: Absence of phytochemical screening of the residue

Table 2: Presence of Phytoconstituents

Phytoconstituents	Chemical Test	Inference
Alkaloids	Dragendroff's test	+
	Hager's test	+
	Mayer's test	+
	Wagner' test	+
Carbohydrates	Barfoed's test	+
	Molish test	+
	Saliwanoff test	+
	Resorcinol test	+
	Test for starch	+
Reducing sugar	Benedict's test	+
	Fehling's test	+
Cardiac glycosides	Keller – killani test	+
	Test for cardenolides	+
Phenolic components	Iodine test	+
	Fecl3 test	+
	Gelatin test	+
	Lead acetate test	+
	Ellagic acid test	+
Saponins	Foam test	+
	Sodium bicarbonate test	+
Resins	Acetic anhydride test	+

Phytoconstituents	Chemical Test	Inference
Tannins	Gelatin test	+
	Braymer's test	+
	Sodium hydroxide test	+
	Bromine water test	+
	Lead sub acetate	+
Phytosterols	Salkowski's test	+
	Hessle's test	+
	Sulphur test	+
Quinones	Alcoholic KOH test	+
	Conc. Hcl Test	+
	Sulphuric acid test	+
Flavonoids	Alkaline reagent test	+
	Lead acetate test	+
	Conc. Sulphuric acid test	+
Gumand mucilage's	Alcohol test	+
Coumarins	Sodium hydroxide Paper test	+
	Sodium hydroxide test	+

Table 3: Absence of phytoconstituents

Phytoconstituents	Chemical Test	Inference
Protein and amino acid	Biuret test	-
	Millon's test	-

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	Ninhydrin test	-
Cholesterol	Detection of cholesterol	-
Terpenoids	Detection of Terpenoids	-
Triterpenoids	Salkowski's test	-
Carboxylic acid	Effervescence test	-
Anthraquinones	Borntrager's test	-
	Ammonium hydroxide test	-
Anthocyanins	Hydrochloride test	-
Emodin's	Detection of Emodin's	-

Antifungal activity of pod extract against *Candida tropicalis*

Zone of inhibition

The antifungal activity of *P. pterocarpum* pod extract was evaluated against *Candida tropicalis* using the agar disc diffusion method. The extract exhibited concentration-dependent antifungal activity, as evidenced by the progressive increase in the zone of inhibition with increasing extract concentration (Figure 5 and Table 4).

No inhibitory activity was observed in the negative control (0 mg/mL). The extract produced inhibition zones of 8 mm, 10 mm, 12 mm, and 14 mm at concentrations of 0.5, 1.0, 1.5, and 2.0 mg/mL, respectively. The standard antifungal drug (0.03 mg/mL) exhibited the highest inhibition zone of 19 mm against *Candida tropicalis*.

The results demonstrate that the pod extract possesses appreciable antifungal activity against *Candida tropicalis*, with the maximum activity observed at 2.0 mg/mL, although it remained lower than that of the standard antifungal agent.

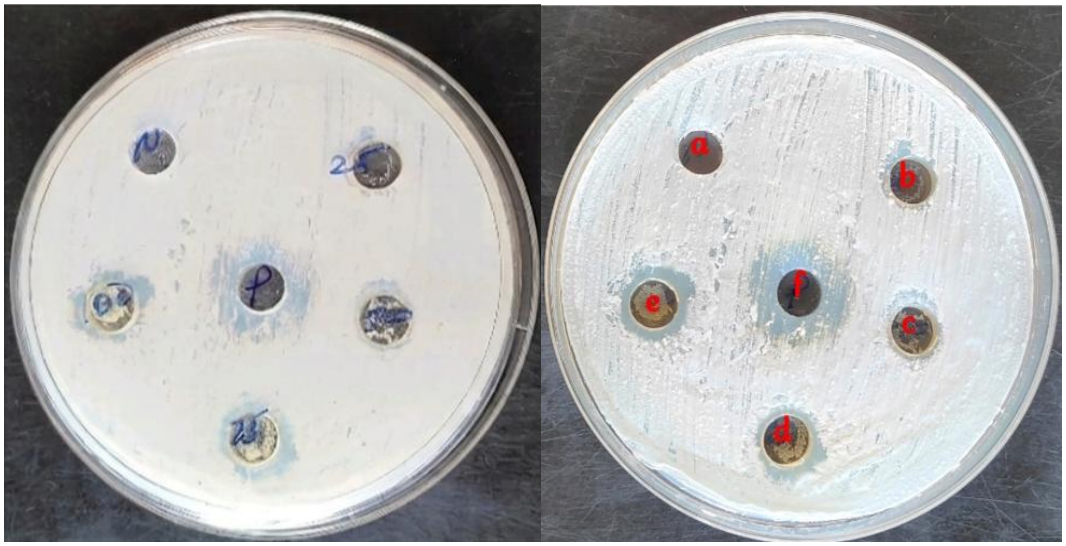

Figure 5: Zone of inhibition of Peltophorum *pterocarpum pod* extract

Table 4: Zone of inhibition in *Candida tropicalis* species

	Zone of inhibition (mm)					
Name of the organism	0 mg/ml	0.5 mg/ml	1 mg/ml	1.5 mg/ml	2 mg/ml	standard 0.03mg/ml

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Candida tropicalis	-	8	10	12	14	19

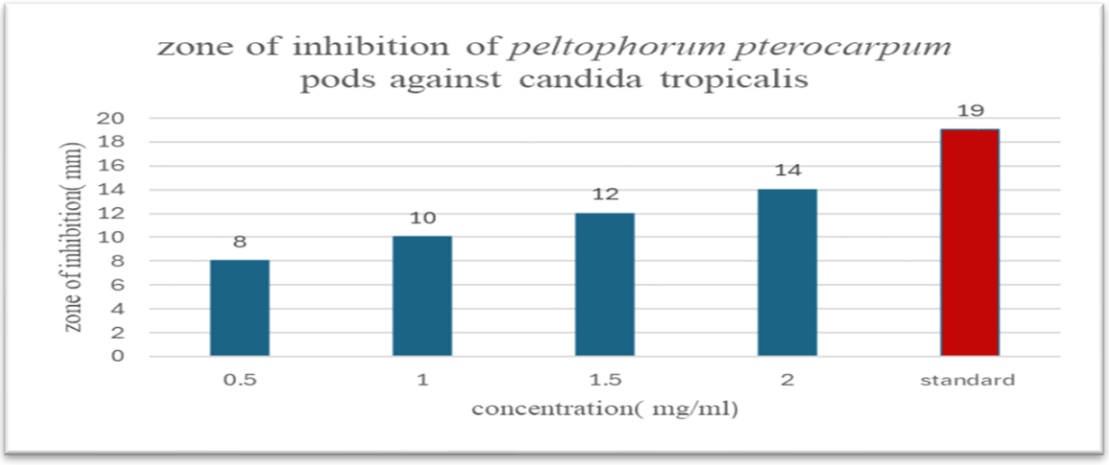

Figure 6:

The antifungal activity of the *P. pterocarpum* pod extract against Candida tropicalis was evaluated using the agar well diffusion method at different concentrations (0.5, 1.0, 1.5, and 2.0 mg/mL). The extract exhibited a concentration-dependent increase in antifungal activity, as evidenced by the progressive increase in the diameter of the zone of inhibition (Figure 6).

Minimum Inhibitory Concentration (MIC)

The minimum inhibitory concentration (MIC) of the ethanolic extract of Peltophorum pterocarpum pods against Candida tropicalis was determined using the broth microdilution method in a 96-well microtitre plate. The microtitre plate was visually examined at 0 h, immediately after inoculation, to establish the initial appearance of the assay before incubation (Figure 7). At 0 h, all wells containing the test extract, growth control, and sterility control exhibited a uniform appearance with no visible fungal growth or turbidity, confirming proper preparation of the assay. The serial dilutions of the ethanolic extract were clearly distributed across the wells, ensuring accurate concentration gradients for MIC determination. The absence of contamination and uniform inoculum distribution indicated that the experiment was initiated under aseptic conditions and was suitable for subsequent incubation and evaluation. Following incubation, the MIC was determined as the lowest concentration of the ethanolic extract that completely inhibited visible growth of C. tropicalis compared with the growth control. The observed inhibitory activity demonstrated the antifungal potential of the extract and supported the concentration-dependent effects observed in the agar diffusion assay.

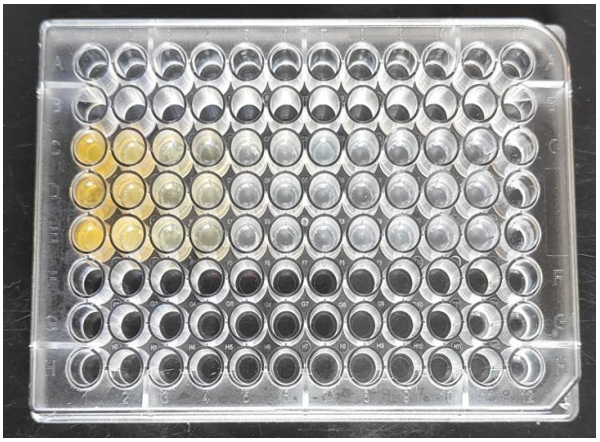

Figure 7: MIC activity of ethanolic extract against *C.tropicalis* at 0th hours

The minimum inhibitory concentration (MIC) of the ethanolic extract of Peltophorum pterocarpum pods against Candida tropicalis was assessed after 48 hours of incubation using the broth microdilution method in a 96-well microtitre plate (Figure 8). Following incubation, distinct differences in fungal growth were

observed among the serially diluted extract concentrations.

The wells containing lower concentrations of the extract showed visible turbidity and fungal growth, whereas wells containing higher concentrations remained clear, indicating effective inhibition of C. tropicalis. The transition from turbid to clear wells enabled the determination of the MIC, defined as the lowest concentration of the extract that completely prevented visible fungal growth. The sterility control remained clear throughout the assay, while the growth control exhibited marked turbidity, confirming the validity of the experimental procedure. The results demonstrate that the ethanolic extract possesses concentration-dependent antifungal activity against C. tropicalis, with higher concentrations effectively suppressing fungal growth after 48 hours of incubation.

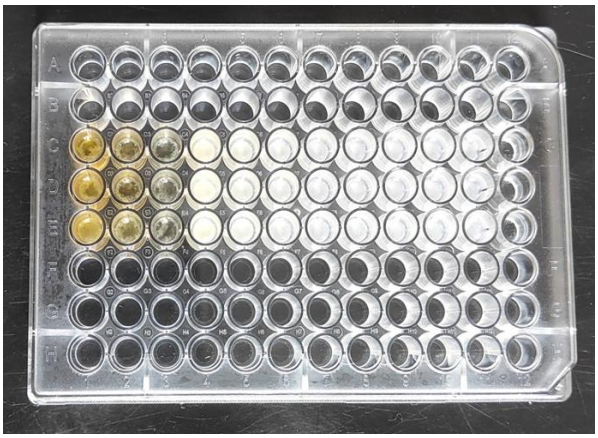

Figure 8: MIC activity of ethanolic extract against *C.tropicalis* at Sample 48thhours

The antifungal efficacy of the ethanolic extract of Peltophorum pterocarpum pods against Candida tropicalis was quantitatively evaluated by measuring the optical density (OD600) of fungal cultures after treatment with different extract concentrations. The percentage of growth inhibition was calculated relative to the untreated growth control (Table X).

The extract exhibited a marked concentration-dependent inhibitory effect on fungal growth. At the highest concentrations tested (8, 4, and 2 mg/mL), the extract produced 93.76%, 93.69%, and 93.92% growth inhibition, respectively, with corresponding OD600 values of 0.112, 0.113, and 0.110. Among these, 2 mg/mL demonstrated the lowest optical density (0.110) and the highest growth inhibition (93.92%), indicating this concentration as the minimum inhibitory concentration (MIC).

A sharp decline in antifungal activity was observed at lower concentrations. At 1 mg/mL, the OD600 increased to 0.988, corresponding to 25.49% inhibition. Further reductions in concentration resulted in minimal inhibition, with 0.5, 0.25, 0.125, 0.0625, 0.03125, and 0.015625 mg/mL exhibiting growth inhibition values of 7.40%, 4.75%, 2.10%, 1.09%, 0.55%, and 0.39%, respectively. The untreated growth control showed the highest OD600 value (1.315) with 0% inhibition, whereas the sterility control recorded an OD600 of 0.032, confirming the absence of contamination

Growth Inhibition percentage analysis

The antifungal efficacy of the ethanolic extract of Peltophorum pterocarpum pods against Candida tropicalis was quantitatively evaluated by measuring the optical density (OD600) of fungal cultures after treatment with different extract concentrations. The percentage of growth inhibition was calculated relative to the untreated growth control (Table 5). The extract exhibited a marked concentration-dependent inhibitory effect on fungal growth. At the highest concentrations tested (8, 4, and 2 mg/mL), the extract produced 93.76%, 93.69%, and 93.92% growth inhibition, respectively, with corresponding OD600 values of 0.112, 0.113, and 0.110. Among these, 2 mg/mL demonstrated the lowest optical density (0.110) and the highest growth inhibition (93.92%), indicating this concentration as the minimum inhibitory concentration (MIC).

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Table 5: % Growth Inhibition

Concentration (mg/mL)	Optical Density (OD600)	% Growth Inhibition

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8	0.112	93.76
4	0.113	93.69
2	**0.110**	**93.92**
1	0.988	25.49
0.5	1.220	7.40
0.25	1.254	4.75
0.125	1.288	2.10
0.0625	1.301	1.09
0.03125	1.308	0.55
0.015625	1.310	0.39
Growth control	1.315	0
Sterility control	0.032	–

DISCUSSION

The present study demonstrated that the ethanolic pod extract of *Peltophorum pterocarpum* possesses significant antifungal activity against *Candida tropicalis*, exhibiting a maximum zone of inhibition of 14 mm, a minimum inhibitory concentration (MIC) of 2 mg/mL, and 93.92% growth inhibition. These findings indicate that the pods of *P. pterocarpum* contain bioactive constituents capable of suppressing fungal growth and support the potential use of this plant as a natural source of antifungal agents.

The antifungal activity observed in this study is consistent with previous reports on the antimicrobial properties of different parts of *P. pterocarpum*. Raj MK et al. (2012) isolated bergenin from the flowers of *P. pterocarpum* and reported significant antifungal activity against *Aspergillus niger*, *Trichophyton mentagrophytes*, *Trichophyton rubrum*, and *Epidermophyton floccosum*, with MIC values ranging from 250 to 500 µg/mL. The authors identified bergenin as one of the major bioactive compounds responsible for the antifungal activity of the plant. Although the present investigation evaluated the pod extract rather than isolated compounds from the flowers, the findings reinforce the notion that *P. pterocarpum* is a rich source of antifungal phytochemicals distributed across different plant parts.

Similarly, Subramanian R *et al.,* (2015) reported that flower extracts of *P. pterocarpum* contain flavonoids, tannins, and phenolic compounds, which were associated with the plant's antimicrobial activity. Flavonoids and tannins have been widely reported to inhibit fungal growth by disrupting cell membrane integrity, interfering with essential metabolic enzymes, chelating metal ions required for microbial metabolism, and inducing oxidative stress within fungal cells.

The present findings are further supported by the work of Sukumaran S *et al.,* (2011), who demonstrated significant antimicrobial activity in the flowers of *P. pterocarpum*. Together with the current results, these studies suggest that antimicrobial constituents are widely distributed throughout the plant and that different plant organs may serve as valuable sources of bioactive compounds with therapeutic potential.

Comparable evidence has also been reported for the bark of *P. pterocarpum*. Verma BK et al. (2022) demonstrated strong antimicrobial activity of bark extracts, with inhibition zones ranging from 16.00 to 18.33 mm and MIC values as low as 31.25 µg/mL against selected microorganisms. Although the bark extract exhibited greater potency than the pod extract evaluated in the present study, differences in antimicrobial activity may be attributed to variations in phytochemical composition, extraction methods, solvent polarity, plant part used, microbial strain susceptibility, and experimental conditions. Nevertheless, both studies consistently highlight the broad-spectrum antimicrobial potential of *P. pterocarpum*.

The comparatively higher MIC value (2 mg/mL) obtained in the present study, relative to studies employing purified compounds or different plant parts, is expected because crude extracts contain a complex mixture of active and inactive constituents, resulting in lower apparent potency. However, crude plant extracts often exhibit synergistic interactions among multiple phytochemicals, which may enhance overall biological activity and reduce the likelihood of resistance development. Such synergistic effects may explain the substantial growth inhibition (93.92%) observed against *Candida tropicalis* despite the higher MIC.

Overall, the present study corroborates previous reports demonstrating the antimicrobial potential of *P. pterocarpum* and extends this evidence by establishing the antifungal activity of its ethanolic pod extract against *Candida tropicalis*. The findings suggest that the pods represent a promising and underexplored

source of natural antifungal compounds. Further studies involving bioassay-guided fractionation, isolation and structural characterization of active constituents, elucidation of their mechanisms of action, toxicity evaluation, and in vivo efficacy are warranted to validate their therapeutic potential and facilitate the development of plant-based antifungal formulations for the management of candidiasis.

CONCLUSION

The present study demonstrated that the ethanolic pod extract of *P. pterocarpum* possesses significant in vitro antifungal activity against *Candida tropicalis*, as evidenced by concentration-dependent growth inhibition, a maximum zone of inhibition of 14 mm, and an MIC value of 2 mg/mL. Phytochemical analysis revealed the presence of flavonoids, tannins, and alkaloids, which are likely to contribute to the observed antifungal effects. These findings support the potential of *P. pterocarpum* pods as a promising source of natural antifungal compounds. However, further studies involving bioassay-guided isolation and characterization of the active constituents, elucidation of their mechanisms of action, and *in vivo* evaluation are necessary to establish their safety and therapeutic efficacy. Such investigations may facilitate the development of effective plant-based antifungal formulations for the management of candidiasis.

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