Antifungal Herbs in Nail Lacquer for Treatment of Onychomycosis: A Review

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***Abstract*: Nails of mammals are specialized epidermal derivatives which protect the delicate tip of fingers and toes against trauma and act as tools or weapons. Fungal infections of the nails or onychomycosis accounts for about 50% of the nail diseases. Oral antifungal drugs and topical creams and lotions are used for treating fungal nail infections. The disadvantages of oral antifungal agents are toxicity and longer treatment period and topical preparation may get wiped off causing less absorption of drug into nails. Medicated nail lacquers have been developed and are used for the treatment of fungal nail infections i.e. onychomycosis, which has shorter treatment period and less toxicity. Amorolfine and ciclopirox are used as antifungal agents in nail lacquers. Long-term use of antifungal drug has side effects. Many of the herbs used today have been valued for their antimicrobial and antifungal effects. The main objective of the paper is to study the herbs having antifungal properties and that can be used in antifungal nail lacquers as active ingredients for treatment of onychomycosis.**

***Keywords:* Antifungal agents, Herbs, Nail lacquers, Onychomycosis.**

I. Introduction:

Nail is a hard covering of finger tips and toe tips. They are ectodermal appendages covering the dorsal aspects of the digits. It is a horn-like envelope used to protect soft ends of the phalanges or digits. (1) It enhances the capacity for fine digital movements and tactile sensation. This allows humans to use them as precise tools for picking up objects. (2) Human nails consist of many parts: the nail plate, the nail bed, matrix, hyponychium, etc. They are described below: (1)

1) The Nail Plate: The nail plate is a thin, hard, yet slightly elastic, translucent, convex structure and is made up of approximately 25 layers of dead keratinized, flattened cells. It is about 0.25 -0.6mm for fingernails and up to 1.3mm for toenails. (3) The nail plate appears pink because of the underlying capillaries. The upper surface of the nail plate is smooth and shiny and may have variable number of longitudinal ridges that change with age resulting in the loss of nail plate luster with age. (1)

2) The Matrix: It is also called as nail root. It is the thickened part of the nail bed and is composed of 3-20 layers of actively dividing cells o stratum germinativum. New cells are added to the root and by this constant addition nail plate is pushed slowly forward over nail bed about 0.5mm/week. (4)

3) Lunula: It is a whitish, crescent-shaped area. The opacity of lunula is probably caused by considerable thickness of nail matrix. (4)

4) The Nail Bed: Nail bed is formed of several layers of epidermal cells, corresponding to stratum basale and stratum spinosum of epidermis underlying the nail plat. Except the nail matrix, these cells do not participate in the formation of nail plate. (4)

5) Cuticle: The cuticle is also known as eponychium. It is situated between the skin of the finger and the nail plate. It fuses these structures together, providing a waterproof barrier. It forms the seal between the nail and the digit to prevent foreign matter from entering. (5,6)

6) Perionychium: It is the skin that overlies the nail plate on its sides also known as the paronychial edge. The perionychium is an indication of ingrown nails, hangnails and an infection of the skin called paronychia. (5)

7) Hyponychium: It is the area between the nail plate and the fingertip. It is the junction between the free edge of the nail and the skin of the fingertip, providing a waterproof barrier and prevents the penetration of foreign bodies, dirt and invasion of pathogens that cannot digest keratin. It is composed of tough keratin layer that seals the subungual space. (1,5)

The rate of growth and length of nails is related to the length of the terminal phalanges i.e. outermost finger bones. The nail of index finger grows faster than that of the little finger. Fingernails grow faster than toenails up to four times. In humans, nails grow at a rate of 3 mm a month. Toenails require 12 to 18 months and fingernails require three to six months to regrow completely. Actual growth rate is dependent upon season, exercise level, sex, age, diet, etc. Nails grow faster in the summer. (5)

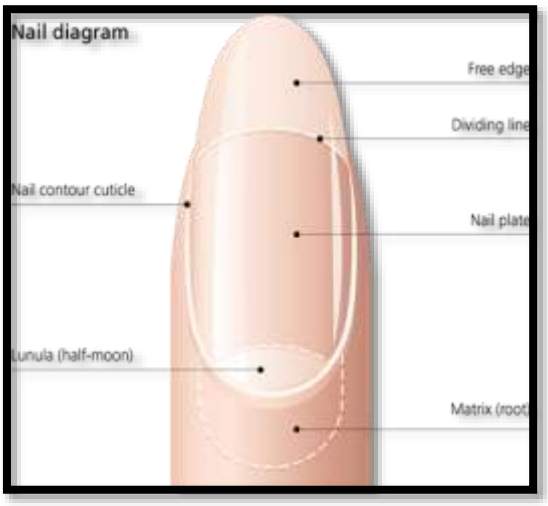

Fig. 1 Human nail

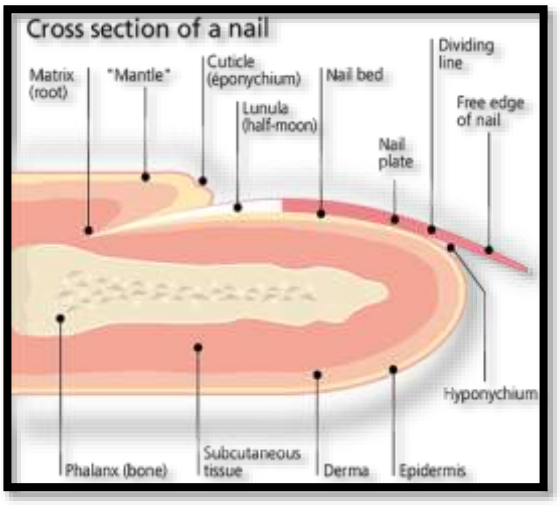

Fig. 2 Cross Section of Nail (7)

II. Functions of Nails:

- Fingernails help to protect fingers. If they weren't there the tips of your fingers would get all scratched up.
- It also helps us the grab hold of things.
- A healthy finger nail has the function of protecting the fingertip, the distal phalanx, and the surrounding soft tissues from injuries.
- It serves to enhance precise delicate movements of the distal digits through counter-pressure exerted on the pulp of the finger.
- The nail then acts as a counterforce when the end of the finger touches an object, thereby enhancing the sensitivity of the fingertip
- The nail functions as a tool, enabling for instance, a so-called "extended precision grip" and helps in picking different objects.
- The most important function of the fingernails consists in enhancing tactile discrimination and fine movements.
- Fingernails are utilized for scratching and grooming and are an efficient natural weapon.
- Toenails protect the distal toes and contribute to pedal biomechanics. The nails also contribute to the aesthetic appearance of the hand and foot. (5, 8)

III. Histology, Ultrastructure and Composition:

The epidermis of the nail bed is similar to that of the skin, but has no stratum lucidum or stratum granulosum and no hair follicles or sweat glands. The nail plate is made up of impacted and adhering layers of flattened and cornified cells i.e. dead onychocytes that have lost their nuclei. The cells contain hard keratin, similar to that of hair, with high sulfur contain mainly on the form of cysteine, which comprises about 9-12 % of the weight of the nail. Nails contains about 7-12% of moisture and 0.15-0.76% of fat, a little more about 1.38% in infants. Calcium Constitute about 0.02-0.04% of the weight and does not contribute to the hardness. The nail bed and matrix have a rich supply of blood from 2 arteries that run lateral along the digit and form oxygen rich capillary bed, which lie below the nail plate. (9)

IV. Rate of Nail Growth:

The rate of fingernail growth arises between 0.5 & 1.2mm per week. Finger nails grow four times faster than toe nails. The 0.1 millimeter/day number is purely an average that is evident in most adults. If a nail is lost, it would take anywhere between 4 and 6 months for it grow completely. Toenails take even more time, around 1 to 1.5 years to grow from cuticle to tip. Also, fingernails of children's grow much faster than they do in adulthood. In fact, it can be as much as 50% faster, which may be why so many children develop that irritating habit of biting their nails if they aren't diligent about clipping their nails. (9,10)

V. Nail Pathologies:

Nails are important to an individual's overall appearance, people spend time cutting, filling and decorating them in order to look presentable. Indeed, individuals with nail dystrophies often suffer from considerable pain and discomfort, can have difficulty in walking and are at risk for significant complications, including bacterial infection and cellulitis. Although, there are variety of disorders that can affect the nails, more than half of all nail dystrophies and are caused by fungal infections i.e. onychomycosis. (11)

There are four distinct types of clinical presentation of onychomycosis:

i. Distal subungual onychomycosis
ii. Superficial white onychomycosis
iii. Proximal subungual onychomycosis
iv. Candida onychomycosis (9)

They are described as follows:

1) Distal subungual onychomycosis: it is the most common form of the fungal invasion of the nail. This occurs when fungus invades the nail bed and undersurface of the nail plate via hyponychium and spreads proximally along the ridges of the nail bed.

(11) Distal and lateral subungual onychomycosis may be confined to one side of the nail or spread sideways to involve the whole of the nail bed, and progresses relentlessly until it reaches the posterior nail fold. Eventually the nail plate becomes friable and may break up, often due to trauma, although nail destruction may be related to invasion of the plate by dermatophytes that have keratolytic properties. (5) A thickened nail and a large amount of debris under the nail may cause discomfort when wearing shoes. (12) Figure 3 given below represents distal subungual onychomycosis.

Features of DLSO are as follows:

- Subungual hyperkeratosis and onycholysis is usually yellow-white in color
- Yellow streaks and/or yellow onycholytic areas in the central portion of the nail plate

2) Superficial white onychomycosis: The second most common type of fungal nail infection accounting about 10% of onychomycosis. It affects the top layer of the nail by forming white spots on the surface of the nail. Eventually the entire nail surface becomes covered with a crumbly and chalky powder. (12) It occurs when fungus localizes superficially on thee dorsal nail plate and form colonies seen as opaque scaly plaques with distinct edges that are scraped away easily. The nail becomes rough, soft and crumbly. (11, 13) Figure 4 given below represents superficial white onychomycosis.

Features of WSO are as follows:

- Confined to the toenails
- Small, white, speckled or powdery patches on the surface of the nail plate
- The nail becomes roughened and crumbles easily
- Molds produce a deep variety of WSO characterized by a larger and deeper invasion of nail plate. (5)

3) Proximal subungual onychomycosis: In proximal subungual onychomycosis the fungal element invades the deeper, ventral aspect of the nail plate from proximal portion of the nail and migrates distally, causing a band or a patch of leukonychia that moves distally the with nail growth. It is relatively uncommon subtype that can suggest the possibility of HIV infection or other types of immunosuppression. It can also occur secondarily to paronychia i.e. infection and inflammation of nail folds. (11) Figure 5 given below represents proximal subungual onychomysis.

Features of PSO are as follows:

- It is an area of leukonychia in proximal nail plate that moves distally with nail growth
- In PSO caused by molds, leukonychia is associated with marked periungual inflammation.

4) Candida onychomycosis: Patients with chronic mucocutaneous candidiasis have more chances of developing candidal infection of the nails. Candida species invade the nails previously damaged by infection or trauma. Candidal paronychia commonly affects the hands and usually occurs in persons who frequently immerse their hands in water. Swelling of the posterior nail fold occurs secondary to chronic immersion in water or due to allergic reactions to some foods items, and the cuticle becomes detached from the nail plate. Yeasts and bacteria, enters the subcuticular space causing swelling of the posterior nail fold. Figure 6 given below represents candida onychomycosis.

Features of candidal onychomycosis are as follows:

- Affects several or all digits
- The digits often take on a bulbous or drumstick appearance
- In more severe cases gross thickening of the nails occurs, which amounts to a Candida granuloma.
- Secondary candida onychomycosis occurs due to other diseases of the nail, mostly psoriasis
- The nails typically are discolored white or yellow and deformed. (5, 11)

5) Total dystrophic onychomycosis: In total dystrophic onychomycosis, the nail is opaque, thickened, and yellow-brown and/or greenish-brown to black. The entire plate and matrix are affected. Total dystrophic onychomycosis may be end result of any of the four main forms of onychomycosis. This condition is characterized by the total destruction of the nail plate. It is the end stage of the disease. (14) Figure 7 given below represents total dystrophic onychomycosis.

Fig. 3 Distal subungual onychomycosis (15)

Fig. 4 Superficial white onychomycosis (16)

Fig. 5 Proximal onychomycosis (17)

Fig. 6 Candida onychomycosis (18)

Fig. 7 Total dystrophic onychomycosis (17)

VI. Causes of Fungal Infections:

Toenails are 10 times more commonly infected as compared to fingernails. About 60 to 80% of cases are caused by dermatophytes (eg, Trichophytonrubrum); dermatophyte infection of the nails is called tineaunguium. Many of the remaining cases are caused by nondermatophyte molds (eg, Aspergillus, Scopulariopsis, Fusarium).Immunocompromised patients and those with chronic mucocutaneous candidiasis may have candida onychomycosis (which is more common on the fingers).(5) Both are seen most often in the elderly, those with impaired immune systems, and in people with diabetes and poor peripheral circulation. Warm and moist environment helps fungi to grow and cause infection. Wearing occlusive footwear or using shower stalls, locker rooms or bathrooms can increase the risk of fungal infections. (19)

VII. Symptoms of Nail Infections:

At the start, there are usually no symptoms. The nails may become so thick that they hurt when pressed on the inside of a shoe. They then become hard to trim. The appearance of an infected nail, particularly a fingernail, may cause embarrassment. The skin nearby may also have a fungal infection; it may itch, crack, form a blister or appear white, especially between the toes. When fungi infect a nail, they usually start at its free edge spreading down the side of the nail towards the base of the cuticle. Eventually the whole nail may be involved. The infected areas turn white or yellowish, and become thickened and crumbly. There may be white areas on the surface of the nail. The nails most commonly affected by fungal infections are on the big and little toes. Sometimes, especially in those who carry out regular wet work such as housewives or cleaners, the skin around the fingernail becomes red and swollen. This is called paronychia, and can allow infection. (19)

VIII. Prevention:

Fungal nail infections can be prevented by the following methods-

- Avoiding injury to nails, which may increase the risk of developing a nail infection.
- Wearing footwear such as flip-flops in public places, such as communal bathing/shower places, locker rooms, etc.
- Avoid towel sharing.
- Replacing old footwear, as it might be contaminated with fungal spores.

IX. Treatment:

Various oral and topical therapies have been used in the past to treat onychomycosis.

1) Oral: Antifungal tablets will often clear a fungal nail infection. The medication helps to clear any associated fungal skin infection, such as athlete's foot. The active ingredients commonly used for treatment are -

- Terbinafine- The usual adult dose is 250 mg once a day; for between 6 weeks and 3 months for fingernails, and for 3–6 months for toenails.
- Itraconazole - 200 mg twice a day for one week, with subsequent courses repeated after a further 21 days. (5)

Griseofluvin- 1000 mg/day orally in 2 to 4 divided doses. (21)

- Ketoconazole- daily doses of 200 mg for 7-8 months. (22)

Unfortunately, the effectiveness of the systemic treatment is low and varies from 40 to 68-80%. In particular, the efficiency of treatment decreases with age due to a slow metabolism and microcirculation in the nail bed.

The adverse effects of systemic antifungal are problematic. Side effects commonly include nausea and headaches and, although rarely, can include liver failure, heart problems, which can (and have) caused death. Also, systemic antifungal drugs interact with other medications patients might be using and such interactions could also cause very severe adverse effects. (20)

2) Topical: Creams, lotions and gels are used for treating fungal infections of nails. The preparation is rubbed into infected nails after soaking. Rubbing helps the medication get through the hard nail surface to the underlying fungus. Topical preparations contain urea as antifungal agent.

3) Device based treatment: Device based treatment are rapidly expanding area for treatment of onychomycosis. Various devices can be used to enhance the delivery of drug, helps to activate the topical drugs applied o by killing the fungi photo thermally. It includes laser treatment and iontophoresis. (23)

X. Approaches for transungual Drug Delivery:

Physical, chemical and mechanical methods have been used to decrease the nail barrier and improve efficiency of drug. Within each of these broad categories, many techniques exist which are used to enhance penetration. Mechanical modes of penetration enhancement are typically straightforward, and have the most in vivo experience associated with them. Many of the chemical and physical methods used are still in the in vitro stages of development. They are described below. (24)

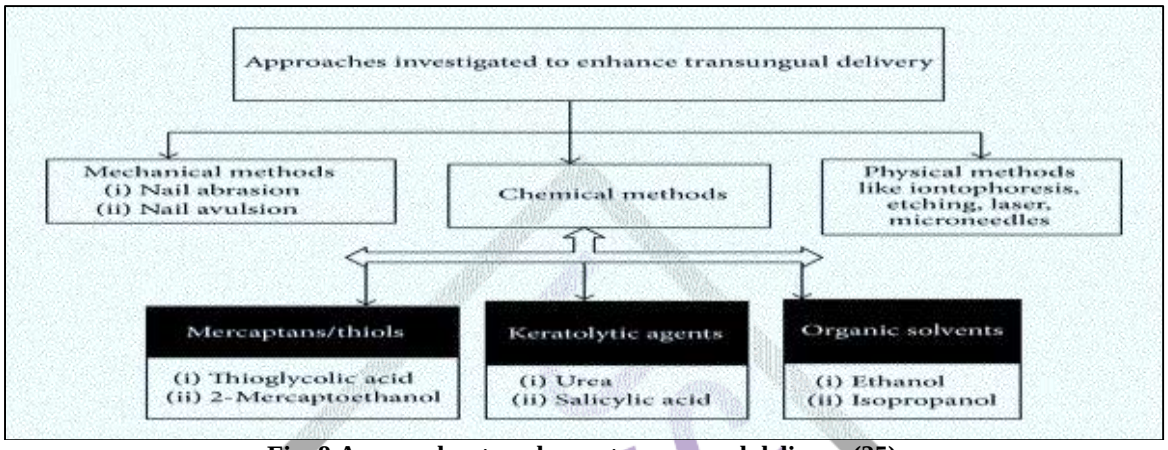

Fig. 8 Approaches to enhance transungual delivery (25)

1) Mechanical Methods: Mechanical methods such as nail abrasion and nail avulsion have been used by dermatologists and podiatrists for many years for treating onychomycosis. Additionally, these methods are invasive and potentially painful. (24)

a. Nail Abrasion: Nail abrasion involves sanding of the nail plate to reduce thickness or destroy it completely. Sandpaper number 150 or 180 can be utilized, depending on required intensity for treatment. Sanding must be done on the edges of the nail and should not cause discomfort. Additionally, dentist's drills have also been used to make small holes in the nail plate, enhancing topical medication penetration. Nail abrasion thins the nail plate, decreasing the fungal mass of onychomycosis, and exposing the infected nail bed. In doing so, it may enhance the action of antifungal nail lacquer. The procedure may be repeated for optimal efficacy. (24)

b. Nail avulsion: Total nail avulsion involves surgical removal of the entire nail plate or partial removal of the affected nail plate, and under local anesthesia. Keratolytic agents such as urea and salicylic acid helps to soften the nail plate for avulsion. Urea or a combination of urea and salicylic acid has been used for nonsurgical avulsion (chemical avulsion) in clinical studies, prior to topical treatment of Onychomycosis. (24)

2) Chemical Methods: In this method various chemicals are used and they help to enhance the penetration of the drugs in the nail plate. Chemically, drug penetration into the nail plate can be assisted by breaking the chemical and physical bonds responsible for the stability of nail keratin. This would help to destabilize the keratin, compromises and adjusts the integrity of the nail barrier and allow penetration of drug molecules in the nails. Wang and Sun (1998), identified the peptide, disulphide, hydrogen and polar bonds in keratin that could potentially be targeted by chemical enhancers for treating onychomycosis. (26)

a. Keratolytic agents: Keratolytic agents like papain, urea, and salicylic acid used in enhancing the penetration of few antifungals like ketoconazole, miconazole, and itraconazole. (25)

b. keratinolytic enzymes: keratinolytic enzymes may hydrolyze nail keratins, thereby weakening the nail barrier and enhancing transungual drug permeation. Keratinase act on the intercellular matrix that holds the cells of the plate of nail together and the dorsal nail corneocytes by damaging their surface. (26)

3) Physical methods: Physical methods are superior to chemical and mechanical methods and help to enhance the penetration of hydrophilic and macromolecular compounds. (26)

a. Iontophoresis: Iontophoresis involves delivery of a compound across a membrane of nails using an electric field. iontophoresis enhances drug diffusion through the hydrated keratin of a nail. The effects of electric current on nails are reversible and hence nail plates will return to normal after iontophoresis treatment. (26)

b. Etching: Etching" results from surface-modifying chemical e.g. phosphoric acid exposure to nails result in formation of profuse microporosities. These microporosities increases the wettability and surface area, and decrease contact angle; they provide an ideal surface for bonding material. Interpenetration and bonding of a polymeric delivery system and facilitation of interdiffusion of a therapeutic agent used is improved by microporosities. Once a nail plate has been "etched," hydrophilic, a sustained-release, polymer film drug delivery system may be applied. (24)

c. Microneedles: Microneedles based drug delivery include the use of arrays of microscopic size needles open the pores present in stratum corneum. Further, also possess the benefit of being so short that they stimulate the pain fibers. (25)

XI. Antifungal Nail Polish:

Nail polish is a coloured suspension in volatile solvents containing viscosity modifying agents applied to human fingernails and toenails for decorating and protecting the nails. It is also called as nail enamel, nail paint and nail varnish. It contains many ingredients and a vast array of colors. (27) when antifungal agents are added in the nail polish it is called as antifungal nail polish.

It has following advantages:

- The topical formulations conventionally used in dermatology i.e. creams, lotions, powders, gels, oils, etc. are not specifically adapted to the nail since they are readily removed by rubbing, wiping, and washing but the film of nail lacquer remains in contact with the nail for longer period of time.
- The drugs which are available in the market are too expensive and some people cannot afford to buy them. Hence, it is necessary to find an alternative method for the treatment of fungal infections.

Herbs having antifungal activity can be used in the preparation of nail polish so that the product will not be having any side effects.

XII. Mechanism of drug penetration through nail lacquers:

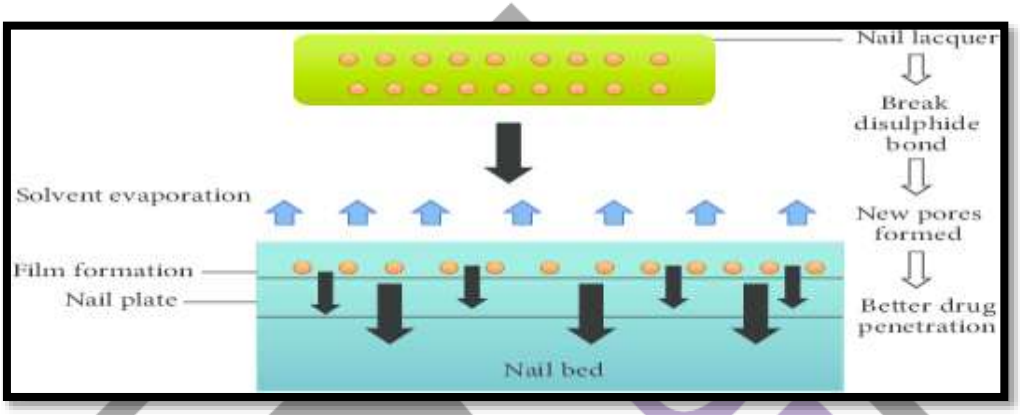

Fig. 9 Mechanism of drug penetration through nail lacquers (25)

Nail lacquers containing drug are fairly new formulations and have been termed transungual delivery systems for treatment of nail infections. These formulations are essentially made of organic solutions of a film-forming polymer and contain the drug to be delivered. When they are applied to the nail plate, the solvent evaporates and leaves a polymer film containing drug onto the nail plate. The drug is then slowly released from the film and penetrates into the nail plate and the nail bed. The drug concentration in the film is much higher than concentration in the original nail lacquer as the solvent evaporates and a film is formed on the nail plate. In addition, lacquers containing drug must be colorless and non-glossy to be acceptable to male patients. (26)

XIII. Herbs with Antifungal Activity:

1) *Mimosa pudica* :

Kingdom	Plantae
Division	Magnoliophyta
Class	Mangnoliopsida
Order	Fabales
Family	Fabaceae/Mimosaceae
Sub – family	Mimosoideae
Genus	*Mimosa*
Species	*Pudica*

Table. 1 Scientific Classification (28)

Fig. 10 Leaves of *Mimosa pudica* (28)

- Synonym: Laajvanti, Touch me not, and Chhui-mui (29)
- Parts Used: Leaves, barks, flowers, fruits and roots. Leaves and roots Provide more antifungal activity.
- Chemical Constituents: leaves of *Mimosa pudica* contains alkaloid known as ‘mimosine’. Roots of *Mimosa pudica* contains tannins, mimosine, calcium oxalate crystals and ash.
- Method of Extraction: Maceration for 24 hours using ethanol, water or methanol.

- Quantity Required for Antifungal Activity: 40mg/ml. (30)

2) *Lawsonia inermis*:

Kingdom	Plantae
Subkingdom	Viridaeplantae
Division	Tracheophyta
Subdivision	Spermatophytina
Class	Magnoliopsida
Order	Myrtales
Family	Lythraceae
Genus	Lawsonia
Species	Inermis

Table. 2. Scientific Classification (31)

Fig. 11 Lawsonia inermis (31)

- Synonym: *Lawsonia alba* Lam., Henna, Samphire, Cypress shrub, Mendhi.
- Parts Used: Leaves, bark, seeds, flowers, roots.
- Chemical Constituents: Leaves contain napthoquinone luteolins, apigenin, and their glycosides, esculetin, fraxetin, scopletin, β-sitosterol, tannin, gallic acid, glucose, mannitol, fat, resin and mucilage. Barks contains napthoquinone, isoplumbagin, triterpenoids-Hennadiol. Seeds contain Linoleic acid, Arachidic acid, Stearic acid, Palmitic acid. (31)
- Method of Extraction: Maceration of Powdered leaves with ethanol or soxhelation of powdered leaves with petroleum ether.
- Concentration Required for Antifungal Activity: At the concentration of 10 mg/ml (32)

3) *Allium sativum*:

Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Equisetopsida
Subclass	Magnoliidae
Superorder	Lilianae
Order	Asparagales
Family	Amaryllidaceae
Genus	Allium

Table. 3 Scientific Classification (33)

Fig. 12 Garlic (34)

- Synonym: Allium sativum L., Lasuna, Garlic.
- Parts Used: Cloves and Bulb, leaves, Flowers. Fruits and seeds. (33)
- Chemical Constituents: It contains sulphur compounds alliin, allicin, ajoene, diallyl trisulfide, sallylcysteine, vinyldithiines, allylpropyl disulfide, S-allylmercaptocystein and others. Enzymes such as allinase, peroxidases, myrosinase and others. Amino acids and their glycosides such as arginine. (35)
- Method of Extraction: Steam distillation or hydrodistillation by Clevenger apparatus.
- Concentration for Antifungal Activity: 20mg/ml (36)

4) *Zingiber officinale*:

Domain	Eukarya
Kingdom	Plantae
Phylum	Magnoliophyta
Class	Liliopsida
Order	Zingiberales
Family	Zingiberaceae
Genus	Zingiber Mill.
Species	Zingiber officinale

Table. 4 Scientific Classification (37)

Fig. 13. Ginger Rhizomes (38)

- Synonym: Zingiber, zingiberis, Ginger, Sunthi (39)
- Parts Used: Leaves, rhizomes and flowers (40)
- Chemical Constituents: Rhizome of ginger contains essential oil upto 4%, phenolic compounds, flavonoids, carbohydrates, proteins, alkaloids, glycosides, saponins, steroids, terpenoids and tannin. (39,41)
- Method of Extraction: Maceration with ethanol, methanol, water or acetone for 3 days. (42)
- Concentration for Antifungal Activity: 0.5gm/ml (42)

5) *Withania somnifera*:

Kingdom	Plantae
Subkingdom	Tracheobionta
Super division	Spermatophyta
Division	Angiosperma
Class	Dicotyledons
Order	Tubiflorae
Family	Solanaceae
Genus	Withania
Species	somnifera

Table.5. Scientific Classification (43)

Fig. 14 *Withania somnifera* (44)

- Synonym: Ashwagandha, Winter Cherry, asgandh (43)
- Parts Used: Leaves, fruits, stem and roots (45,46,47)
- Chemical Constituents: The biologically active chemical constituents are alkaloids ashwagandhine, cuscohygrine, anahygrine, tropine. Steroidal compounds, withaferin A. Other constituents include saponins. The plant also contains constituents like withaniol, acylsteryl glucosides, starch, reducing sugar, hantreacotane, ducitol. A variety of amino acids including aspartic acid, proline, tyrosine, alanine, glycine, glutamic acid, cystine, tryptophan, and high amount of iron. (43)
- Method of Extraction: Extraction with alcohol, di-ethylether, ethyl acetate, hexane, distilled water using a Soxhlet apparatus or maceration. (46,47)
- Concentration for Antifungal Activity: 4% (47)

6) *Curcuma longa* :

Kingdom	Plantae
Subkingdom	Tracheobionts
Super division	Spermatophyta
Division	Mangoliophyta
Order	Zingiberales
Family	Zingiberaceae
Genus	Curcuma
Species	Longa
Scientific name	*Curcuma longa*

Table. 6 . Scientific Classification (48)

Fig. 15 *Curcuma longa* rhizome (49)

- Synonym: Curcum, Haridra, Haldi, Turmeric, Indian Saffron (50)
- Parts Used: Rhizomes, leaves. (51)
- Chemical Constituents: Turmeric comprises volatile as well as nonvolatile compounds. It contains fat, protein, carbohydrates, minerals and moisture. Essential oil of turmeric rhizomes possesses sabinene, borneol, a-phellandrene, cineol, sesquiterpines, zingiberene and curcumin. Volatile compounds are turmerone, zingiberene, curlone and arturmerone. The nonvolatile components include the curcuminoids. (48)
-
- Method of Extraction: Maceration and Sonication with Ethanol. Extraction of oil by Distillation. (51)
- Concentration Required for Antifungal Activity: 7.8mg/ml (52)

7) ***Anacardium occidentale :***

Kingdom	Plantae
Subkingdom	Tracheobionta
Superdivision	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Sapindales
Family	Anacardiaceae
Genus	*Anacardium* L.
Species	Anacardium occidentale L.

Fig. 16 Cashew Tree

- Synonym: Cashew, The cashew nut, Cassavium pomiferum, Agnikrita, Kaju.
- Parts used: Fruits, leaves, bark, seeds. (55,56)
- Chemical Constituents: Leaves of cashew nut contains Vitamin A & C, protein, fat, carbohydrate, calcium, phosphorus, iron and water. Cashew nuts contain tannins, cardol and anacardic acid. Immature nut oil contains triglycerides, fatty acids, alkyl-substituted phenols and cholesterol. The seed contain allergenic phenolic resin, anacardic acid. The kernel contains 8-16% moisture, 18-24% protein, 43-57% fats, and 19-21% carbohydrates. The stem bark contains a mixture of tannins. The apple of cashew contains flavanoids. (57)
- Method for Extraction: Hot Percolation method with different solvents such as alcohol, ethyl acetate, acetone for seeds of cashew. (56) Maceration of leaves with alcohol, acetone or water. (58)
- Concentration for Antifungal Activity: 10-50 mg/ml (56)

8) ***Olea europaea:***

Kingdom	Plantae
Clade	Angiosperms
Clade	Eudicots
Clade	Asterids
Order	Lamiales
Family	Oleaceae
Genus	*Olea*
Species	*O. europaea*

Table. 8 Scientific Classification (59)

Fig no.17 Olive (59)

- Synonym: Oleum Olivae (39)
- Parts Used: Leaves, fruits, seeds, barks, Wood. (60)
- Chemical Constituents *O. europaea* contains flavonoids, flavone glycosides, flavanones, iridoids, iridane glycosides, secoiridoids, secoiridoid glycosides, triterpenes, biophenols, benzoic acid derivatives, xylitol, sterols, isochromans, sugars, and a few other types of secondary metabolites from its different parts. Phenolic compounds, flavonoids, secoiridoids, and secoiridoid glycosides are present in almost all the parts of *O. europaea*. (60)
- Method for Extraction: Fresh olive leaves are extracted using various solvents such as water, ethanol, acetone, ethyl acetate in Soxhlet apparatus. (61)
- Concentration for Antifungal Activity: 10-48mg/ml (61)

9) *Lavandula angustifolia*:

Kingdom	Plantae
Clade	Angiosperms
Clade	Eudicots
Clade	Asterids
Order	Lamiales
Family	Lamiaceae
Subfamily	Nepetoideae
Tribe	Ocimeae
Genus	*Lavandula L.*

Table.9 Scientific Classification (62)

Fig. 18 *Lavandula angustifolia* (62)

- Synonym: Comman lavendor. (39)
- Parts Used: Flowers, leaves, stem, bark. (39,63)
- Chemical Constituents: The oil of lavender contains esters, linalyl acetate, linalool, pinene, geraniol and cineol.. Leaves, stem and bark contains coumarins, tannins, flavonoids, volatile oil and fatty acids. (39,63)
- Method of Extraction: Steam distillation method is used for extraction of oil. Leaf and stem are extracted with hexane and alcohol using soxhlet apparatus. (39,63)
- Concentration Required for Antifungal Activity: 1-3mg/ml (64)

10) *Azadirachta indica*:

Kingdom	Plantae
Division	Magnoliophyta
Class	Magnoliopsida
Order	Sapindales
Family	Meliaceae
Genus	Azadirachta
Species	A.indica
Scientific Name	Azadirachta indica

Table.10 Scientific Classification (65)

Fig. 19 Neem Tree (65)

- Synonym: Margosa, Nimba. (39, 65)
- Parts Used: Leaves, Barks, Seeds, Flowers, Fruits and roots. (39)

- Chemical Constituents: Neem leaves contains several active ingredients such as desactylimbin, quercetin and sitosterol, triterpenes or the limonoids such as meliantriol, azadirachtin, desactylimpin, quercetin, sitosterol, nimbin, nimbinin, nimbidin, nimbosterol and margisine, different bitter substances such as alkaloids, phenols, resins, glycosides, terpenes and gums. (39, 66)
- Method of Extraction: Maceration and sonication with water, Alcohol or ethyl acetate. (66)
- Quantity Required for Antifungal Activity: 125mcg/ml (67)

XIV. Conclusion:

Nail lacquers give life and beauty to the nails. Using them can be tempting, especially if one is currently frustrated over an attractive nail problem like nail fungal infections. It is the easiest way to fix the fungal infection problems of nails. There are special nail lacquers that are used for treatments for onychomycosis. But the marketed products contain drugs which possess side effects on prolonged use. Also, the nail paints available are expensive. The aim of the article is to suggest the importance of antifungal herbs that can be used in the treatment of fungal nail infections without any side effects.

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