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REVIEW ARTICLE
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"HERBAL REMEDIES FOR ONYCHOMYCOSIS: TARGETING INFLAMMATION AND FUNGAL INFECTIONS"

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ABSTRACT
When fungal organisms infect the nails, their ability to cause different effect which wasa compromised.Approximately 30% of mycotic cutaneous infections are onychomycosis, a fungal nail infection caused by yeasts, dermatophytes, or non-dermatophyte molds. Predisposing factors for this fungal infection include diabetes, HIV, immunosuppressant, obesity, smoking, and advanced age.Patients might encounterpain and other negative effects from the illness, which may also interfere with their social and professional lives. This review discusses the causes, categorization, diagnosis, and treatment of onychomycosis. Onychomycosis is classified into four kinds according to the pattern and location of fungal invasion. Thecurrent gold standard for diagnosing onychomycosis is potassium hydroxide and culture, which can identify the species and show fungal vitality. Fluorescence staining, polymerase chain reaction methods, and periodic acid-Schiff staining are further diagnostic assays that are readily accessible. Patients may experience pain and other negative effects from the illness, which may also interfere with their social and professional lives. Treatment is chosen depending on the modality of nail invasion, fungus species and the number of affected nails. Oral treatments are often limited by drug interactions, while topical antifungal lacquers have less efficacy. A combination of both oral and systemic treatment is often the best choice.

Key words: Etiology, Pathogenesis, Diagnosis, Clinical Presentation, Treatment, Herbal Medicinal Products and Oils

1. INTRODUCTION
The most common nail infection in the world is onychomycosis, a fungal nail infection that causes the diseased nail plate to thicken and darken. It was previously thought that dermatophytes were the primary cause of onychomycosis, but current research has demonstrated that mixed infections such as those caused by non-dermatophyte molds (ndms) are more frequent than originally thought, especially in warmer climates[1].More than 20% of those over 60 and more than 50% of those over

70 are affected. Treatment is necessary for onychomycosis since it can result in pain, psychological issues, and secondary infections. Fda-approved systemic medications and topical treatments are among the therapy methods covered in this analysis. New and developing topical and oral treatments are also covered[2]. The four main clinical manifestations of onychomycosis are superficial and complete dystrophic onychomycosis, proximal subungal(most common kind among people infected with the human immunodeficiency virus, and distal subungal (the most prevalent form the illness)[3].

For patient satisfaction, patients can get a range of treatment modalities, such as topical, oral, laser, light therapy, operations including matrixectomy and avulsion, supplements, otc medication, and plasma therapy, which are used alone or in combination [4].though less beneficial than oral medications, topical therapy—which includes tavaborole 5%, ciclopirox 8% and efinaconazole 10%-can cure mild to moderate onychomycosis with less drug interaction and side effects. When combined with pharmaceutical therapy, nail cutting and debridement enhance therapeutic response [5].

Figure.1 (onychomycosis nail infection) Https://skinsight.com/skin-conditions/onychomycosis/

1.2. Etiology

Yeasts, non-dermatophytes, and dermatophytes (tineaunguium) can all cause onychomycosis [6,7,8]. About 90% of toenail and 75% of fingernail onychomycosis cases are liable ondermatophytes, particularly trichophyton mentagrophytes and trichophytonrubrum[9,10].

The most frequent overall cause of nail involvement was dermatological illness (45%), which consequently causes nail infections (36%). Systemic, traumatic, genetic, and drug-related factors causes 19% disorders of nails. The most frequent cause overall was onychomycosis (28.5%), which was followed by nail psoriasis [11].

1.3.Pathogenesis

Direct contact of the nail with dermatophytes, non-dermatophyte molds, or yeasts can cause onychomycosis. The nail unit is susceptible to fungal infection due to the fact that it does not have effective cell-mediated protection [12]. Proteolytic, keratinolytic, and lipolytic enzymes secreted by fungi facilitate degradation of keratin in the nail plate and encourage fungal penetration into the nail [13,14]. The risk for fungal infection may rise as a result of factors that resist to fungal infection [13]. The development of several clinical subgroups of onychomycosis is explained by the location and pattern of fungal invasion [14]. Fungal biofilm development contributes to antifungal resistance and enables the fungus to avoid existing antifungal treatments [15].

Figure.2 (non-dermatophyte molds, yeasts)
https://www.istockphoto.com/vector/structure-of-a-nail-nail-gm1204004554-346272591?searchscope=image%2cfilm

1.4 Symptoms of nail infection

Nail infection should be suspected if the following changes are seen in the nails:
1. The arrival of yellow or white patches on the nail.
2. As the nail growsdiscoloured, either white or yellow.
3. The nail gets thicker.
4. Nails that are readily broken, brittle, and flaky.
5. The nail has a warped form.
6. Nails that smell bad.
7. Acute bacterial nail infections can cause pain, redness, and swelling in the nails and surrounding tissue.
8. In paronychia, yellow pus forms and discharges from the nail.
9.Fever accompanying an acute nail infection caused by bacteria.

2. DIAGNOSIS

Based on appearance, the diagnosis is typically suspected and verified by laboratory tests[12]. The four primary assays are smear of potassium hydroxide, culture, histological analysis, and (pcr) polymerase chain reaction [12,13]. Typically, nail clippings or scrapings are the sample under examination. These are taken from as far up the nail as is practical[13].
Periodic acid-schiff staining on nail plate biopsies seems to be more beneficial than culture or direct kohanalysis[14]. Several samples might be required in order to accurately identify nondermatophytemolds[15].
It's critical to differentiate onychomycosis from other nail conditions before starting antifungal treatment. Ignored diagnosis, undesirable side effects, and illness progression could result from not doing this [16]. Making a diagnosis without laboratory confirmation is extremely incorrect,even thorough physical examination of patient and history can aid in narrowing the various diagnosis. Onychomycosis and a number of nail disorders have comparable clinical presentations (table 1) [17,18].

Table1. Differential diagnosis for onychomycosis

S.no.	Condition	Feature
1.	Psoriasis	Splinter haemorrhages, "oil staining", and nail pitting.
2.	Lichen planus	Longitudinal ridges or grooves, weakening nails.
3.	Lichen striatus	Children frequently have longitudinal striae, which typically damage one nail.
4.	Alopecia areata	Pitting nails and onychomadesis,
5.	Contact dermatitis	Erythematous patches that include nail fragility, thickening and folds.
6.	Paronychiacuticle	Loss and inflammation of the surrounding nail tissues are frequently brought on by streptococcus, staphylococcus an candida.
7.	Verruca	Verrucous papules with longitudinal grooves and nail folds.
8.	Trauma	Frequently, friction from shoes.
9.	Browen's disease, squamous Cell, carcinoma	Onychodystrophy, paronychia, discoloured nail plates, verrucous Papules involving the nail fold or bed and bleeding discomfort.
10.	Melanoma	Nail plate splitting, a red nodule or brown -black longitudinal bandandhutchison's sign (hyperpigmentation involving the nail fold or hyponychium

1.1 Anotomy of the nail:

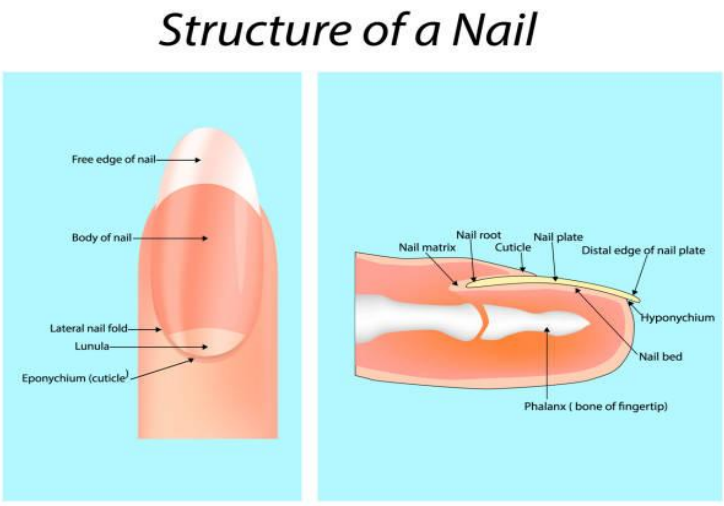

Figure.3

Crissey jt. Common dermatophyte infections. A simple diagnostic test and currentmanagementpostgrad med. 1998;103(2):191-1.

Reviewing the anatomy of the nail unit and the nail growth process may help one better understand the pathophysiology of dermatophytic fungus in the nail unit. Figure-3 illustrates the nail unit diagram [19].The components of this structure include the cuticle, matrix, nail plate (also called the nail), nail bed, proximal and lateral folds, and hyponychium.Made of modified stratum corneum, the cuticle in the horny layer of the proximal nail fold protects the nail matrix from infection.thegrowing center of nail's is called the nail matrix. The plate of the nail is formed by the division, differentiation, and keratinization of nail matrix cells as the nail grows. The lunula is the

visible, distal portion of the matrix that resembles a "half moon”. The matrix extends roughly 5 mm proximally beneath the proximal nail fold [20]. The nail plate, which extends by migrating forward over the nail bed until the distal end splits from the nail bed, is the primary component of the nail unit [32]. A granular layer matching the plantar and volar surfaces is present in the epidermis of the hyponychium, the nail bed's farthest point.fingernails grow 2 to 3 mm every month, while toenails grow 1 mm per month.consequently, replacing a fingernail takes roughly six months, while replacing a toenail takes twelve to eighteen months. The elderly and those with onychomycosis and peripheral vascular disease frequently have slower growth rates [20].

3. CLINICAL PRESENTATION

3.1.Distal and lateral subungual

Fungi enter in the nail through the hyponychium and spread proximally, invading the base of the nail unit plate. One or both great toenails are typically affected by distal and lateral subungual onychomycosis (dlso), which is frequently linked to tinea pedis[21].

Onycholysis causes the plate of nail to become detached, giving it a yellow-white appearance, and distal subungual hyperkeratosis. Rarely, an onycholytic nail darkening that is brown, black, or orange a noticeable periungual irritation is usually linked to onychomycosis caused by non-dermatophytes.

Traumatic onycholysis, which is typically symmetrical and subungual, is one of the differential diagnosis of dlso.Absence of hyperkeratosisand nail psoriasis (diffuse hyperkeratosis, involvement of many or all toenails, and other psoriasis symptoms on the skin and nails).

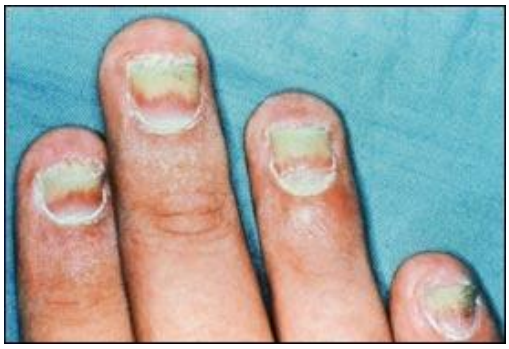

Fig. (4). Distal and lateral subungual

Https://www.aafp.org/pubs/afp/issues/2001/0215/p663.html

3.2. Subungual proximal onychomycosis

The relatively rare subtype of proximal subungual onychomycosis (pso),organisms that enter the nail unit through the proximal nail fold, pierce the cuticle layer, enter the freshly formed nail plate, and then travel distally are the cause of proximal white subungual onychomycosis (pwso).Leukonychia, proximal onycholysis, subungual hyperkeratosis, and proximal nail plate disintegration are among the clinical manifestations. T. Rubrum is the primary cause of pso in the united states.

Beginning from the proximal nail fold on the lunula area and progressing distally, pso develops in a pattern that incorporates all nail layers.[22]. Despite being the most rare form of onychomycosis in the general community, pso is widespread in aids patients and is thought to be an early clinical sign of hiv infection[23].In rare cases, trauma might also lead to infection development.

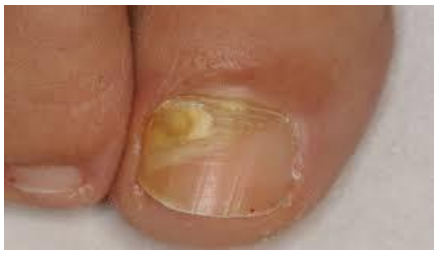

Fig. (5). Subungual proximal onychomycosis
Https://plasticsurgerykey.com/proximal-subungual-onychomycosis/

3.3. White superficial onychomycosis

Colonies of fungi that penetrate the dorsal nail plate are readily scraped away and have an opaque white appearance. Trichophyton interdigitale is responsible for the traditional form, in which dermatophytes proliferate the nail plate's outermost layers without entering it nevertheless, fusarium spp. And other

White superficial onychomycosis (wso) with deep invasion of nail can be caused by molds [24,25]. T. Interdigitale frequently causes athlete's foot (tinea pedis interdigitalis) [21].transverse toenail leukonychia from trauma and fragility of superficial nail from extended use of nail polish are examples of differential diagnosis.

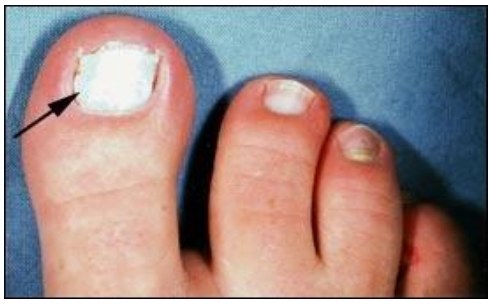

Fig. (6). White superficial onychomycosis
Elewskibe. Onychomycosis: pathogenesis, diagnosis, and management. Clin microbiol rev. 1998;11:415–-29.

3.4.Endonyxonychomycosis

Nail plate fungal infection without nail bed infection is the cause of endonyxonychomycosis [26,27,28]. Trichophyton soundanense and trichophyton violaceumare typically the source of clinical subgroup [26,27,28]. Lamellar splitting, indentations, and nail plate having milky spots are clinical signs of endonyx onychomycosis [26,27,12]. There is no subungual hyperkeratosis and the nail plate is securely affixed to the nail bed [27,29].

3.5. Total dystrophic onychomycosis

End-stage nail disease is directed as total dystrophic onychomycosis, while other medical professionals view it as a separate category. Any one of the four primary onychomycosis patterns could lead to it. The whole nail unit thickens and becomes dystrophic [30].

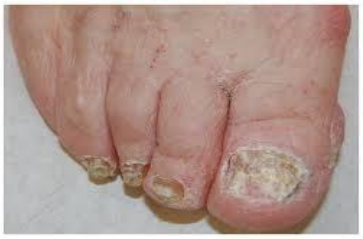

fig. (7). Total dystrophic onychomycosis
Piraccini bm, alessandrini a. Onychomycosis: a review. Journal of fungi. 2015 mar 27;1(1):30-43.

4.CANDIDA ONYCHOMYCOSIS:

It frequently affects fingernails, and half of onychomycosis cases connected to fingernails are caused by candida species. Co is more frequently observed in women, maybe as a result of vaginal candida flora self-inoculating nails. Handling soap and water frequently while doing housework could also be a factor [33]. The following are some possible presentations of co:

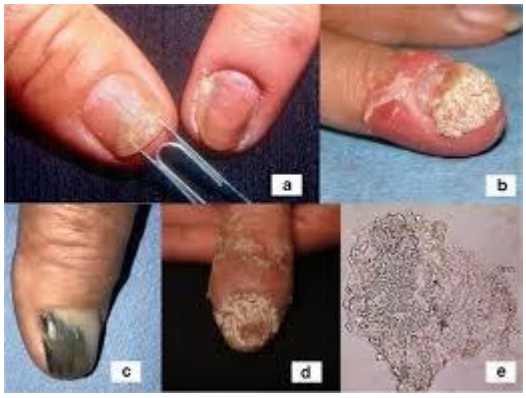

Fig. (8). Candida onychomycosis

Https://www.researchgate.net/figure/acandida-paronychia-and-onycholysis-in-a-diabetic-patient-b-paronychia-by-candida-in-a_fig1_342116797

4.1. Candida paronychia:

Most co cases are secondary invasion of the nail plate via the soft tissues surrounding the nail. The proximal and lateral nail folds are erythematous and swollen painfully. Beau's lines are depressions in the transverse nail plate due to infection of the nail matrix. The final result is a rough, uneven, convex, and finally dystrophic nail[32,33]. In contrast to tdo, there is no subungual hyperkeratosis, and the nail does not split off.

4.2. Candida granuloma:

candida invasion over the entire nail thickness is the hallmark of this unusual presentation, which is typically observed in individuals with cmc [32]. Pseudoclubbing, also known as the chicken drumstick appearance, is a deformity of the digits caused by progressive thickening of the nail and swelling of the proximal and lateral nail folds.

4.3. Candida onycholysis:

this condition causes onycholysis when a yellowish-grey mass associated with distal subungual hyperkeratosis pulls off the plate of nail.

Other complicationOnychomycosis in diabetics

Onychomycosis is 2.5–2.8 times more seen in diabetics, especially men, than general population[72]. These individuals are at risk due to ischemia, sensory neuropathy, poor glycemic management, and compromised host defense[73]. According to dogra et al[72].The most frequent causal agent in this category is yeast, which is followed by dermatophytes and ndm.

Although topical medicines are better, their disadvantages include lengthy treatment times and difficult administration because of concomitant obesity and senior age. It has been demonstrated that topical treatments combined with nail drilling are a beneficial foot care strategy[80]. Itraconazole and terbinafine therapy often do not cause substantial drug interactions that result in hypoglycemia in patients using concurrent hypoglycemic medicines[81]. Because of its shown effectiveness and low risk of medication interactions, terbinafine is the first-line treatment[82]. Despite being regarded as safe and effective, itraconazole is not first-line medication because of drug interactions and black box cardiac warnings[80].

5. TREATMENT

In order to prevent misinterpretation, laboratory confirmation of onychomycosis prior to starting a treatment regimen is economical and should be taken into consideration [26,36,29,37,38,39]. An incorrect diagnosis could lead to needless treatment and put the patient at risk for pharmacological side effects, possible adverse drug interactions withsystemic antifungal drugs, and therapeutic failure. The patient may also be financially burdened [7].Nonetheless, many doctors continue to treatonychomycosis empirically [40]. Due to the deep-seated nature of the fungus within the nail plate, the length of time needed for resolution, low patientcomplianceand frequent recurrences, onychomycosis is infamously difficult to treat [41]. Oral and topical antifungal therapy, laser therapy, photodynamic therapy, and surgical avulsion are available forms of treatment (for example particularly thick fungal nail).

5.1. Oral medications

Itraconazole, ketoconazole, terbinafine, and griseofulvin are the mostly used medication for the onychomycosis treatment which are administered orally. The lengthier treatment duration and increased adverse effects of oral antifungal medications, such as terbinafine (lamisil®), are its drawbacks. This medication is administered every day for eight weeks to treat fungus of finger nail and twelve weeks to treat fungus of toenail. Lamisil®'scommon adverse effects are headache, rash, increased liver enzymes, and gastrointestinal disturbances (diarrhea and/or dyspepsia) [42].

The drug itraconazole (sporanox) is frequently administered in "pulse doses" once a week for two or three months. Various common medications, including the antibiotic erythromycin or various asthma treatments, may interact with it. Skin rash, elevated triglycerides, elevated liver function tests, and gastrointestinal side effects (diarrhea, bloating, and nausea) are the most common sporanox® adverse effects.

For a few months, ketoconazole (diflucan®) may be used once weekly. Most frequent adverse effects are headache, skin rash, and/or gastrointestinal (gi) disturbance (diarrhea, vomiting, nausea, and/or abdominal discomfort).

Griseofulvin is also called as fulvicin®, gifulvin®, or gris-peg®, has long been the cornerstone of oral antifungal treatment. Despite being safe, this medication is not very effective in treating toenail fungus[42].

Monitoring for adverse effects

Liver function tests: keep an eye on the levels of aspartate aminotransferase (ast) and alanine aminotransferase (alt), especially in individuals who have a history of alcohol abuse, hepatitis, or other liver conditions.

Drug interactions: azoles: significant interactions with statins, antiepileptics, and psychiatric drugs; terbinafine: minimal interactions but contraindicated with phenothiazines or pimozide due to qt prolongation risk.

Cost effectiveness

Onychomycosis is systematically treated in europe and canada using griseofulvin, ketoconazole, itraconazole, and terbinafine. Pharmacoeconomic modeling has been used to assess each of these drugs' treatment cost-effectiveness. The assessments were derived from extensive meta-analyses of these drugs' published safety and effectiveness studies.19'20 clinical success rates, relapse rates, and side effect frequency were among the factors taken into account while evaluating clinical outcomes. The expense of purchasing and administering drugs, regular medical care, laboratory testing, and handling adverse responses were all factors considered in economic study. Overall, the most economical agent under investigation was determined to be oral terbinafine [34,35]. Despite the fact that this medication cost the most to get, the short treatment duration and excellent success rates of terbinafine therapy resulted in the lowest predicted cost. It was also discovered that oral terbinafine produced the most days without illness[35].

5.2. Topical route medication

Fungal infection of nails is generally not treated with creams or other external forms of therapy. This is because surface of nails is hard for external treatments to penetrate. Nevertheless, in individuals who have healthy immune systems, a new medicated nail polish has been approved for the treatment of toenail or finger fungus that does not involve the white nail part (lunula).

The nail lacquers that are already on the market, ciclopirox and amorolfine, are good in treating or preventing fungal infections such onychomycosis. 2-n-nonyl-1,3-dioxolane or a comparable penetration enhancer, a water-insoluble film-forming polymer,afungicidally effective amount of ciclopirox, amorolfine, or another antifungal agent in a transparent, stable, film-forming lacquer vehicle, and a volatile solvent make up the nail lacquer.

The application of ciclopirox olamine nail lacquer is done every day, while amorolfine is done once a week [43]. Distal subungual onychomycosis confined to the distal nail of a few digits and white superficial onychomycosis both received treatment with long-term (6–12 months) monotherapy. Additionally, nail lacquers are used for secondaryprevention or as an adjuvant therapy for severe onychomycosis.About half of the instances of distal subungual onychomycosis were resolved with amorolfine nail lacqueralone [44]. In previous studies, tioconazole 28% nail solution was recommended as one of the topical treatments for onychomycosis, despite the lack of current reports[45]. Topical acidified nitrite therapy has recently demonstrated encouraging outcomes [46].

5.3. Laser treatment

Both the patient and the practitioner may find laser treatment for onychomycosis to be an appealing alternative.Althoughoral medicines work well, there may be side effects. Although topical therapies are safer than oral ones, they are less effective and typically take longer to workperiods. Alternatively, the pathogenic fungi on the nail plate can be targeted by lasers, removing the possibility of systemic adverse consequences. A clinician administers laser therapy, which necessitates less patient compliance.

To penetrate the nail and possess a pulse duration interval shorter than the pathogenthermal relaxation time[47]. They would need to be delivered in wavelength range from 750 and 1300 nm.in order to permit heat, lasers also require a spatially homogeneous beam that avoids "hot spots”. Heat buildup in the fungi and dissipation in the tissues [48]. Since the fda has only licensed lasers for the "temporary increase of clear nail," more research on their effectiveness using similar medical outcomes is required[49].

5.4. Surgical treatment

- The removal of the nail either surgically or chemically is one surgical method for treating onychomycosis.
- Using a urea compound, thick nails can be chemically removed. It is usually best to leave this procedure to a dermatologist or surgeon.
- Without further treatment, surgically excising the nail plate is ineffective in treating onychomycosis. This process ought to be regarded as an additional treatment in addition to oral medication.
- Combining topical, oral, and surgical treatments may improve treatment outcomes and lower the price of continuing care[50].

5.5 Photodynamic therapy

The photodynamic treatment procedure consists of three steps:

- The application of a photosensitizer: the afflicted nail ortissues are exposed to a photosensitizing agent, like mal or 5-ala. Healthy tissues absorb very little of the photosensitizer, so when it accumulates within the fungal cells, it guarantees targeted therapy.

- Following photosensitizer absorption, exposure to light with a specific wavelength—typically in the red, blue, or green spectrum—activates it. The wavelength of activation is determined by the photosensitizer used [69].
- When exposed to light, the photosensitizer goes into an excited state, which gives the surrounding oxygen molecules energy. This procedure produces singlet oxygen, hydroxyl radicals, and superoxide anions, among other reactive oxygen species (ros).The proteins, mitochondria, and membranes of fungal cells are oxidatively damaged by these ros., which leads to necrosis or apoptosis. In rare cases, pdt may even break up fungal biofilms, which are infamously tough to cure. This is a crucial factor to take into account since biofilms can form on the nail plate and lead to the recurrence of onychomycosis [70].

Potential advantages:

One of pdt's primary advantages over traditional antifungal therapies is its capacity to target sick areas specifically. Being so precise lowers the risk of negative consequences and minimizes damage to nearby healthy skin and nails. Pdt has extremely low systemic absorption as compared to oral antifungal medications, which significantly lowers the risk of adverse consequences such drug interactions and liver damage. The potential for fungal infections to develop resistance is one issue with traditional antifungal treatments. This drug lowers the chance of this happening by producing reactive oxygen species (ros), which target many pathways [70].

Because pdt is non-invasive, it can be done as an outpatient procedure without requiring systemic medication or general anesthesia; thusis particularly advantageous for those who struggle to react to systemic therapy.When treating chronic onychomycosis, pdt can be used in combination with oral or topical antifungal medications to improve outcomes. Patients who receive pdt often recover and have faster nail regeneration than those who receive systemic medications. Pdt is a useful therapeutic option for managing onychomycosis due to its customized treatment, safety, and accelerated recovery [71].

5.6. Herbal treatments

An alternate therapeutic treatment for onychomycosis that is more accessible, safer, and less costly is herbal antifungal medication. It has been shown that plant-based extracts from native species exhibit antifungal activity, including antifungal effects on yeast, non-dermatophyte molds, and dermatophytes [64]. Due to its ability to cure illnesses and absence of side effects, herbal treatments have been more and more popular in recent years. Researchers found that another effective tactic for treating fungal infections is the use of plant-basedproducts. It has been demonstrated that some plants, including neem, chives, garlic cloves, tulsi, henna, aloe vera, ginger root, and others, have antifungal efficacy against fungal illnesses.these plants include a variety ofbioactive compounds, such as polyphenols, alkaloids, tannic acid, dihydrogeraniol, geranyl alcohol, and thymoquinone[64,65].

5.6.1. Garlic

Garlic, or *allium sativum*, is a species of plant belonging to the allium genus. Originally from central asia, garlic has been grown all over the world for its culinary and therapeutic uses. The bulb, which is composed of individual cloves, is the medicinal part of garlic.one of the many uses for these cloves is as a natural treatment for fungus infectiongamong these potentially dangerous microorganisms are fungi like tinea pedis. Over the years, garlic has proven to be an effective treatment for even the most severe toenail fungus situations. Treating toenail fungus with garlic is easy and painless.

Mechanism of action

Allicin, which is produced when garlic is diced or crushed, is the main antifungalsubstance ingarlic. Garlic cloves produce allicin as a protective mechanism against physical harm; unbroken cloves do not contain it. It is thought that allicin has antifungal propertiesby compromising the fungal cell membranes' integrity. It increases membrane permeability and causes the release of vital cellular

components by interacting with fungal enzyme having group likethiol (sulfhydryl)and proteinselements. Fungal cell death is the ultimate result of this damage, which jeopardizes the structural and functional integrity of the fungal cell. Several in vitro laboratory tests can be used to evaluate the fngicidal effect of garlic and extracts from garlic. Allicin and other bioactive substances are released from garlic cloves through crushing, chopping, or other processing methods.
Example-Water or ethanol are examples of solvents that can be used to prepare extracts.
Fungal cultures are treated to varying amounts of garlic extract in a lab setting. The fungus's growth is tracked for a predetermined amount of time [54]. Inhibition of the growth of fungi, changes in fungal morphology, and determination of the minimum inhibitory concentration (mic) are among the procedures employed to assess antifungal activity. The minimum inhibitory concentration (mic) of garlic extract required to effectively inhibit the growth of fungi.
Allicin, the main ingredient in garlic, has shown antifungal efficacy against a variety of fungus species. This contains dermatophytes that can cause onychomycosis, such as trichophyton rubrum[55].

5.6.2. Oregano oil *(Origanum vulgare)*:

The woody plant oregano is primarily found in the mediterranean region.
Chemical constituents: Current study indicates that oregano oil contains carvacrol, which has potent antiviral, antibacterial, and antifungal qualities. Thymol is found in oregano oil.

Mechanism of action
It is thought that carvacrol damages and killsmicroorganisms, particularly fungus, by rupturing their cell membranes by interacting with lipids. It shown strong antifungal activity against organisms including malassezia furfur and trichophyton spp.[56].to treat toenail fungus, apply oregano oil to theaffected nail twice daily with a cotton swab. Some people utilize oregano oil and tea tree oil together.Bothproducts are potent and may cause irritation or allergic reaction. Combining them may increase this risk.

5.6.3. Cassia alata linn

The candle bush, or *cassia alata*, is a flowering plant indigenous to the tropics of theunitedstates.**Chemical constituents:** Additionally, it can be found in a number of tropical locations worldwide. Candle bush’s different component leaves and stems, are extracted and utilized in variety of medical applications. cAnthraquinones (including chrysophanol and emodin), flavonoids, and tannins are among the phytochemicals found in cassia alata. Flavonoids are the most common compounds isolated from this plant. These substances are what give it its therapeutic qualities.

Mechanism of action
Anthraquinones and other bioactive substances engaged in mechanism of antifungal activities.theyhave the ability to disrupt fungal growth processes and interfere with fungal cell membranes. The antifungal properties of *c.alata* extract have been shown against fusarium sp., chrysosporium sp., scopulariopsis sp., a. Terrus, and t.mentagrophytes[57].

5.6.4. Snakeroot *(ageratina altissima/pichinchensis)* extract

An antifungal compound named snakeroot extract is obtained from sunflower-family plants.snakeroot, is a south american native flowering plant, specifically the Andean region.
Chemical constituents: Alkaloids and flavonoids are some of the various phytochemicals present in ageratinapichinchensis.

Mechanism of action
In vitro cultures of a. Niger, candida albicans, t. Mentagrophytes, and trichophyton rubrum have been found to be susceptible to the action of a hexane extract of its aerial part. Moreover, it has also

been seen that the active component enkephalin is not useful against the commonly occurringdermophytes in tinea unguium and tinea pedis. Therapeutic advantages were found for individuals suffering from mild to severe onychomycosis on their nails through extracts ofa.pichinchensis[58].

5.6. 5. Euphorbia cotinifolia

Euphorbia cotinifolia is a flowering plant belonging to the euphorbiaceae family, also known as the tropical smokebush or mexican shrubby spurge. The plant is native to the tropical and subtropical regions of the americas, particularly mexico and central america. The plant is normally cultivated as an ornamental shrub.

Chemical contituents: The exact phytochemicals present will vary, euphorbia plants are known to contain a wide range of secondarymetabolites, such as phorbol esters, diterpenes, and others. Methanol extracts of leaves and bark of e. Cotinifolia were assayed, and the findings showed antifungal activity against a. Niger, t. Rubrum, and t. Mentagrophytes[59].

5.7. Anti fungal properties of essential oils

Various essential oils have demonstrated therapeutic action against the onychomycosis-causing fungus. These oils can target various pathways in their mode of action. Here, following essential oils are discussed that have potential to treat onychomycosis.

5.7.1.Clove oil:

Eugenia cariophylata, commonly known as clove or syzygiumaromaticum, is a tree belonging to the mirtaceae family native to the maluku islands of eastern indonesia. Cinnamon, oregano, clove, thyme, and mint are some of the aromatic herbs that have been found in various studies to have antibacterial, antiviral, anticancer, and antifungal properties. But out of other spices, clove has received a lot of interest due to its high antibacterial and antioxidant properties[60].

Chemical constituents: primary components are eugenol, eugenyl acetate, and beta caryophyllene. Eugenol is the major constituent typically accounting for 50% more of the oil. Other minor components are alpha humulene and various other terpenes and terpenoids.

Mechanism of action

Generally, oil of cloves has a pale yellowcolor. In accordance with the clinical and laboratory standards institute guidelines, the antifungal activity of the essential oil of cloves and its main component, eugenic acid, against american type culture collection (atcc) strains and candida, aspergillus, and dermatophyte was evaluated by minimal inhibitory and minimum fungicidal concentrations. The eugenol and oil inhibited all the strains that were tested.

Candida albicans germ tubes growth was completely or almost totally inhibited by oil and eugenic acid concentrations below the lowest inhibitory concentration values.

The antifungal and anti-yeast activities of eugenol against mold and yeast species of onychomycosis isolates are valuable [61].

5.7.2.Lemon oil:

Lemon (citrus limon) is a flowering plant within the rutaceae family. Lemon oil, an essential oil, is a volatile oil that is obtained from fresh lemon peelsof lemons.

Chemical constituents: It is a blend of several natural compounds, which comprises alcohols, ketones, aldehydes, monoterpenoid, sesquiterpenes, and esters. Its major constituent, limonene, constitutes 50 to 70 percent of the overall composition of lemon oil [62].Citral (neral and geranial) is a mixture of two isomeric aldehydes that provides lemon oil with its characteristic lemony scent. It possesses antibacterial, antiviral, and antifungal activity[63].

Mechanism of action:
Citralis able to degrade bacterial membranes and suppress the activity of vital enzymes such as atpase and gyrase[70].Afloral-scented terpene alcohol is terpineol. It possesses antibacterial and antioxidant activities. It is able to alter the structure and function of fungal and bacterial cell membranes and inhibit pathogenic organisms from reproducing[64].
Lemon oil also includes the trace constituents γ-terpinene, terpinolene, α-pinene, β-bisabolene, and nerol, which may influence the oil's aroma and therapeutic activity.

5.7.3.Peppermint oil:
Peppermint (*mentha piperita*) is a hybrid mint that combines watermint and spearmint.in the wild, it sometimes coexists with its parent type[65].
Chemical constituents: The active components of peppermint oil include sesquiterpine, dipentene, menthone, apigenol, and peppermint camphor. At least 44% of peppermint oil is free menthol. The primary sources of activity are the abundant peppermint and menthone[66].

Mechanism of action
Peppermint can act against fungi in two possible ways. Structural alterations, such as irregular, attended, empty, and smooth hyphae, as well as particular depressions on the very surface of cells, induced structural alterations, such as formation of pits, an interruption of the chlamydoconidia structure, a retardation of the loss of colour of the fungal growth stage, and plasmolysis[66]. The hyphae of the fungus probably leaked due to their contact with peppermint oil and the plasma membrane of the fungal pathogen [65].

5.7.4.Tea tree oil:
Melaleuca, or tea tree oil, is an essential oil with antifungal, antiviral, anti-inflammatory, anti-cancer, a pain relieving pesticidal, and herbicide effectand antibacterialproperties. The tree is native to australia, where it occurs naturally along the northern new south wales coastline [67]. The oil is referred to as australian tea tree oil since the species only occurs in australia.
Chemical constituents: considering over 100 different constituents of oils, monoterpenoids, sesquiterpenes, and their respective alcohols constitute the majority.The primary active constituent in the intricate chemical composition of oil is 4-carvomenthenol. Its antiviral, anti-inflammatory, and antifungal properties have been emphasized [68].

Mechanism of action
Tea tree oil's constituents, especially terpinen-4-ol and α-terpineol, mediate antibacterial activities by impairing the bacterial membrane's structural and functional integrity. Hydrocarbons can penetrate microorganisms' cell and cytoplasmic membranes and interfere with essential processes, perhaps causing ions like potassium to leak out and inhibiting respiration [78]. Cell lysis can eventually happen as a result of the cell wall weakening, turgor pressure reduction, and cytoplasmic membrane rupture. Loss of 260-nm-absorbing material could be a sign of nucleic acid loss and a compromised cytoplasmic membrane [79]. Cell morphology, glucose-dependent respiration, disturbed potassium homeostasis, and the capacity to reject propidium iodide were all noted in e. Coli**.**
Tea tree oil also acts as a mediator in its antifungal effects in a similar manner, where it influences the permeability of candida albicans and suppresses its respiration in a dose-dependent fashion[84]. Fungal species plasma and mitochondrial membranes are also believed to be negatively impacted by tea tree oil inhibition of glucose-induced medium acidification through inhibition of membrane atpase that is responsible for the extrusion of protons. Tea tree oil also inhibits germ tube formation, or mycelial conversion, in c. Albicans, thus inhibiting cell morphogenesis. Water-soluble fraction of tto, terpinen-4-ol, and α-terpineol, may suppress the lipopolysaccharide-induced production of inflammatory mediators like tnf-α, il-1β and il-10 by human peripheral monocytes by about 50% and that of prostaglandin e2 by about 30% after 40hour. These tea tree oil components can also

inhibit superoxide production by agonist-stimulated monocytes and reduce the generation of reactive oxygen species by stimulated neutrophils and monocytes [78].

5.7.5. Ozonized oil:

This type of ozone exposure at low concentrations for a brief period of time can then inactivate many organisms, including fungi, yeast, and bacteria. Another study found that ozonized sunflower oil was more effective in treating toenail fungus than the prescription topical antifungal, ketoconazole (xolegel). Ozonized oils, like olive oil and sunflower oil, are "injected" with ozone gas.

5.8. Adjuvant treatment

5.8.1.patients should receive foot hygiene counselling to improve treatment outcomes and prevent Recurrence.
5.8.2.patient should advised to keep feet dry throughout the day.
5.8.3. Patient should wear breathable footwear and cotton socks.
5.8.4. Similar infection patterns seen in households and among users of public restrooms point to the Importance of foot protection in high-risk areas.
5.8.5. Identification and management of tinea pedis.
5.8.6. Preserving and enhancing long-term health issues (e.g., managing diabetes, stopping smoking, Etc)[77].

6. CONCLUSION

Onychomycosis's significance is sometimes undervalued. An infected nail is much more than just a superficial aesthetic issue; it is a persistent source of infection that can result in recurrent mycotic infections of the mucous membranes and skin. Candida species have become significant onychomycosis-causing infections due to the rise in immunocompromised individuals and changes in fungal virulence. The prevalent nail condition known as onychomycosis is brought on by dermatophytes, yeasts, and ndms. Multiple digit involvement, moderate to severe instances, and/or topical therapy failure are indications for oral treatment. Future management may be significantly impacted by the emergence of terbinafine-resistant isolates, despite the availability of various antifungal oral medications.We recommend systemic therapy with fluconazole, itraconazole, or terbinafine for dlso extending to the proximal nail, dermatophyte pso, and deeply infiltrating white superficial onychomycosis. Standardization of use before treatment is needed, but further studies on lasers and photodynamic therapy are needed. New drugs are needed to treat this condition, and several studies have reported promising first results with newer antifungal drugs. For these new drugs, additional studies are needed to assess and compare safety profiles, doses, and develop guidelines.

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