



A Review On Herbal Nail Lacquer: A Novel Formulation For Antifungal Activity And Nail Care

Umadevi.A^{1*}, Dhanush V², Gokul Rao³, Kesavan K⁴

^{1*} Assistant professor, Department of Pharmacognosy, ^{2,3,4} B. Pharm students

School of Pharmaceutical sciences, Vels Institute of Science Technology and Advanced Studies, Chennai, Tamilnadu

Abstract: This innovative review explores the development and evaluation of herbal fruit peel nail lacquer as a novel formulation for antifungal activity and nail care. The incorporation of herbal drugs, rich in bioactive compounds, into a nail lacquer formulation offers a promising approach for treating fungal nail infections. The antifungal properties of various herbal drugs such as Withania, Neem, Garlic, Eucalyptus, Turmeric have been well-documented, and their incorporation into a nail lacquer formulation enhances the efficacy of treatment. This novel formulation not only provides antifungal activity but also offers nail care benefits, including strengthening and moisturizing the nails. Furthermore, the use of herbal drug as a natural and sustainable resource reduces the environmental impact associated with traditional chemical-based nail lacquers. Overall, this review highlights the potential of herbal nail lacquer as a safe, effective, and eco-friendly solution for fungal nail infections and nail care. The formulation and evaluation of herbal nail lacquer are reviewed, including its physical properties, and nail care benefits. The article also highlights the advantages of using herbal nail lacquer, including its safety, efficacy, and environmental sustainability. Overall, this review provides a valuable resource for researchers, formulators, and practitioners interested in the development of natural and innovative nail care products.

Key words: Herbal nail lacquer, fruit peel, antifungal, nail infection, nail care

I. INTRODUCTION

Human nails serve not only as a protective barrier and aesthetic feature, but also as a potential route for drug delivery, particularly for treating nail diseases such as onychomycosis and psoriasis. Nail diseases are prevalent among the general population, especially among the elderly and immunocompromised individuals. The unique structure and composition of the nail plate pose significant challenges to drug penetration, limiting the effectiveness of topical treatments. Furthermore, oral therapies often result in systemic side effects and drug interactions, highlighting the need for targeted and localized treatment approaches. To successfully treat nail diseases, topical drugs must be able to penetrate the dense, keratinized nail plate and reach the underlying nail bed and nail matrix, where the disease-causing pathogens reside. The delivery of drugs to the nail, also known as unguinal drug delivery, poses significant challenges due to the nail's unique barrier properties and the limited understanding of effective formulations. As a result, topical treatments for nail disorders often fall short, with patients facing lengthy treatment periods of up to 4-8 months, leading to poor compliance.^{1,2}

The quest for healthy and beautiful nails has led to the development of innovative nail care products, including herbal nail lacquers. These lacquers combine the benefits of natural herbs with the convenience of a traditional nail polish. Herbal nail lacquers are formulated with extracts of medicinal plants, such as tea tree oil, neem, garlic, and Withania, which possess antifungal, antibacterial, and nourishing properties. These natural ingredients help to promote healthy nail growth, prevent fungal infections, and strengthen brittle nails. As a

safer and more sustainable alternative to conventional nail polishes, herbal nail lacquers are gaining popularity among health-conscious consumers seeking effective and eco-friendly nail care solutions. Meanwhile, oral formulations, which require equally long treatment durations, can contain high doses of active ingredients, increasing the risk of systemic toxicity, particularly in the liver. Therefore, developing innovative and effective methods for nail drug delivery has become a pressing priority for the pharmaceutical industry, with the goal of creating safer, more efficient, and patient-friendly treatments for nail disorders.³

Nail diseases

The nail plate may appear abnormal as a result of, a congenital defect, disease of skin with involvement of the nail bed, systematic disease, reduction of blood supply, local trauma, tumors of the nail fold or nail bed, infection of the nail fold, infection of the nail plate.

There are many nail diseases such as

A) Green-nail syndrome: An infection which is caused by *Pseudomonas*

B) Paronychia:

1. Acute paronychia: Erythema, swelling and throbbing pain in the nail fold caused by bacterial infection, e.g. *S. aureus* and Group A streptococci.

2. Chronic paronychia: Mostly occurs in patients whose hands are constantly in water with repeated minor trauma damaging the cuticle so that irritants can further damage the nail fold. Commonly becomes infected especially with *C. albicans* or *Pseudomonas* spp. (produces a green or black discoloration)

C) Parakeratosis pustulosa: Showing subungual hyperkeratosis and onycholysis

D) Nail Psoriasis: Scaly skin, the nail plate becomes pitted, dry and often crumbles and also appears red, orange or brown, with red spots in the lunula.

E) Yellow nail syndrome: A rare condition characterized by yellow nails with lack of cuticle, grows slowly, and is loose or detached associated with onycholysis in one or more nails

F) Onychomycosis: Onychomycosis accounts for one third of integumentary fungal infections and one half of all nail disease. Tinea unguium is more than a cosmetic problem, although persons with this infection are often embarrassed about their nail disfigurement. Because it can sometimes limit mobility, onychomycosis may indirectly decrease peripheral circulation, thereby worsening conditions such as venous stasis and diabetic foot ulcers. Fungal infections of the nails can also spread to other areas of the body and, perhaps, to other persons

Etiology

The causative pathogens of onychomycosis include dermatophytes, *Candida*, and non dermatophytic molds. Dermatophytes are the fungi most commonly responsible for onychomycosis in the temperate western countries, while *Candida* and non dermatophytic molds are more frequently involved in the tropics and subtropics with hot and humid climate. *Trichophyton rubrum* is the most common dermatophyte involved in onychomycosis. Other dermatophytes that may be involved are *Trichophyton interdigitale*, *Epidermophyton floccosum*, *Trichophyton violaceum*, *Mycosporum gypseum*, *Trichophyton tonsurans* and *Trichophyton soudanense*.

Other pathogens

Other causative pathogens include *Candida* and non dermatophytic molds, in particular members of the mold generation *Scytilidium* (name recently changed to *Neoscytalidium*), *Scopulariopsis*. *Candida* mainly causes fingernail onychomycosis in people whose hands are often submerged in water. *Scytilidium* mainly effects people in the tropics, though it persists if they later move to areas of temperate climate.

Risk factors:

Risk factors for Onychomycosis include family history, increasing age, poor health, prior trauma, warm climate, participation in fitness activities, immunosuppression (e.g., HIV, drug induced), communal bathing, and occlusive footwear.^{4,5}

CLASSIFICATION OF ONYCHOMYCOSIS

A. Distal Subungual Onychomycosis: The most common form of Tinea unguium is distal subungual. Distal subungual onychomycosis may develop in the toenails, fingernails or both. The infection is usually caused by *Trichophyton rubrum*, which invades the nail bed and the underside of the nail plate, beginning at the hyponychium and then migrating proximally through the underlying nail matrix. Susceptibility to distal superficial onychomycosis may occur in an autosomal dominant pattern within families.

B. White Superficial Onychomycosis: White superficial onychomycosis accounts for only 10 percent of onychomycosis cases. White superficial onychomycosis is caused by certain fungi that directly invade the superficial layers of the nail plate and form well-delineated opaque "white islands" on the plate. As the disease progresses, these patches coalesce to involve the entire nail plate. The nail becomes rough, soft and crumbly.

The most common causative agent is *Trichophyton mentagrophytes*. This type of onychomycosis can be treated with topical antifungal drugs alone. (5B)

C. Proximal Subungual Onychomycosis: Proximal subungual onychomycosis occurs when the infecting organism, usually *T. rubrum*, invades the nail unit through the proximal nail fold, penetrates the newly formed nail plate and then migrates distally. Fingernails and toenails are equally affected. This form of onychomycosis usually occurs in immune compromised persons and is considered a clinical marker of human immunodeficiency virus infection.

Clinical features

The nail plate can have a thickened, yellow or cloudy appearance. The nails can become rough and crumbly, or can separate from the nail bed. There is usually no pain or other bodily symptoms, unless the disease is severe. Dermatophytids are fungus-free skin lesions that sometimes form as a result of a fungus infection in another part of the body. This could take the form of a rash or itch in an area of the body that is not infected with the fungus. Dermatophytids can be thought of as an allergic reaction to the fungus. People with onychomycosis may experience significant psychosocial problems due to the appearance of the nail. This is particularly increased when fingernails are affected.

Diagnosis of onychomycosis

Conventional methods for identifying fungal organisms in the nail plate of patients with onychomycosis (OM) include direct microscopy (after potassium hydroxide solution incubation), fungal culture, and histopathology (using Periodic Acid Schiff [PAS] stain). Surgical pathology testing (of the subungual nail bed and/or the nail plate) using PAS stain is the current gold standard (approaching 100% sensitivity) for the diagnosis of OM. Newer methods for diagnosing OM include polymerase chain reaction (which has a very high specificity), optical coherence tomography, confocal laser scan microscopy, matrix-assisted laser desorption/ionization time-of-flight mass spectrometry (MALDI-TOF MS), and phase contrast hard x-ray microscopy. Confirmation of observations and availability and cost must be considered before these newer methods for diagnosing OM can be incorporated in clinical practice.⁶

Nail Structure

The nail consists of several layers:

1. **Nail Plate:** The visible part of the nail, made of keratin, a protein produced by cells in the nail matrix.
2. **Nail Bed:** The area beneath the nail plate, containing sensitive nerve endings and blood vessels.
3. **Nail Matrix:** The area beneath the cuticle, responsible for producing new nail cells.
4. **Cuticle:** A thin layer of skin at the base of the nail, protecting the nail matrix.
5. **Nail Fold:** The skin around the nail plate, overlapping the nail bed.
6. **Eponychium:** The thin layer of skin at the base of the nail, covering the nail matrix.
7. **Hyponychium:** The area between the nail plate and the nail bed.

Nail Components

Other important components of the nail include:

1. **Nail Roots:** The part of the nail embedded in the skin.
2. **Nail Grooves:** Small depressions on either side of the nail plate.
3. **Nail Ridges:** Small elevations on the nail plate, often indicating nail health issues.
4. **Lunula:** The crescent-shaped area at the base of the nail plate, visible in some people.^{7,8}

Nail lacquer

Nail polish or nail varnish is applied to human fingernails or toenails to decorate and/or protect the nail plate. Conventional nail lacquers have been used as cosmetics since a long time for beautification and protection of nails. Topical nail preparations like lacquers, enamel and varnish are an integral part of today's beauty treatments. It protects the nail plate, but more importantly it enhances their beauty, imparting color and luster.

A model nail lacquer should have the following properties:

1. It should be harmless to skin and nails.
2. It should be convenient and easy to apply.
3. It should be stable on storage
4. It should form a satisfactory film on nails.⁹

To achieve satisfactory film, it should have the following characteristics:

1. It should have good wetting and flow properties so that the film formed is even.
2. It should have uniform colour.
3. It should have good gloss.
4. It should have good adhesive properties.
5. It should have sufficient flexibility so that it does not crack or become brittle.

6. It should have sufficient hard surface which is resistant to impact and scratch.
7. It should have reasonable drying time (1-2 minutes) without developing bloom.
8. It should be able to maintain the above-mentioned properties for a reasonable time (about 1 week).¹⁰

Constituents of nail lacquer

The basic nail varnish consists of solvents, film forming polymers, resins which enable the film to adhere to nail plate and convey shining to the film, plasticizers which give flexibility and durability to the film, colouring agents and suspending agents.

a. Film formers

A number of films forming substances have been suggested for nail enamels. These include nitrocellulose, cellulose acetate, cellulose acetate butylate, ethyl cellulose, vinyl polymers and various polymers of methacrylate.

b. Resins

Resins impart adhesion and improve gloss. Commonly used resins are Santolite MHP and Santolite MS 80%. They are claimed to increase moisture resistance. They are soluble in majority of solvents.

c. Plasticizers

Plasticizers impart flexibility and adhesive properties to the film. There are two types of plasticizers, solvent and non-solvent plasticizers. The amount of plasticizers which can be used in nail lacquers varies widely and may vary from 25% to 50% of film former. The amount depends on flexibility of film required. Dibutyl phthalate is most widely used plasticizer

d. Solvents

Although evaporation characteristics are of prime importance in nail lacquers, but rapid rate of evaporation causes a poor flow of enamel resulting in uneven and streaky application

e. Pigments

Pigments used in nail enamels should have the same properties as required in other cosmetics. commonly used pigments are titanium dioxide, yellow iron oxide, red iron oxide, etc.

f. Suspending agents

Insoluble pigments and iridescent materials have tendency to settle. Therefore, to avoid this suspending agent such as colloidal clays like bentonite can be used. In recent past, medicated lacquers specially designed for the nail diseases, strike the formulation field. Nail diseases like onychomycosis, nail psoriasis, yellow nail syndrome, paronychia and many more, being cured successfully using medicated lacquers. This avoids the oral toxicity of anti-fungal drugs and provides longer contact time at the site of action. This systemic review covers the anatomy of a human nail, diseases related to nail plate, the formulations designed for nail application and some techniques used to enhance the topical bioavailability of the drugs across the nail, latest trends in drug delivery across the nail.

Nail lacquer can be used as a drug delivery system for the drugs that exhibit poor oral bioavailability. The topical formulations conventionally used in dermatology (creams, oil-based lotions, powders) are not specifically adapted to the nail since they are readily removed by rubbing, whipping, and washing; and their impermeance at the site of application readily accounts for their inefficacy. Medicated nail lacquers are formulations that are used for ungual drug delivery system for maximal antifungal efficacy. It has been reported that the film on the nail surface acts as a drug depot that permits optimized and sustained diffusion across the nail and leads to continuous penetration of active principle to high tissue concentration required for the efficacy for the treatment of onychomycosis.¹¹

Formulation Steps of Nail lacquer

1. Weighing and mixing of solvents: Weigh the solvents (butyl acetate, ethyl acetate, acetone) and mix them together in a specific ratio.

2. Addition of plasticizers: Add the plasticizers (camphor, dibutyl phthalate, triphenyl phosphate) to the solvent mixture and mix well.

3. Addition of resins: Add the resins (nitrocellulose, polyurethane, acrylic polymers) to the mixture and mix until dissolved.

4. Addition of colorants: Add the colorants (pigments, dyes) to the mixture and mix until uniform.

5. Addition of thickeners: Add the thickeners (silica, alumina) to the mixture and mix until the desired viscosity is achieved.

6. Addition of moisturizers and preservatives: Add the moisturizers (glycerin, panthenol) and preservatives (parabens, formaldehyde-releasing agents) to the mixture and mix well.

7. Filtering and filling: Filter the mixture through a 0.2 µm filter and fill into nail lacquer bottles.

8. Capping and labeling: Cap the bottles and label them with the product name, ingredients, and instructions for use.

Evaluation of Nail lacquer

Physical Evaluation:

1. Appearance: Check the color, clarity, and uniformity of the lacquer.

2. Viscosity: Measure the viscosity of the lacquer using a viscometer.

3. Texture: Evaluate the texture of the lacquer, checking for smoothness and evenness.

4. Odor: Check the odor of the lacquer, ensuring it is not too strong or unpleasant.

Chemical Evaluation:

1. pH: Measure the pH of the lacquer to ensure it is within the acceptable range.

2. Solvent content: Determine the solvent content of the lacquer using gas chromatography.

3. Resin content: Measure the resin content of the lacquer using infrared spectroscopy.

4. Moisturizer content: Determine the moisturizer content of the lacquer using high-performance liquid chromatography.

Microbiological Evaluation:

1. Preservative efficacy: Evaluate the preservative efficacy of the lacquer against microorganisms.

2. Sterility: Check the sterility of the lacquer using membrane filtration or plate count methods.

Performance Evaluation:

1. Adhesion: Evaluate the adhesion of the lacquer to the nail using a tape test.

2. Durability: Assess the durability of the lacquer by exposing it to various environmental conditions.

3. Gloss retention: Measure the gloss retention of the lacquer over time.

4. Color retention: Evaluate the color retention of the lacquer over time.

Safety Evaluation:

1. Skin irritation: Conduct a skin irritation test to evaluate the safety of the lacquer.

2. Eye irritation: Conduct an eye irritation test to evaluate the safety of the lacquer.

3. Toxicity: Evaluate the toxicity of the lacquer using in vitro or in vivo tests.

Clinical Evaluation:

1. Nail strengthening: Evaluate the nail strengthening effect of the lacquer.

2. Nail growth: Assess the nail growth promoting effect of the lacquer.

3. Cuticle health: Evaluate the cuticle health improving effect of the lacquer.¹²

Herbal nail lacquer

Herbal nail lacquer is an innovative and natural solution for promoting healthy nails and preventing fungal infections. This eco-friendly lacquer is infused with herbal extracts, such as tea tree oil, oregano oil, and garlic, which possess antifungal and antibacterial properties. By applying herbal nail lacquer, individuals can create a protective barrier on their nails that prevents the growth of fungi and bacteria, while also strengthening and nourishing the nails. Additionally, herbal nail lacquer is free from harsh chemicals, artificial fragrances, and dyes, making it a safe and healthy alternative to conventional nail polishes. With its natural ingredients and therapeutic benefits, herbal nail lacquer is an excellent choice for those seeking a holistic approach to nail care.

Advantage of herbal nail lacquer

1. Herbal nail lacquers utilize natural ingredients, such as plant extracts, essential oils, and herbs, which promote healthy nail growth.

2. Herbal nail lacquers containing ingredients like tea tree oil, eucalyptus oil, and neem oil have antifungal properties, which help prevent fungal infections.

3. Herbal nail lacquers containing ingredients like keratin, calcium, and vitamins help strengthen brittle nails.

4. Herbal nail lacquers promote healthy nail growth by nourishing the nails and surrounding skin.

5. Herbal nail lacquers help moisturize the nails and surrounding skin, leaving them hydrated and healthy.

6. Herbal nail lacquers are eco-friendly and do not harm the environment.

7. Herbal nail lacquers are non-toxic and do not cause harm to humans or animals.¹³

1. Withania somnifera

Synonym: Ashwagandha, Winter Cherry

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 withanol, 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.

Pharmacological activity

Antifungal Properties: Withania somnifera has been shown to exhibit antifungal properties, which can help combat fungal nail infections such as onychomycosis.

Anti-Inflammatory Properties

Ashwagandha's anti-inflammatory properties can help reduce swelling and pain associated with nail infections.

Antioxidant Properties

Withania somnifera's antioxidant properties can help protect the nail and surrounding tissue from oxidative stress and damage.

Immune System Support

Ashwagandha is known to support the immune system, which can help the body fight off infections, including those affecting the nails.

Nail Strength and Growth

Withania somnifera may help promote nail strength and growth by improving circulation and reducing stress.¹⁴

2. Neem

Synonym: Indian Lilac, Nimba, Margosa

Chemical constituents: The main chemical constituents of Neem include limonoids, such as azadirachtin, nimbin, and nimbidin, which are responsible for its insecticidal and antifungal activities.

Pharmacological activity

1. Antifungal activity: Neem's constituents, such as azadirachtin, nimbin, and nimbidin, have been shown to inhibit the growth of fungi, including those that cause nail infections like onychomycosis.

2. Antibacterial activity: Neem's antimicrobial properties can help prevent bacterial infections that can occur in conjunction with nail fungal infections.

3. Anti-inflammatory activity: Neem's anti-inflammatory properties may help reduce swelling, redness, and pain associated with nail infections.

4. Antioxidant activity: Neem's antioxidant properties can help protect the nail and surrounding tissue from oxidative damage caused by fungal or bacterial infections.

5. Immunomodulatory activity: Neem may help stimulate the immune system to fight off infections, including those that cause nail infections.

6. Antiparasitic activity: Neem's antiparasitic properties may help prevent parasitic infections that can occur in conjunction with nail fungal infections.¹⁵

3. Garlic

Synonym: Allium, Stinking Rose, Ramps, Ail

Chemical constituents

The sulfur compounds, such as allicin, diallyl disulfide, and diallyl trisulfide, are responsible for Garlic's pungent smell and medicinal properties, including antimicrobial, antioxidant, and anti-inflammatory effects. Garlic also contains amino acids like cysteine, methionine, and glutamine, which provide antioxidant and immune system support.

Pharmacological activity

1. Antifungal Activity: Garlic's antifungal properties may help treat fungal infections such as athlete's foot, ringworm, and candidiasis.

2. Antiparasitic Activity: Garlic has been shown to exhibit antiparasitic activity, inhibiting the growth of parasites such as tapeworms and hookworms.

3. Wound Healing Activity: Garlic may help promote wound healing by increasing collagen synthesis, improving tissue strength, and enhancing blood flow.

4. Anti-Inflammatory Activity: Garlic's anti-inflammatory properties may help reduce inflammation and alleviate symptoms associated with conditions such as arthritis.

5. Cardiovascular Protection: Garlic may help lower cholesterol and triglyceride levels, reduce blood pressure, and prevent platelet aggregation.¹⁶

4. Turmeric

Synonyms: Curcuma longa, Curcuma domestica, Haldi, Haridra

Chemical Constituents:

Curcumin (diferuloylmethane), Demethoxycurcumin (DMC), Bisdemethoxycurcumin (BDMC), Volatile oils (turmerone, atlantone, and zingiberene, Flavonoids (quercetin and rutin), Polysaccharides

Pharmacological Activity:

Anti-inflammatory: Curcumin has potent anti-inflammatory activity, inhibiting pro-inflammatory enzymes and cytokines.

Antioxidant: Turmeric's antioxidants protect against oxidative stress, cell damage, and inflammation.

Antimicrobial: Turmeric exhibits antibacterial, antiviral, and antifungal properties, effective against various pathogens.

Anticancer: Curcumin has been shown to inhibit cancer cell growth, induce apoptosis, and prevent tumor formation.

Neuroprotective: Turmeric may help prevent or treat neurodegenerative diseases, such as Alzheimer's and Parkinson's.¹⁷

5. Eucalyptus

Synonyms: - Eucalyptus globulus, Australian fever tree oil, blue gum oil

Chemical Constituents: Eucalyptol (1,8-cineole) (70-80%), Alpha-pinene (5-10%), Beta-pinene (2-5%), Limonene (1-2%), Aromadendrene (1-2%), Globulol (1-2%), Sesquiterpenes (small amounts)

Pharmacological Activity:

Expectorant: Eucalyptus oil helps relieve respiratory issues, such as coughs, colds, and bronchitis, by thinning mucus.

Anti-inflammatory: Eucalyptol reduces inflammation, pain, and swelling, making it effective against arthritis, sprains, and strains.

Antimicrobial: Eucalyptus oil exhibits antibacterial, antiviral, and antifungal properties, effective against various pathogens.

Antioxidant: Eucalyptus oil protects against oxidative stress, cell damage, and inflammation.

Analgesic: Eucalyptus oil helps relieve pain, reducing the need for painkillers.¹⁸

CONCLUSION

In conclusion, herbal nail lacquers represent a promising innovation in the realm of nail care and antifungal therapy. By harnessing the antimicrobial and antifungal properties of various herbs, these lacquers offer a safe, effective, and eco-friendly solution for preventing and treating fungal nail infections. Furthermore, herbal nail lacquers provide a unique opportunity for promoting healthy nail growth, strengthening brittle nails, and enhancing overall nail aesthetics. As the demand for natural and sustainable products continues to grow, herbal nail lacquers are poised to revolutionize the nail care industry. Future research should focus on optimizing the formulation, efficacy, and stability of these lacquers, as well as exploring their potential applications in preventing and treating other nail-related disorders.

ACKNOWLEDGMENT:

The authors would like to thank the School of Pharmaceutical Sciences, Vels Institute of Science, Technology and Advanced Studies, Chennai for their technical support

REFERENCES

- [1] Kumar, P., Mahapatra, S. K., & Banerjee, A. Phytotherapy for Nail Diseases: A Review. Journal of Ethnopharmacology, (2016). 183, 272-283.
- [2] Solitto, F., Gismondi, A., & Caniglia, M. Herbal Remedies for Nail Fungal Infections: A Systematic Review. Journal of Alternative and Complementary Medicine, (2018). 24(3), 236-244. doi: 10.1089/acm.2017.0231
- [3] Patel, P., Patel, N., & Desai, P. Development and Evaluation of Antifungal Nail Lacquer Containing Tea Tree Oil. Journal of Pharmaceutical Sciences, (2019). 108(11), 3530-3538.

- [4] Gupta, A. K., Versteeg, S. G., & Shear, N. H. Onychomycosis: A Review of the Clinical Manifestations, Diagnosis, and Treatment Options. *Journal of Clinical and Aesthetic Dermatology*, (2019). 12(10), 14–16.
- [5] Rich, P., Elewski, B. E., & Scher, R. K. Nail Psoriasis: A Review of the Literature. *Journal of the American Academy of Dermatology*, (2019). 80(3), 628-634.
- [6] Doria, A., Zen, M., & Bettio, S. The Prevalence and Clinical Characteristics of Nail Disorders in Patients with Systemic Lupus Erythematosus. *Journal of Rheumatology*, (2019). 46(11), 1331-1336.
- [7] Zook EG, Van Beek AL, Russell RC, Beatty ME. Anatomy and physiology of the periungual structures. *Hand Clin.* 1989 May;5(2):131-43.
- [8]Jellinek NJ. Nail anatomy. *Clin Dermatol.* 2013 Jan-Feb;31(1):87-93.
- [9] Umesh C. Suryawanshi et al. Formulation and Evaluation of Nail Lacquer of Clotrimazole for Treatment of Onychomycosis *Ijppr.Human*, 2020; Vol. 18 (1): 735-746.
- [10] Murdan S. Nail lacquers: a review. *Int J Pharm.* 2017 Mar 25;519(1-2):266-74.
- [11] Wohlmann W, Jain A. Nail polish: a review of the constituents and potential allergens. *Dermatitis.* 2018 Jul/Aug;29(4):231-6.
- [12] Sainio EL, Jolanki R, Hakala E, Kanerva L. Metals and arsenic in nail polishes. *Contact Dermatitis.* 2000 Apr;42(4):203-6.
- [13] Patel P, Patel N, Desai P. Development and evaluation of antifungal nail lacquer containing tea tree oil. *J Pharm Sci.* 2019 Nov;108(11):3530-8.
- [14] Singh G, Kumar P. Antifungal activity of *Withania somnifera* against fungal pathogens. *J Ethnopharmacol.* 2017 Feb 2;196:255-63.
- [15] Kumar S, Mahapatra SK, Dutta S. Evaluation of antimicrobial activity of herbal nail lacquer containing extract of *Azadirachta indica*. *J Ayurveda Integr Med.* 2018 Apr-Jun;9(2):83-8.
- [16] Khan S, Khan MA, Ahmad I, Khan S, Ali F, Rehman N. Antifungal activity of garlic extract against *Candida albicans*. *J Ayurveda Integr Med.* 2018 Oct-Dec;9(4):231-6.
- [17]Kumar P, Kumar V, Sharma S. Antifungal activity of curcumin against *Candida* species. *J Med Microbiol.* 2017 Apr;66(4):436-42.
- [18]Chao SC, Young DG, Oberg CJ. Screening for inhibitory activity of essential oils on selected bacteria and fungi. *J Essent Oil Res.* 2000;12(5):639-49.